Abstract Book
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Tuesday LT1

A case study of assessing exposure misclassification of greenspace for pregnant women based on residential mobility during pregnancy

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Abstract

Background/Aims

Despite the advance in exposure assessment for birth outcomes using geographic information, there exists uncertainty about exposure during pregnancy. Exposure assessment largely relies on residential address at delivery, not accounting for residential mobility. We examined the extent to which assigning exposure during pregnancy based on residence at birth, rather than accounting for residential mobility, leads to exposure misclassification for greenness. We further investigated if maternal characteristics were associated with exposure misclassification.

Methods

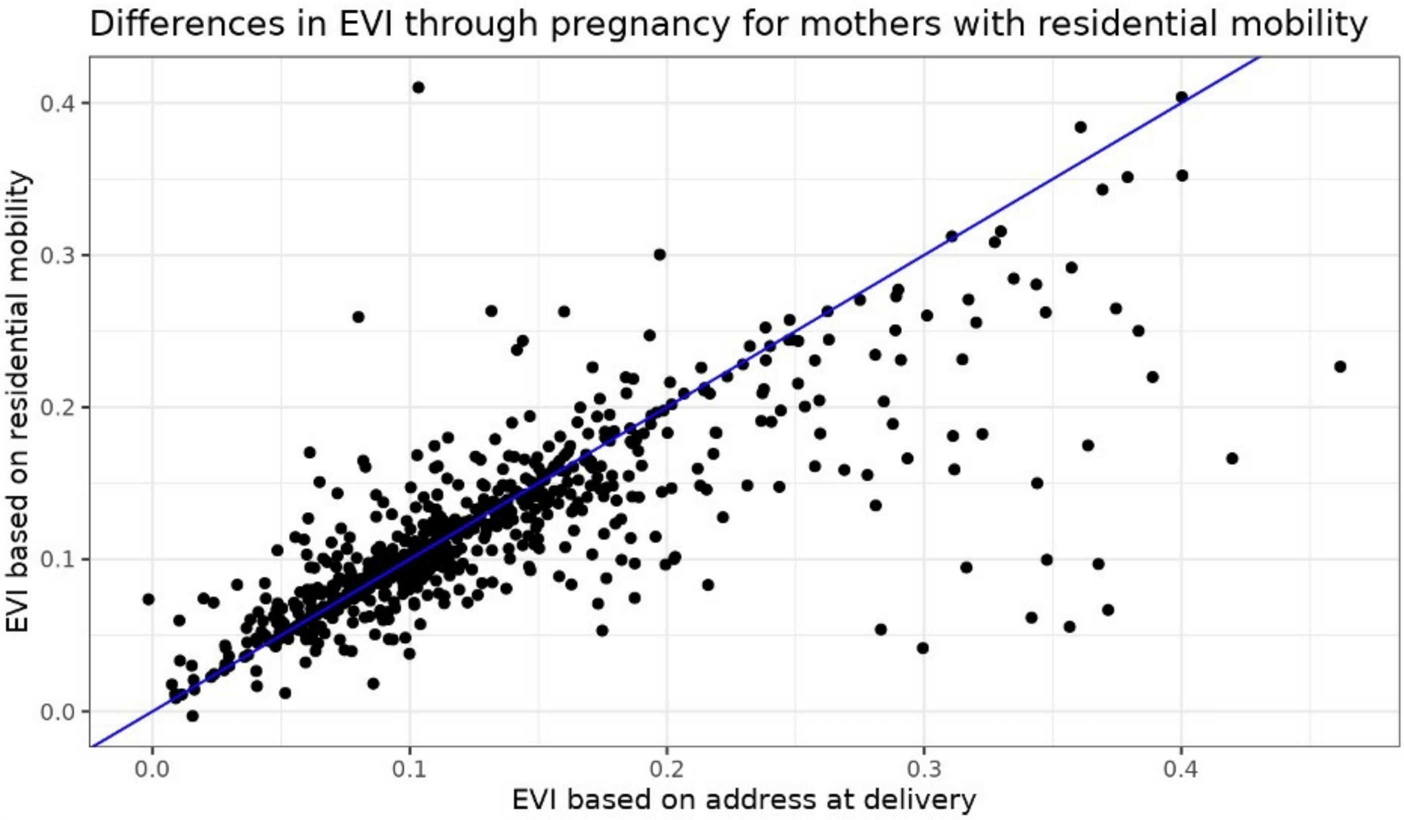
We used data from pregnant women recruited in NYU CHES cohort in New York City Metropolitan Area (2016-2019, N=1899). Using all residential addresses recorded for pregnant women, we grouped participants into 'movers' and 'non-movers' during pregnancy. Statistical analysis was applied to participants' characteristics (e.g., alcohol/smoking in pregnancy, marital status, race/ethnicity, education, income, insurance type, employment status, age) to examine factors associated with move. Average levels of Enhanced Vegetation Index (EVI), an index of vegetation density levels, during pregnancy were compared between two exposure assessments: (1) averaging EVIs based on residential addresses at birth, thereby ignoring residential mobility; (2) averaging EVIs using all addresses during pregnancy, thereby accounting for residential mobility.

Results

Twenty-four percent of women (N=449) moved during pregnancy and 82.2% of the movers moved during the 1st-2nd trimesters. Most movers moved less than 5 km. Mothers with a history of alcohol use in pregnancy, those with high education and income, and those with Hispanic partners were more likely to move. EVI was overestimated when using only the address at birth (average difference=0.002, maximum difference=0.307). The overestimation was more pronounced for mothers with higher education and private insurance.

Conclusion

Our findings indicate that measurement error for exposure to greenspace can occur when residential mobility is ignored and is disproportional by individual-level characteristics. Epidemiological studies should consider residential mobility in exposure assessments based on geolocation.



Differences in EVI through pregnancy for mothers with residential mobility
EVI based on residential mobility
EVI based on address at delivery
0.0
0.1
0.2
0.3
0.4

Tuesday LT1

Do local air pollutant concentrations modify or mediate the relationship between residential greenspace and childhood asthma exacerbation? A longitudinal investigation in Philadelphia, Pennsylvania.

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Abstract

Background/Aims. Greenspace near children’s homes may protect against respiratory symptoms. However, few studies have examined whether the effects differ or are explained by local air pollutant concentrations.

Methods. We evaluated effect modification and mediation effects by air pollutant concentrations in the relationship between residential greenspace and pediatric asthma exacerbations within a cohort of asthma patients from the Children’s Hospital of Philadelphia (2011-2016). Children (ages <18) were followed from their first clinical visit with an asthma diagnosis until their first asthma exacerbation. We evaluated whether air pollutant levels modified the effects of greenspace in a buffer distance around children’s homes and whether air pollutant concentrations mediated the impacts of greenspace in the census tracts where children lived. Daily air pollution data (average PM2.5 (µg/m3), eight-hour maximum ozone (ppb), maximum NO2 (ppb), and maximum SO2 (ppb)) were from US EPA. We used Cox proportional hazard models to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for each greenspace measure with asthma exacerbation incidence, adjusting for individual and neighborhood covariates.

Results. Effect modification analyses showed that the highest quartile of tree canopy coverage (within 1000 m of children’s homes) was associated with 11% lower asthma exacerbation incidence on days with high NO2 concentration (HR=0.89, 95% CI=0.77, 1.02; p<0.01), but with 17% higher asthma exacerbation incidence on low NO2 concentration days (HR=1.17, 95% CI=1.01, 1.35). There was no modification of estimated tree canopy effects by PM2.5 or ozone. Likewise, we did not observe evidence of mediation by daily air pollutant concentrations.

Conclusion. Observed effect modifications suggest that additional vegetation in urban areas with high air pollution may protect childhood respiratory health. However, we did not find mediation of the greenspace effect by air pollutants as a mechanistic pathway for the suggested benefit in our study population.

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Modification of the relationship between residential greenness and mortality: a systematic review and meta-analysis

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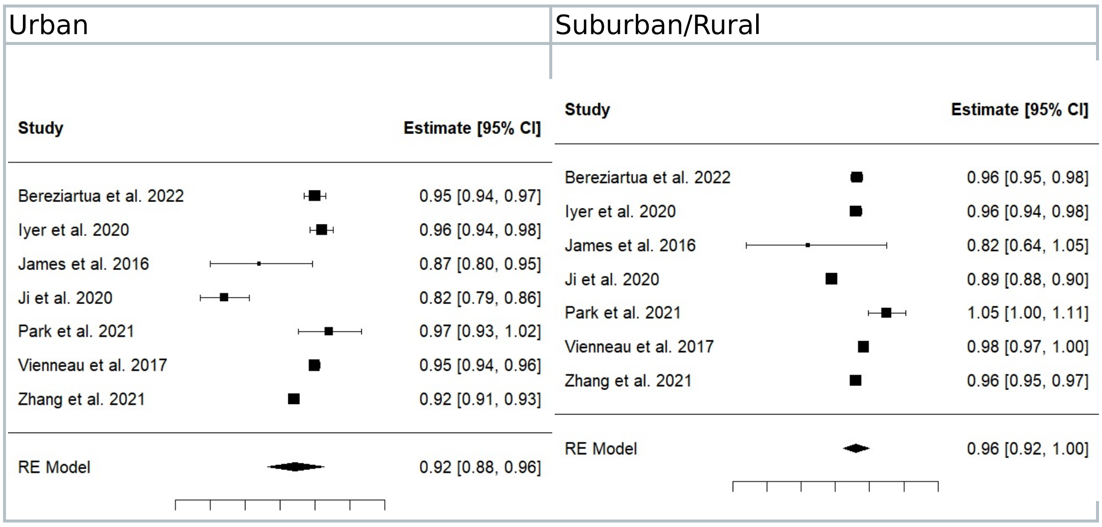
Abstract

Background/Aims. The ‘greenness’ of residential neighborhoods (measured by the normalized difference vegetation index (NDVI)) has been associated with lower mortality in multiple studies. Although the relationship is rather consistent, studies have also reported that the magnitude of the association varied by population and neighborhood characteristics. Our objective was to summarize modification of the greenness-mortality relationship.

Methods. We conducted a systematic literature review and meta-analysis of peer-reviewed published studies of the association between residential greenness (NDVI within 500 m) and mortality (all-cause or all natural causes) stratified by age (≤65, >65 years), gender (men, women), socioeconomic status (SES, highest vs. lower), education (highest vs. lower), or urbanicity (urban vs. suburban/rural). We estimated the relative risk (RR) and 95% confidence interval (CI) for the linear exposure-response relationship within each stratum of a potential modifier variable, across studies, using random effects meta-analysis.

Results. The relationship between greenness (per 0.1-unit) and mortality was stronger in younger (10 studies, meta-relative risk [mRR]=0.95, 95% CI: 0.93-0.97) than older persons (10 studies, mRR=0.98, 95% CI: 0.96-0.99). We found no substantial difference in the association between men (7 studies, mRR=0.94, 95% CI: 0.92-0.97) and women (7 studies, mRR=0.95, 95% CI: 0.92-0.98). An association of higher greenness with lower mortality was stronger for individuals with the highest SES in the studies (6 studies, mRR=0.91, 95% CI: 0.86-0.95) than for those with lower SES (6 studies, mRR=0.94, 95% CI: 0.91-0.98), and a similar difference was found for education (4 studies). Inferred protection from higher greenness was notably stronger in urban areas (7 studies, mRR=0.92, 95% CI: 0.88-0.96) than suburban/rural (7 studies, mRR=0.96, 95% CI: 0.92-1.00).

Conclusion. Our review provides robust evidence that the potential benefits of greenness in protecting against mortality differ substantially by the characteristics of populations and neighborhoods.



Tuesday LT1

EVALUATING STATISTICAL METHODS TO PREDICT INDOOR BLACK CARBON IN AN URBAN BIRTH COHORT

Sherry WeMott[1], Sheena Martenies[2], Grace Kuiper[1], Matt Koslovsky[1], William Allshouse[3], Anne Starling[3], John Adgate[3], Dana Dabelea[3], Sheryl Magzamen[1]
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Abstract

Background. Though individuals in the United States spend a majority of their time indoors, epidemiologic studies often use only ambient air pollution data for exposure assessment. In addition, fine particulate matter (PM2.5), often used to estimate exposure to ambient air pollution, is composed of many chemical constituents, including black carbon (BC). Recent research has shown that PM2.5 from combustion sources, such as BC, may be more harmful than PM from other sources. To better understand total air pollution exposure, we utilized indoor and outdoor air quality data along with household characteristic survey data from the Healthy Start (HS) urban birth cohort in study in Denver, Colorado to evaluate the relationship between indoor and outdoor black carbon.

Methods. A total of 29 residences were selected from the cohort to complete survey and host one indoor and one outdoor sampler over a period of 5 days throughout three campaigns (spring, summer and winter, 2018-2019). Wilcoxon rank-sum tests were used to evaluate seasonal differences in indoor and outdoor BC concentrations. Ridge, Lasso and multiple regression techniques were used to build the best predictive models for indoor BC.,

Results. There was no significant difference between median indoor ($p = 0.31$) or outdoor ($p = 0.86$) BC concentrations by season. The best performing predictive model was built using the Ridge LSE method (MPSE 0.50). A linear regression model fit for inference indicated that pets in the home (0.117), hard flooring (0.090), and outdoor BC (0.036) had the largest contributions to indoor BC.

Conclusion. Ambient pollution measurements in addition to housing characteristics can explain approximately 27% of the variability in indoor BC concentrations in the selected households from the HS cohort study.

Tuesday LT1

Latent class analysis of housing types in California and their impact on exposure to indoor pollutant exposures of pregnant mothers

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Abstract

- Background/Aims: Pregnant mothers are vulnerable to air pollution exposure including risks of preterm birth, low birth weight, and stillbirth. The infiltration of outdoor pollutants into a residential space is critical to understanding air pollution exposure and associated health effects in pregnant mothers during wildfire events. Relying on ambient measurements of wildfire smoke alone can result in exposure misclassification. Homes with higher infiltration are more often older, smaller by square footage, and occupied by lower-income residents. We leveraged data from the California Tax Assessor and California birth records database to 1) detect home typologies based on physical characteristics recorded by the tax assessor, and 2) determine if racial and socioeconomic disparities exist for homes with high infiltration characteristics.

- Methods: We merged data from the California tax assessor including the physical characteristics of maternal residences with birth record data for California from 2008-2016. With Latent Class Analysis, we created housing typologies based on individual level home physical characteristics.

- Results: A four-subgroup solution was selected. Two exhibited characteristics relevant for infiltration with “high infiltration potential” and “low infiltration potential”, based on the probability of small square footage, older building, and type of heating, ventilation, and air conditioning system. High infiltration potential homes were more likely to be in metro areas and occupied by a non-white pregnant mother. Low infiltration homes were more likely to be in non-metro areas and occupied by a white pregnant mother.
- Conclusion: These results highlight the need for programs and policies targeted to improve housing conditions for residents of high infiltration potential homes in urban areas. More research is needed to understand the difference in exposures to those in higher infiltration urban homes versus lower infiltration non-urban homes in California that may be closer to epicenters of agricultural and wildfire burn areas.

Tuesday LT1

A novel index for assessing open space exposures in rural areas

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Abstract

Background: Evidence is growing that greenspace, most commonly assessed using satellite-derived measures of vegetation (e.g., normalized difference vegetation index, NDVI), promotes health. In addition, positive effects may be more pronounced in vulnerable populations. However, much of this work is urban-focused with few studies examining health impacts in rural communities. This is an important gap because rural areas may have distinct open space opportunities that may not be adequately captured by NDVI and similar measures. In addition, travel distance and transportation needs may serve as barriers to greenspace access in rural areas. We aim here to develop comprehensive open space exposure metrics that quantify both quality of and accessibility to a broad set of open space exposures.

Methods: Using principal components analysis, we will create two sets of indices for open space exposure in each of four seasons: a) an open space index for quantity (OSI_Q), which measures not only presence but also amount of quality open spaces based on amenities, and b) an OSI for accessibility (OSI_A), which encompasses public access designation and incorporates novel approaches to quantify both proximity and use. Specifically, in defining access, we will estimate travel times and quantify access within a variety of buffers. We will also apply novel metrics of use that incorporate aggregated social media data, mobile device information, and recreation demand.

Results: We have constructed a comprehensive database of all proposed open space components (Figure). Generation of summary indices is underway.

Conclusion: In order to translate promising greenspace findings into action and maximize the potential of open spaces as a strategy to promote health, it is critical to evaluate open space holistically. The indices developed here will be particularly valuable for application to health studies in rural populations.

Figure. Key components of open space indices.


Number of public parks overall and by amenity (ParkServe)
Gross visitation to public parks by amenity (Near Vista)
Average person days of recreation (InVest)
Minimum linear distance to water source (NLCD & JRC Global Surface Water)
Minimum linear distance to open space by type (USGS PAD)
Number of daytrips for bird watching and fishing (EnviroAtlas)
OSI_A Open Space Access
OSI_Q Open Space Quantity
Normalized Difference Vegetation Index (NDVI)
Enhanced Vegetation Index (EVI)
Percent landcover by type (NLCD – National Land Cover Database)
Minimum linear distance to open space by type and percent protected area by type (USGS PAD)
Percentage of large body of water coverage (JRC Global Surface Water)
Number of fishing access sites (Fish, Wildlife & Parks)

Tuesday LT1

Associations between Urban Stress and Children's Lung Function in Mexico City and Potential Effect Modification by Sex

Grant Tore[1], Marcela Tamayo-Ortiz[2], Adriana Mercado-García[3], Héctor Lamadrid-Figueroa[4], Rosalind J. Wright[5,6], Martha Maria Téllez-Rojo[3], Robert O. Wright[5,7], Maria José Rosa[5]
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Abstract

Background: Reduced pediatric lung function has been associated with exposure to psychosocial stressors during childhood. We assessed the relationship between urban stress with lung function in children, and whether the relationship is sexually dimorphic.

Methods: We analyzed 327 mother-child pairs from the longitudinal Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study in Mexico City. Mothers reported experiencing urban stressors via a Spanish version of the Nuisances Environnementales scale, which were modeled on a continuous scale from 0 to 28. Concurrent 8-9 year old children's lung spirometry included forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC, and forced expiratory flow at 25-75% of pulmonary volume (FEF_{25-75}). For analysis, FEV_1, FVC and FEF_{25-75} were transformed to z-scores based on the child's sex, age, and height. Associations between urban stress and lung function were modeled using multivariate linear regression adjusting for maternal education and age, environmental tobacco smoke at age 8-9, and whether lung function was collected prior or after the pandemic began. Sex by urban stress interactions were assessed by stratified analyses.

Results: No associations were observed between urban stress and lung function among the overall sample. However, effect estimates approached significance and were stronger among males compared to females for FEV_1 (males, β: 0.09, 95%CI: [0.00, 0.19]; females, β: 0.03, 95%CI: [-0.08, 0.13]) and FVC (males, β: 0.09, 95%CI: [-0.01, 0.18]; females, β: 0.01, 95%CI: [-0.10, 0.12]). Sex by urban stress interactions did not reach statistical significance for FEV_1/FVC or FEF_{25-75}.

Conclusion: Urban stress may impact pediatric lung function in a sex-specific manner. Although not significant, observed associations were positive, which may reflect different perceptions of urban stressors between mothers and children. Future research should evaluate perceived urban stressors among children directly and investigate potential interactions between psychosocial and other environmental exposures.

Tuesday LT1

Bridging the Environment and Neurodevelopment for Children's Health: Comparing children's $PM_{2.5}$ exposure using personal air sensors and EPA monitor data

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Abstract

Background--Elevated $PM_{2.5}$ exposure has been linked to children's poor cognitive/mathematical performance, which is a strong predictor of poor later academic performance. To investigate the relationship between daily air pollution exposures and children's cognitive functioning, the Bridging the Environment and Neurodevelopment for Children's Health Study provided low-cost (~$150) personal air quality sensors (Flow by Plume Labs) to 30 Washington, D.C. metro area children. We investigated differences between $PM_{2.5}$ measurements by the Flows and EPA stationary monitors in participants' residential county, evaluating whether correlations between Flows and cognitive assessment performance were similar to those using monitor data. **Methods**--To assess correlation between Flow-measured and EPA stationary monitor-measured $PM_{2.5}$, we collected Flow data during both winter 2020-2021 (Round 1) and spring/summer 2021 (Round 2) and EPA monitor data from the EPA's website for study participation days. To evaluate correlation between the monitors' and Flows' three-day averages, we performed Wilcoxon rank-sum tests to assess differences between the two exposure measurement types and Spearman's rank correlation tests to understand whether relationships between the EPA monitors and Flows and children's cognitive assessments were consistent. **Results**--We found statistically significant differences between the Flows' and EPA monitors' $PM_{2.5}$ measurements during both experimental rounds (median Flow vs. EPA Round 1--3.66 $\mu g/m^3$ vs. 6.77 $\mu g/m^3$; median personal sensor vs. EPA Round 2--3.01 $\mu g/m^3$ vs. 5.47 $\mu g/m^3$). We compared Flows' and EPA monitors measurements and the cognitive assessment correlations (i.e., arithmetic assessment: vs. Flows Round 1 r_s=-0.1, p=0.63; vs. EPA monitor Round 1 r_s=0.12, p=0.56), finding more consistency between Round 2 Flows and the EPA monitor vs. the cognitive assessment correlations. **Conclusions**--There was greater consistency between Flows and EPA monitors vs. the cognitive assessments during the warmer season with increased time outdoors. To understand these dynamics, longitudinal personal sensor vs. regional monitor comparison studies are needed.

Tuesday LT1

Assessing disparities in adverse birth outcomes in Alaska

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Abstract

Background: Ten percent of births in the U.S. are preterm, which can result in short and long term physical and developmental harms, costing billions each year. Alaska is a unique environment for providing prenatal care. While the majority of the population lives in three urban centers, more than 80% of Alaskan communities are located completely off the road network. While regional hospitals or clinics provide some prenatal care services to rural residents, many women have to travel for prenatal care and birth. Research on disparities in birth outcomes and associated risk factors in Alaska is sparse.

Methods: We examined birth record information for 218,222 singleton live births occurring in Alaska between 2000 and 2020. We coded births as preterm, very preterm, and low birthweight and assessed trends in these outcomes by known risk factors including maternal educational attainment, smoking status, pre-pregnancy diabetes and hypertension, and number of prenatal care visits. We also assessed the impact of geographic remoteness on birth outcomes and mapped distances traveled from a mother's residence to a birth facility.

Results: Preliminary results show that smoking status, pre-pregnancy diabetes or hypertension, being Alaska Native or other non-White race, and having less than high school education are associated with higher risk of all adverse birth outcomes in this Alaskan cohort. Having more prenatal care visits decreased the risk of adverse outcomes. We have yet to complete the road analysis at the time of abstract submission.

Conclusions: There are major disparities in birth outcomes in Alaska with demographic, geographic, and behavioral risk factors. Pregnant women travel vast distances to receive prenatal care, which may also have impacts on birth outcomes. The risk factors identified in this study may be useful to consider when designing prenatal care services in the state.

Tuesday LT1

Association of Reported Dust In US Residences With the Number Of Symptoms.

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Abstract

Occupants of US residences responded to a free questionnaire on the web site haywardscore.com from 2016 to 2020. The questionnaire design and intent was exploratory rather than experimental, consisting of 50 primary questions plus another possible 200 nested sub-questions. There were three categories of questions: Occupant responses to characteristics of building structure; Occupant use of the home: and, Occupant selection from a list of 23 symptoms. A proprietary algorithm calculated a score as an estimate of how healthy the house was anticipated to be with a range from 20 to 100, with 100 being the best. After about 70,000 responses the median score was 54, indicating that housing was generally less "healthy" than the assumptions of the design study.

House dust was not an initial consideration of the questionnaire, with only two questions about observed dust in the house in general and observed dust on window sills. The questions about dust were isolated from the questions about reported symptoms by both the structure of the questions and the sequence. Three different methods of regression analysis (Symptom Type Logistic Regression, Number of Symptoms Linear Regression, and Dust Logistic Regression) all identified observed dust in the top three of all possible associations with the number of reported symptoms.

The results imply a need for further study along with increasing education of occupants and service providers for an expansion of considerations and increased diligence in comprehensive and open-ended identification of indoor characteristics of homes associated with occupant perceptions of health and well-being.

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Tuesday LT1

Climate and Health Impacts of Harvard University Buildings: Application of the CoBE Projection Tool to a Campus Building Portfolio

Mahala Lahvis[1], Parichehr Salimifard[2,1], Jonathan Buonocore[3,1], Joseph Pendleton[4,1], Joseph Allen[1]
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Abstract

The building sector is a major consumer of energy in the U.S. with considerable concomitant greenhouse gas (GHG) emissions and air pollution. Recent climate policies have directed focus toward buildings in order to reach their climate change mitigation goals. New York City and Boston are two cities that have enacted legislation that set emission intensity caps for buildings to meet eventual net zero citywide emissions. However, these climate policies (LL97 and BERDO) have ignored the health impact of emissions in policy development. In this study, we use the Harvard University campus building portfolio to evaluate the performance of buildings on campus with respect to the goals of these climate policies. We then use the Co-benefits of the Built Environment (CoBE) Projection tool to evaluate the climate and health impacts from buildings to elucidate focal areas for energy conservation.

In Harvard University campus buildings, health impact distribution was not aligned with that of energy consumption. For example, while wood makes up about 0.5% of total energy consumption, it is responsible for roughly 7% of the health impacts. The results indicate that while some energy conservation measures can have climate co-benefits, they may aggravate health impacts, and there is not always alignment between energy sources with climate and health co-benefits. For example, switching from natural gas to wood would decrease the GHG footprint but would increase the air pollutants that cause adverse health impacts. Health impacts deriving from buildings must be accounted for in order to realize the comprehensive influence of buildings. This study demonstrates an application of the CoBE Projection tool for a large building portfolio to determine which buildings to choose for energy retrofit to fulfill climate policy emissions intensity limits, and where to focus efforts for health and climate co-benefits optimization.

Tuesday LT2

Pollen and Emergency Department Visits for Asthma and Wheeze in Atlanta: A 26-Year Time-Series Study

Brooke Lappe[1], Stefanie Ebelt[2], Rohan D'Souza[3], Arie Manangan[4], Claudia Brown[4], Shubhayu Saha[5,4], Drew Harris[6], Howard Chang[2,3], Noah Scovronick[1]

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Abstract

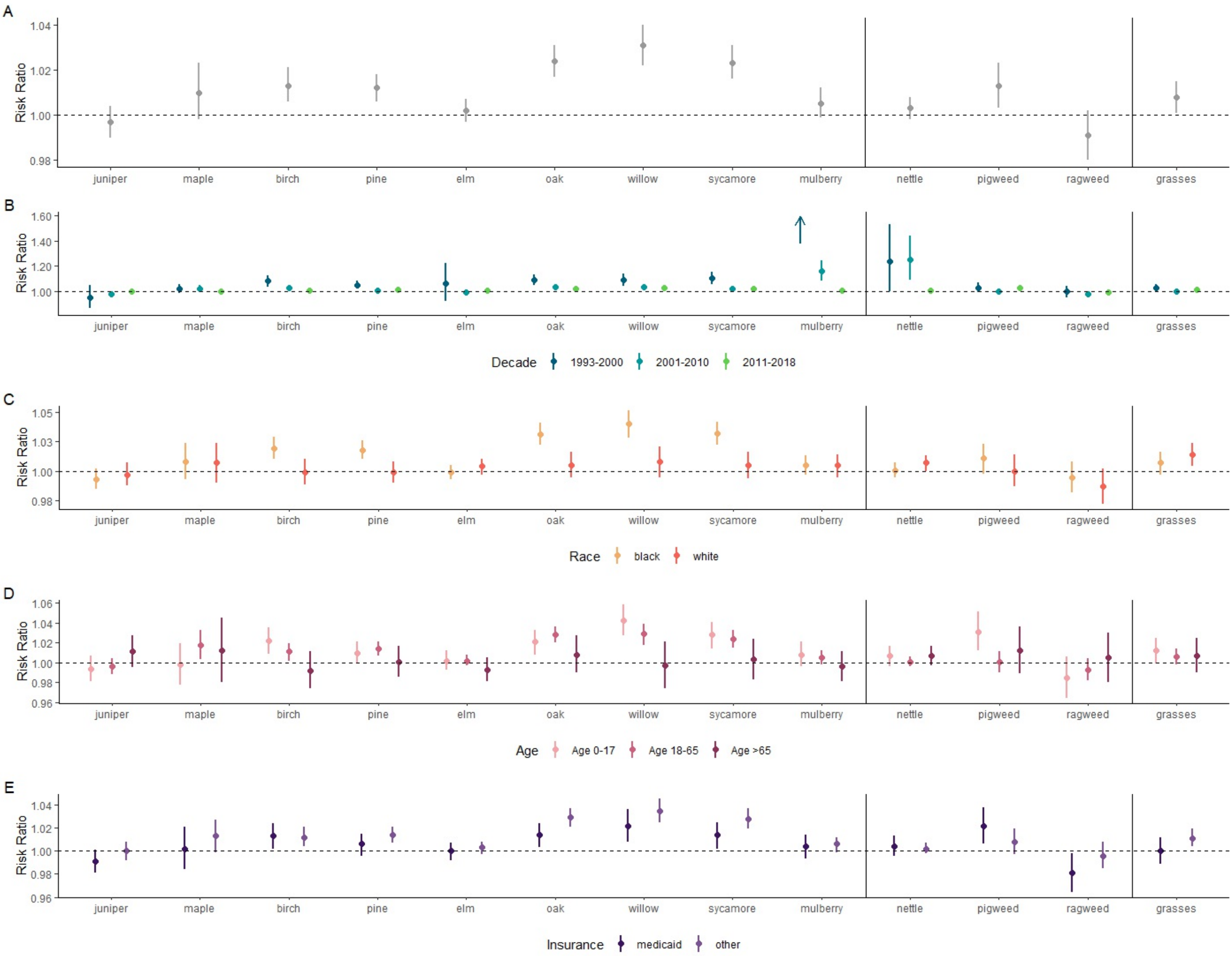
Background/Aims: Compared to many environmental risk factors, the relationship between pollen and asthma is understudied, including how associations may differ by pollen type and between subgroups, and how associations may be changing over time. We evaluated the association between ambient pollen concentrations and emergency department (ED) visits for asthma and wheeze in Atlanta, Georgia during 1993-2018. We estimated overall associations for 13 individual pollen taxa, as well as associations by decade, race, age, and method of payment (Medicaid vs non-Medicaid).

Methods: Speciated pollen data were acquired from Atlanta Allergy & Asthma, a nationally certified pollen counting station. ED visit data were obtained from individual hospitals and from the Georgia Hospital Association. We performed time-series analyses using quasi-Poisson distributed lag models, with primary analyses assessing 3-day (lag 0-2 days) pollen levels. Models controlled for day of week, holidays, air temperature, month, year, and month-by-year interactions.

Results: We observed positive associations of asthma/wheeze ED visits with seven of the 13 pollen taxa: five trees (birch, oak, pine, willow, and sycamore), one weed (pigweed), and grasses. Rate ratios indicated 1-4% increases in asthma/wheeze ED visits per standard deviation increases in pollen. In general, we observed stronger associations in the earliest period (1993-2000), in younger people, and in Black patients; however, results varied by pollen taxa.

Conclusion: In the longest time series study conducted on pollen and asthma/wheeze to date, we found that some types of pollen are associated with increased ED visits for asthma/wheeze. Associations are higher in Black and younger patients and appear to have decreased over time.

Figure 1. Rate ratios and 95% CIs for asthma/wheeze ED visits per standard deviation increase in pollen taxa concentration: a) overall, b) by decade, c) by patient race, d) by patient age, and e) by patient insurance status.


A
B
C
D
E
Risk Ratio
juniper
maple
birch
pine
elm
oak
willow
sycamore
mulberry
nettle
pigweed
ragweed
grasses
Decade
1993-2000
2001-2010
2011-2018
Race
black
white
Age
Age 0-17
Age 18-65
Age >65
Insurance
medicaid
other

Tuesday LT2

Early pregnancy plasma per- and polyfluoroalkyl substance (PFAS) concentrations and maternal midlife adiposity

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Abstract

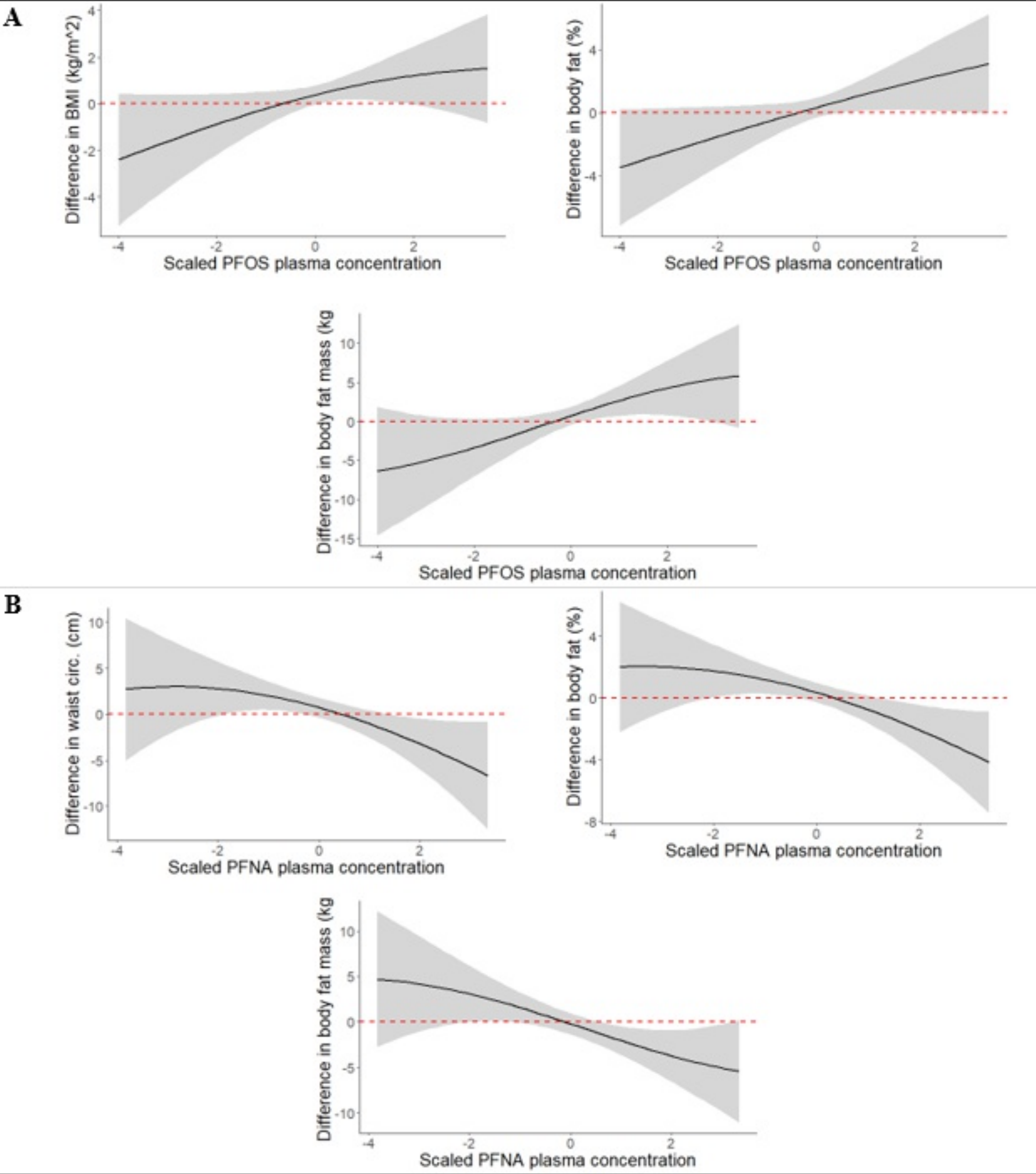
Background/Aims: Prior epidemiologic evidence links pregnancy PFAS exposure to maternal cardiometabolic disease risk factors, including postpartum weight retention and adiposity. However, no studies have evaluated associations with maternal adiposity in midlife.

Methods: We studied women recruited between 1999 and 2002 in Project Viva with pregnancy plasma concentrations of six PFAS. At a midlife visit (median 17.4 years post index pregnancy; median age 50.8), we assessed anthropometric measures, total body fat percent (TBF%) and total body fat mass (TBFM) in 549 individuals, and visceral adipose tissue (VAT) area via dual-energy x-ray absorptiometry in 429 individuals. We estimated individual and joint effects of PFAS exposure with adiposity outcomes using multivariable linear regression and Bayesian Kernel Machine Regression (BKMR), adjusting for covariates assessed at baseline including maternal age, race/ethnicity, pre-pregnancy body mass index (BMI), education, smoking status, parity, and marital status.

Results: To account for skewed distributions, PFAS concentrations were $\log_2$-transformed, and VAT area was ln-transformed. We observed lower mean waist circumference (-1.66 cm [95% CI: -3.01, -0.32]) and TBFM (-1.31 kg [95% CI: -2.50, -0.12]) at mid-life per doubling of PFNA levels during early pregnancy. We observed lower mean waist circumference (-0.96 cm [95% CI: -1.92, 0.00]) and VAT area (-0.06% [95% CI: -0.11, -0.01]) per doubling of PFHxS. BKMR showed that, holding other PFAS at their medians, higher pregnancy PFOS concentrations were associated with higher BMI, TBF%, and TBFM at midlife (Figure 1A), while higher PFNA concentrations were associated with lower waist circumference, TBF%, and TBFM (Figure 1B). Lastly, the pregnancy PFAS mixture was associated with lower mean waist circumference, TBF%, and TBFM at midlife, although trends were not statistically significant.

Conclusion: Select early pregnancy PFAS exposures may differentially impact maternal midlife adiposity. Our results have important implications for long-term maternal cardiometabolic health postpartum that warrant additional studies.

Figure 1. Covariate-adjusted exposure-response functions, estimated by Bayesian Kernel Machine Regression, illustrating the independent associations of early pregnancy plasma (A) PFOS and (B) PFNA concentrations with select markers of adiposity in midlife, holding all other PFAS constant.



Note: Functions are adjusted for covariates assessed at baseline including maternal age, race/ethnicity, pre-pregnancy body mass index, education, smoking status, parity, and marital status.

Abbreviations: circ, circumference; cm, centimeters; kg, kilograms; m, meters; PFAS, per- and polyfluoroalkyl substances; PFNA, perfluorononanoate; PFOS, perfluorooctane sulfonate.

Associations between short-term PM2.5 and smoke exposure and blood cholesterol concentrations among MI survivors

Samantha Catalano[1,2], Joshua Moyer[3], Cavin Ward-Caviness[3]
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Abstract

Introduction:

Elevated blood cholesterol concentrations are a cardiovascular disease (CVD) risk factor and can be an indicator of metabolic dysfunction, particularly for those with a prior cardiovascular event, e.g. myocardial infarction (MI). However, few studies have explored associations between air pollution and blood cholesterol concentrations among individuals with a prior cardiovascular event.

Methods:

We examined associations between blood cholesterol concentrations and PM2.5 and smoke exposure in a cohort of 5,683 MI survivors. Measurements of low-density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), and total cholesterol were extracted from electronic health records spanning 2004-2016 along with patient address, demographics, and smoking status. Daily, zip code level smoke exposure was assessed using the NOAA hazard mapping system data. PM2.5 was assessed using 1x1km resolution daily modeled concentrations while daily meteorology was determined based on the nearest National Oceanic and Atmospheric Administration (NOAA) monitoring station. We adjusted for age, sex, race, temperature, relative humidity, smoking status, area-level socioeconomic status using data from the 2010 US Census, and a spline term for time since study start. We examined associations based on exposure on the day of measurement and up to 4 days prior as well as the 5-day average exposure.

Results

We observed a decrease in HDL-C in association with 5-day average PM2.5 exposure (β = -0.64 mg/dL per 10 μg/m3 increase in PM2.5, 95% confidence interval = -1.22 -0.06 and smoke exposure (β = -0.76 mg/dL per additional smoke day; 95% confidence interval = -1.43 -0.09). We also observed a decrease in total cholesterol in association with both 5-day average smoke exposure and PM2.5. No associations were observed for LDL-C.

Discussion

Short-term exposure to air pollution is associated with a decrease in cardioprotective HDL-C among MI survivors. These results may help to understand environmental health risks among clinically vulnerable individuals.

Tuesday LT2

Modification of $PM_{2.5}$ associated wintertime mortality by individual risk factors in patients with chronic obstructive pulmonary disease (COPD)

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Abstract

Background

Air pollution is a contributor to premature mortality, but potential impacts differentiate in populations with existing disease, particularly for individuals with multiple risk factors. Our study evaluates the association between wintertime air pollution and mortality in patients with chronic obstructive pulmonary disease (COPD) and the modifying role of individual risk factors and cardiopulmonary comorbidities.

Methods

We evaluated deceased Veterans with a prior COPD diagnosis residing in 25 U.S. metropolitan regions (2016-2019). Electronic health records include individual patient demographics, geocoded home addresses, smoking status, and comorbidities, including asthma, lung cancer, coronary artery disease, chronic kidney disease, obesity, and diabetes. Individuals were assigned wintertime PM2.5 and NO2 air pollution exposures using geocoded addresses. We estimated associations between acute air pollution and mortality using a time-stratified case-crossover design with a conditional logistic model. Stratified analyses were used to assess individual risk differences.

Results

In 19,243 deceased Veterans with COPD, we estimated a 1.05 (95% CI: 1.02-1.09) mortality risk for each 10ug/m^3 daily wintertime $PM_{2.5}$ exposure. Older patients, African American, and individuals with a smoking history showed elevated risk. Air pollution was not associated with elevated risk in COPD patients with asthma, lung cancer, or congestive heart failure. However, obesity was a substantial risk factor (OR: 1.11; 95% CI: 1.01-1.23) of air pollution-related mortality and for individuals with obesity plus coronary artery disease or obesity plus diabetes, estimated risk was 16% higher.

Conclusions

Wintertime $PM_{2.5}$ exposure was associated with elevated mortality risk in people with COPD, but individuals with multiple comorbidities, notably obesity, had high vulnerability. Our study suggests that obesity may be an understudied modifier of air pollution-related risks for people with existing respiratory disease.

Tuesday LT2

Could people with pre-existing blood disorders be more susceptible to temperature effects?

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Abstract

Background and Aim: The link between heat and cardiovascular events (stroke, acute myocardial infarction, etc.) has been examined over the last decade or longer, but less is known about the role pre-existing blood disorders such as sickle cell disease (SCD), thalassemia, or being a carrier of either disease can have on hospitalizations related to temperature. Blood disorders can create complications from lower oxygen saturation due to anemia or lead to higher blood viscosity and eventual clumping and clotting due to dehydration. Acting together, these complications could disrupt cardiovascular functioning, particularly because cardiovascular demand increases while the body tries to cool down. In this analysis, we examined whether higher daily mean apparent temperature was associated with increased sickle cell and thalassemia-related hospitalizations in California from 1999 to 2019.

METHODS: Using California Patient Discharge Data records and monitored temperature data, we used time-series Poisson regression models to first estimate associations at each of the 16 California climate zone (CZ)-levels during the warm months of May to October while adjusting for year, holidays, and weekends. We then used random-effects meta-analyses to produce overall effect estimates, focusing on lag 0 to lag 2 days.

RESULTS: For preliminary results, a 10-degree Fahrenheit (°F) increase in daily mean apparent temperature at lag 1 day was associated with a 2.46% (95% Confidence Interval (CI), 0.64-4.31%) increase in overall hospitalizations for all secondary outcomes of SCD, sickle cell trait (SCT), and thalassemia minor and major. A 10 °F increase in mean apparent temperature was associated with a 4.28 % (95% CI: -0.49-9.28%) increase in hospitalizations for secondary SCD only at lag 1.

CONCLUSIONS: Our findings indicate that those with certain pre-existing blood disorders could be at higher risk for hospitalizations due to higher apparent temperature.

KEYWORDS: sickle cell, thalassemia, blood disorders, temperature, climate change, heat

Tuesday LT2

Prescribed Fires, Smoke Exposure, and Hospital Utilization Among Heart Failure Patients

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Abstract

Background and Aim: Prescribed fires are increasingly utilized, but their environmental health risks have been infrequently studied. We investigated associations between residing near a prescribed fire and heart failure (HF) patients' hospital utilization.

Methods: We used electronic health records from January 2014 to December 2016 in a North Carolina hospital-based cohort to determine HF diagnoses, primary residence, and hospital utilization. Using a cross-sectional study design, we associated prescribed fire occurrences within 1, 2, and 5 km of the patients' primary residence with the number of hospital visits and 7- and 30-day readmissions for each patient. We also compared associations with those observed using zip code-level smoke density data, which captures more wildfire smoke exposure than prescribed fires. Quasi-Poisson regression models were used for the number of hospital visits, while zero-inflated Poisson regressions models were used for readmissions. All models were adjusted for age, sex, race, smoking status, and neighborhood socio-economic status and included an offset for follow-up time. The results are the percent change and the 95% confidence interval (CI).

Results: Associations between prescribed fires and hospital visits were generally null with the few associations observed being with prescribed fires within 5 and 2 km of the primary residence but not the more restrictive 1 km radius. However, exposure to medium or heavy smoke days at the zip code level was associated with both 7-day (8.6% increase; 95% CI = 1.5%, 16.1%) and 30-day readmissions (5.3%; 95% CI = 2.3%, 8.5%), and to a lesser degree, hospital visits (1.3%; 95% CI: -0.2%, 2.7%).

Conclusions: Area-level smoke exposure is positively associated with hospital utilization but not proximity to prescribed fire occurrences. This abstract does not necessarily reflect U.S. EPA policy.

Tuesday LT2

Association of long-term exposure to ultrafine particles, nitrogen dioxide, and black carbon with dementia incidence in the Adult Changes in Thought cohort

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Abstract

Background: While epidemiologic evidence links elevated exposure to fine particulate matter ($PM_{2.5}$) to reduced cognitive function, few studies have investigated links with traffic-related air pollution (TRAP). None have examined ultrafine particles (particles ≤ 100 nm) and late-life dementia incidence.

Objective: To evaluate associations between TRAP exposures (ultrafine particles [UFP], black carbon [BC], and nitrogen dioxide [NO_2]) and late-life (≥65 years) dementia incidence.

Methods: We ascertained dementia incidence in the Seattle-based Adult Changes in Thought (ACT) prospective cohort study from 2005-2020 and assessed ten-year average TRAP exposures from an extensive mobile monitoring campaign in the region. We applied Cox proportional hazards models to investigate TRAP exposure and dementia incidence while adjusting for age, apolipoprotein E (APOE) e4, sex, race, year, education, socioeconomic status (SES), and fine particulate matter ($PM_{2.5}$). We ran sensitivity and secondary analyses with alternative adjustment covariates, different exposure models, subsets of the cohort, dementia subtypes, and different exposure windows. We assessed effect modification by sex, APOE, race, and SES in exploratory analyses.

Results: We identified 701 incident all-cause dementia cases in 2,904 participants and over 21,950 person-years of follow-up. We did not find strong evidence of a greater hazard of late-life dementia incidence with elevated long-term TRAP exposures. The estimated hazard ratio of all-cause dementia was 1.00 (95% CI: 0.95-1.04) for every 1,000 pt/cm^3 increase in UFP, 0.94 (0.87-1.02) for every 100 ng/m^3 increase in BC, and 0.86 (0.71-1.05) for every 5 ppb increase in NO_2. These findings were consistent in sensitivity and secondary analyses, and we did not find evidence of effect modification.

Discussion: We did not find evidence of a greater hazard of late-life dementia risk with elevated long-term TRAP exposures in this population-based prospective cohort study.

Tuesday LT2

Psychosocial susceptibility in acute air pollution and temperature effects on seizures and epilepsy in children.

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Abstract

BACKGROUND: Psychosocial stress, air pollution, and ambient temperatures are being linked to multiple neurological disorders, with potential synergistic effects. However, research investigating their impact on seizures and epilepsy is scarce. We examined the combined effects of acute exposures to multiple pollutants, temperature, and neighborhood violent crime (a critical urban psychosocial stressor) on seizure/epilepsy aggravation among children (aged 0-4 years) in New York City.

METHODS: Using conditional logistic regression in a time-stratified, case-crossover design, we quantified the percent excess risk of seizure/epilepsy event per 10-unit increase in daily, residence-level exposures to $PM_{2.5}$, NO_2, SO_2, O_3, and minimum temperature (Tmin). Data on seizure/epilepsy cases (n = 28,385), presented at NYC emergency departments from 2005 to 2011 were obtained from New York Statewide Planning and Research Cooperative System. Spatio-temporal exposures were assigned to each case using spatial data from NYC Community Air Survey, and daily EPA pollution and NOAA weather data. Point-level NYPD crime data for the year 2009 (midpoint of study period) were aggregated to create tract-level annual average crime rates. Separate models were fit for each exposure for lag days 0 to 6, controlling for case-day effects of all co-exposures and humidity. Interactions with quintiles of crime rates were assessed, controlling for potential interactions with socioeconomic deprivation.

RESULTS: Strongest main effects were observed for $PM_{2.5}$ on lag day 1 [2.93% (95% CI: 0.63%, 5.28%)] and lag day 3 [2.47% (0.44%, 4.54%)]. NO_2, SO_2, O_3, and Tmin effects were statistically non-significant. Violence non-linearly modified $PM_{2.5}$ effects, with generally stronger effects in lower violence quintiles compared to higher violence quintiles.

CONCLUSION: Acute $PM_{2.5}$ exposures may be associated with pediatric seizure and epilepsy aggravation, possibly via neuroinflammatory mechanisms. Greater apparent effects in the lower violence communities need further investigation but could result, in part, from saturation effects in socio-environmental stressor synergism.

Uncaptioned visual

Association between fine particulate matter exposure, APOE-ε4 allele status, and cerebrospinal fluid biomarkers of Alzheimer's disease in a cognitively healthy population-based cohort study

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[2]Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, USA. [3]Department of Neurology, School of Medicine, Emory University, Atlanta, USA.
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Abstract

Background: Air pollution exposure has been associated with many chronic illnesses, including Alzheimer’s disease (AD). So far, most evidence comes from data on AD diagnosis or cognitive decline, and little is known about the biological effect of air pollution on early biomarkers of AD as predictors of disease risk.

Methods: This study included 1113 cognitively healthy individuals aged 45-75 years from the Emory Healthy Brain Study (EHBS) in Georgia. Cerebrospinal fluid (CSF) biomarker concentrations of $A\beta_{42}$, t-tau, and p-tau, which can be used for AD diagnosis and as a measure of disease risk, were collected at enrollment (2016-2020) with the Roche Elecsys system. Annual residential fine particulate matter ($PM_{2.5}$) baseline exposures were estimated at a 1 km resolution using well-validated prediction models. We conducted linear regression to estimate the association between $PM_{2.5}$ and CSF biomarkers, adjusting for potential confounders (age, sex, race/ethnicity, BMI, and individual/neighborhood socioeconomic status), and tested for effect modification by APOE-ε4 carriership, the strongest genetic risk factor for AD.

Results: One unit (μg/m^3) increase in annual residential $PM_{2.5}$ exposure was significantly associated with decreased CSF $A\beta_{42}$ [β: -38.96; 95% confidence interval (CI): -68.63, -9.28]. $PM_{2.5}$ exposure had a greater effect estimate on the $A\beta_{42}$ levels of individuals with at least one APOE-ε4 allele (β: -61.14, 95% CI: -115.47, -7.26) when compared to non-carriers (β: -42.96, 95% CI: -82.28, -3.63). However, the interaction term between APOE-ε4 allele status and $PM_{2.5}$ was not significant (p=0.59). Annual $PM_{2.5}$ exposure was not associated with t-tau (β: -0.02, 95% CI: -0.05, 0.00) or p-tau (β: -0.02, 95% CI: -0.05, 0.01).

Conclusion: Our results indicate that annual $PM_{2.5}$ exposure is an important and modifiable risk factor for AD, particularly among APOE-ε4 carriers. A significant decrease in CSF $A\beta_{42}$ suggests an increased risk of developing AD.

Tuesday LT2

Agricultural paraquat dichloride use and Parkinson's disease in California Central Valley

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Abstract

Background: Paraquat dichloride is currently among the most widely used commercial herbicides in the United States. Exposure has been linked to Parkinson's disease (PD) through experimental and epidemiologic research. In the current study, we provide further epidemiologic assessment of ambient paraquat exposure and Parkinson's risk in a large population-based study of PD in agricultural regions of Central California.

Methods: In 829 patients and 824 community controls, we assessed associations between ambient paraquat dichloride exposure estimated via residential and workplace proximity to commercial agricultural applications since 1974 and PD. We evaluated exposure according to three measures (any exposure, duration of exposure, and average exposure [average pounds applied per acre per year]) in four time-windows ranging from 10 to 30 years.

Results: Ambient paraquat exposure assessed at both residence and workplace was associated with PD based on all three exposure measures, indicating that PD patients lived and worked near agricultural facilities applying greater amounts of the herbicide than community controls. For workplace proximity to commercial applications since 1974, any exposure (yes/no, OR=1.25, 95% CI=1.00, 1.57), duration of exposure (per SD, OR=1.26, 95% CI=1.10, 1.44), and long-term average exposure (per SD, OR=1.22, 95% CI=1.08, 1.39) all indicated increased odds. Similar associations were observed based on residential proximity (duration of exposure: OR=1.23, 95% CI=1.07,1.40; long-term average exposure: OR=1.16, 95% CI=1.02, 1.32). Risk estimates were similar for men and women. Stronger odds, however, were observed among those diagnosed ≤60 relative to those diagnosed >60 (duration of workplace exposure: diagnosed ≤60 OR=1.45, 95% CI=1.04, 2.03, >60 OR=1.21, 95% CI=1.04, 1.41; duration of residential exposure: diagnosed ≤60 OR=1.54, 95% CI=1.12, 2.11, >60 OR=1.17, 95% CI=1.01, 1.36).

Conclusion: This study provides further evidence that paraquat dichloride exposure increases the risk of Parkinson's disease and may also be associated with an earlier age at onset.

Tuesday LT2

Association of Ambient Air Pollution and Pesticide Mixtures on Respiratory Inflammatory Markers in Agricultural Communities

Matthew Hughes[1], Grace Kuiper[1], Lauren Hoskovec[1], Sherry WeMott[1], Bonnie Young[1], Wande Benka-Coker[1,2], Casey Quinn[1], Grant Erlandson[1], Nayamin Martinez[3], Jesus Mendoza[3], Greg Dooley[1], Sheryl Magzamen[1]

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Abstract

Background. Exposure to air pollution is associated with adverse respiratory health outcomes; additional evidence from occupational and community-based studies suggests negative impacts from agricultural pesticides on respiratory health.Populations are exposed to multiple inhalation hazards simultaneously, yet these environmental pollutant mixtures arerarely studied.

Methods. We investigated the association of three criteria air pollutants estimated via the Community Multiscale Air Quality (CMAQ) model (fine particulate matter, ozone, and nitrogen dioxide) and urinary metabolites oforganophosphate pesticides (total dialkyl phosphates (DAPs), total diethyl phosphates (DE), and total dimethyl phosphates (DM)) with urinary leukotriene E4 (LTE4), a biomarker of respiratory inflammation, over two seasons in participants in four Central California communities (n=80). We implemented multiple linear regression models to investigate associations in single pollutant models adjusted for sex, age, asthma status, occupational status, work in agriculture, temperature, and relative humidity, and evaluated if these associations changed seasonally. We then implemented Bayesian Kernel Machine Regression (BKMR) to analyze these criteria air pollutants, DAPs, DE and DM as a mixture to determine associations with LTE4.

Results. Our multiple linear regression models suggested an interquartile range (IQR) increase in DM was associated with an increase in urinary LTE4 in winter (b:0.04, 95% CI: [0.01, 0.07]), and an IQR increase in total DAPs wasassociated with an increase in urinary LTE4 in winter (b: 0.03, 95% CI: [<0.01, 0.06]). Confidence intervals for all criteria air pollutant effect estimates included the null value. Our BKMR analysis indicated non-linear interactions between exposures in the air pollution-pesticide mixture, but all critical intervals contained the null value.

Conclusion. Our analysis demonstrated a positive association between organophosphate pesticide metabolites and urinary LTE4 in a population with low asthma prevalence. This study adds to the limited research on joint effects ofambient environmental mixtures of air pollution and pesticides on respiratory health.

Tuesday LT2

Impacts of new-use & legacy pesticide exposure and early life adversity on neurodevelopment in the CHAMACOS study of Mexican-American children

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Abstract

Background: Children living in agricultural regions of California face a higher risk of exposure to pesticides which can lead to potential long-term health problems. However, little is known about the impact of chronic, low-level exposures to pesticide mixtures in early childhood and potential interactions with social adversity.

Aims: This study aims to investigate the relationship between early life exposure to pesticide mixtures in house dust and children's neurodevelopment, taking into account co-exposures and potential interactions with social adversity. Specifically, the study will explore the relative effect of individual pesticides and pesticide classes, such as pyrethroids and organophosphates.

Methods: The study will use data from the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) study, a longitudinal birth cohort study of vulnerable children in an agricultural Mexican American population. The study will focus on exposures during early childhood through non-dietary ingestion and dermal absorption pathways.

The outcome measure will be cognition measured by the Wechsler Intelligence Scale for Children (WISC-IV) at age 7 years, and the exposure will be pesticide concentrations in indoor dust collected at 6- and 12-month visits.

Expected Results: Preliminary results suggest that higher levels of multiple pesticide classes detected in house dust are be associated with lower IQ scores at age 7 years. We will examine if effects vary by the level of stress. The study will determine the relative effect of each pesticide class (current-use pyrethroids, legacy organophosphates, and other pesticides) and examine potential interaction with social adversity among low-income children from an agricultural community where environmental and non-chemical stressors are likely to co-occur.

Conclusion: Examining the relationships between early childhood exposures to mixtures of different classes of pesticides, early life stress, and neurodevelopmental outcomes, among particularly vulnerable children, can elucidate potential points for intervention.

Tuesday LT3

Heat and cold waves increase risk of mortality among U.S. Veterans with COPD

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Abstract

BACKGROUND & AIMS: Chronic obstructive pulmonary disease (COPD) is a heterogeneous pulmonary disease affecting 16 million Americans. People with COPD are a vulnerable population susceptible to environmental disturbances that can exacerbate disease symptoms including extreme weather events such as heatwaves and cold waves which may become more frequent and intense under climate change. We collected individual level data with precise home geocodes from the Veteran's Health Administration (2016 – 2019) on a cohort of 377,545 deceased United States Veterans diagnosed with COPD to estimate the associations between heat and cold waves with all-cause mortality among this vulnerable population. METHODS: We designed a time stratified case crossover study and estimated the incidence rate ratios (IRR) of the association between heat and cold waves with all-cause mortality among our deceased Veterans using conditional logistic regression models. Lagged effects of heat and cold waves on the order of 7 days were examined. Effect modification by underlying comorbidity status and urbanicity of residence were also explored. RESULTS: Heatwaves had the strongest effect on all-cause mortality on lag day 0 (IRR: 1.04 [1.02, 1.06]) and effects attenuated by lag day 3. The effect of cold waves on mortality steadily increased over time and plateaued at lag day 4 (IRR: 1.04 [1.02, 1.06]) with declining observed effects, however, impacts of cold waves persisted over the entire 7-day lag period. Differences in risk were observed for individuals with underlying comorbidities and by urbanicity of residence. CONCLUSION: Our study demonstrated harmful associations between heat and cold waves among a vulnerable population of Veterans with pre-existing COPD using individual level health and location data. Future research should emphasize the usage of individual level health and location data to better estimate the associations between extreme weather events and health outcomes.

Tuesday LT3

A CASE CROSS-OVER INVESTIGATION OF THE EFFECTS OF EXTREME HEAT ON PAEDIATRIC HEALTH, ONTARIO 2005-2015

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University of British Columbia, Vancouver, Canada

Abstract

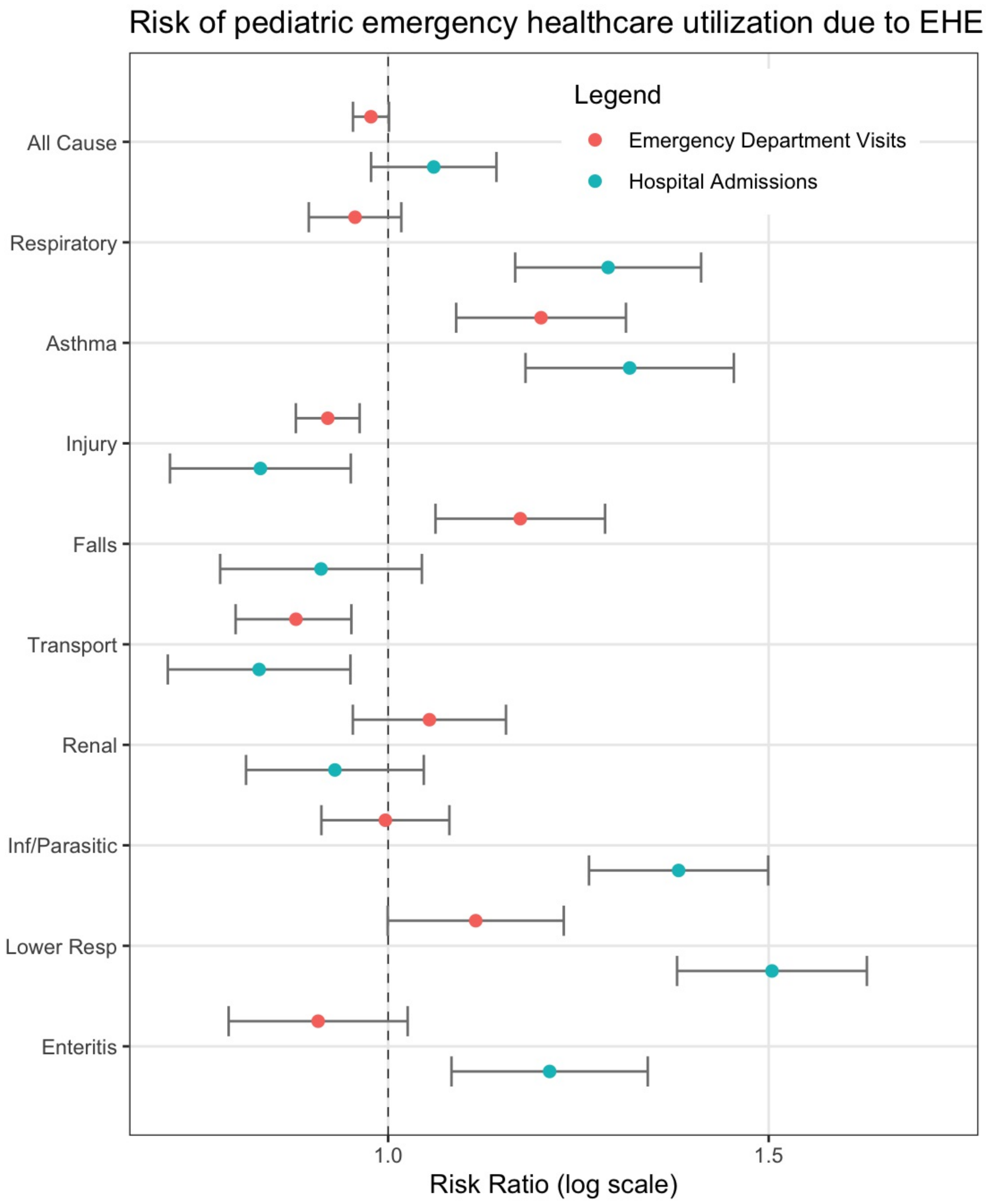
BACKGROUND: Global climates are changing and as temperatures rise, so too are the frequency and severity of extreme heat events (EHEs). In Canada, annual EHEs are estimated to double over the next 30 years. A large body of literature links extreme heat to multiple health endpoints, including heatstroke and the exacerbation of other medical conditions. Children are believed to be uniquely vulnerable due to their higher surface area to mass ratio, lower sweating capacity, higher temperature at which sweating begins, lower cardiac output, and lower blood volume. However, there remain gaps in knowledge concerning the specific causes of illness associated with heat in children.

METHODS: It was hypothesized that EHEs are associated with increased paediatric hospital admissions and emergency departments (ED) visits in Ontario. This case-crossover study used conditional Poisson regression to produce risk ratios to asses these effects.

RESULTS: EHEs were positively associated with paediatric hospital admissions for general respiratory illnesses, asthma; general heat-related illnesses, heatstroke; general infectious and parasitic diseases, lower respiratory infections, and enteritis. In stratified analyses, all-cause hospital admissions were positively associated with children 13-18, and males.

EHEs were also positively associated with ED visits due to asthma; drowning; general heat-related illnesses, heatstroke, dehydration; and lower respiratory infections. General injuries and transportation-related injuries were negatively associated with both hospital admissions and ED visits. When stratified by age, no associations were found among children 0-4 or 13-18, nor among females or males when stratified by sex. However, a negative association was found among children 5-12.

CONCLUSION: This study characterized associations between EHEs and causes of paediatric hospital admissions and ED visits in Ontario. Our findings suggest EHEs increase risk of some causes and argues that it is crucial that policies and programs be tailored to reflect these specific vulnerabilities in the face of this quickly warming climate.



Risk of pediatric emergency healthcare utilization due to EHE
Legend
Emergency Department Visits
Hospital Admissions
All Cause
Respiratory
Asthma
Injury
Falls
Transport
Renal
Inf/Parasitic
Lower Resp
Enteritis
1.0
1.5
Risk Ratio (log scale)

Tuesday LT3

Climate and Health Capacity Building for Health Professionals in the Caribbean: A Pilot Course

Cecilia Sorenson[1,2,3], Nico Hamacher[1,3], Haley Campbell[1], Paula Henry[4], Keriann Peart[4], Loren De Freitas[4], James Hospedales[4]
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Abstract

Climate change is a reality in the Caribbean and its effects are already harming health, yet the health workforce capacity to implement climate mitigation and adaptation measures is lacking. From March-May of 2022, a free, live-virtual, evidence and competency based 10-week climate and health course targeted toward health risks in the Caribbean was deployed to: 1) increase communication about climate and health 2) equip health professionals with knowledge and skills that could be readily incorporated into practice, and 3) engage health professionals with climate and health initiatives within their communities. Participants in this course came from 37 countries, 10 different health-related fields, and five different general places of work. Longitudinal surveys revealed significant changes in health professional communication, engagement and application of climate and health knowledge and skills. Live-virtual, evidence and competency-based courses, regional-specific courses have the potential to change health professional behaviors towards addressing climate impacts on health.

Tuesday LT3

Daily temperature variability and mental health-related hospital admissions in New York State

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Abstract

Background: Environmental exposures may trigger mental health conditions through behavioral and physiological pathways. While some previous work details temperature-related exacerbation of mental morbidity, evidence on the impact of temperature variability on mental health is lacking. We estimated associations between diurnal temperature range (DTR)–an indicator of daily temperature variability–and mental health admission rates in New York State during 1995–2014.

Methods: We implemented a case-crossover design with distributed lag non-linear DTR terms (0-6 days) to estimate associations between daily ZIP Code-level DTR and mental health hospitalizations for mood, anxiety, adjustment, and schizophrenia conditions, adjusting for daily mean temperature with distributed lag terms. We evaluated how estimated associations varied by age, sex, admission type (in-/out-patient), and season.

Results: Mood conditions were the leading cause of mental health-related admission in New York State during study period with 4,680,294 admissions recorded, followed by anxiety (2,445,837), adjustment (368,206), and schizophrenia (211,973) conditions. Mean (SD) DTR among both case and control periods was 7.7°C (3.3), ranging from 0.1°C to 23.7°C. For all outcomes, we observed a positive 7-day cumulative association at DTRs up to 12°C (90^{th} percentile), with a minor plateau in associations slightly below period mean (5.5°C-7.5°C), and a negative association above 12°C. For mood conditions, a daily increase in DTR from period daily average (7.7°C) to 90^{th} percentile (12°C) over 7 days was associated with a cumulative 4.8% (95%CI, 4.0%–5.6%) increase in daily hospitalization rates. This association was larger in magnitude in transition seasons (spring and autumn) compared to summer and winter and among out-patient compared to in-patient admissions. We did not observe effect-modification by sex and age.

Conclusion: Our study highlights potential impacts of daily temperature variability, an important meteorological indicator related to global climate change, on mental health morbidity.

Uncaptioned visual

Tuesday LT3

Spatial variation in the effect of heat waves on pediatric acute care utilization in California (2000-2019)

Allan Ndovu[1], Lara Schwarz[2], Sheri Weiser[1], Tarik Benmarhnia[2]
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Abstract

The increasing frequency and severity of heat waves due to climate change present unique risks to children. We aim to assess how various heat wave definitions impact pediatric acute care utilization across California. We also hope to examine heat waves’ localized effects at the zip code level and how contextual factors modulate these effects.

A time-stratified case crossover will evaluate the association between different heat wave definitions and pediatric acute care utilization throughout California (for different ICD codes and age groups). A within-community matched design analysis coupled with a Bayesian hierarchical model will examine heat waves’ effects at the zip code level. A random effect meta-regression will determine which contextual factors modulate heat waves’ impact across zip codes. Temperature data will be pulled from Cal-Adapt and interpolated to each zip code population centroid. Data for all unscheduled pediatric hospitalizations and ED visits in California from 2000 – 2019 will be obtained from the California HCAI. Contextual factors will be sourced from the US Census and the Healthy Places Index.

We expect heat waves will be associated with increased pediatric acute care utilization throughout California for select ICD codes. At the zip code level, we anticipate finding considerable spatial variation in the association between heat waves and care utilization based on zip code characteristics. Furthermore, we expect to see significant variation in the association between heat waves and hospitalizations based on the selected heat wave definition. Based on previous work, we predict that zip codes with the highest increases in care utilization will have higher percentages of non-white residents, lower socioeconomic status, and fewer heat protective factors like park density and tree coverage. Understanding which pediatric populations are most affected during heat waves is critical for designing policies and interventions that protect the most vulnerable communities.

Tuesday LT3

Optimizing Solar+Storage Resilience Hub Deployment in California to Improve Climate Adaptation and Energy Equity

Yanelli Nunez[1,2], Yunus Kinkhabwala[1], Patrick Murphy[1], Shina Robinson[3], Laura Gracia[4], Bethany Kwoka[1], Elena Krieger[1]
[1]PSE Healthy Energy, Oakland, USA. [2]Columbia University, New York City, USA. [3]Asian Pacific Environmental Network, Richmond, USA. [4]Communities for a Better Environment, Wilmington, USA

Abstract

Background: Power outages across California are increasing in frequency and duration alongside intensifying heat waves and wildfires. Loss of electricity during these climate events poses severe health risks and can be life-threatening. Resilience hubs (RHs) with a strong community foundation provide year-round resources and services to increase communities' adaptative capacity and resilience. RHs supplemented with solar and battery storage (solar+storage) can provide vulnerable communities with critical energy services during outages and contribute to equitable clean energy distribution. **Objective:** Identify optimal deployment of solar+storage RHs throughout California, prioritizing vulnerable communities. **Methods**: We analyzed the solar+storage potential and associated cost for 18,749 sites (e.g., community centers, places of worship, libraries, etc.) for normal operations and various outage scenarios. We paired this with a population vulnerability index integrating socioeconomic, health, environmental, and climate resilience/capacity indicators. We then used location-allocation models to identify optimal solar+storage RH deployments that minimize cost while maximizing people served and prioritizing vulnerable communities. We worked closely with Wilmington and Richmond, California communities—both currently building solar+storage RHs—to identify local-level challenges and priorities to better inform this modeling. **Results:** Preliminary results show that, with a budget of $900 million, RHs could be constructed within 3 miles of half of the census block groups in the upper quartile of our vulnerability index and a quarter of the population overall. Based on community input, we found that not all buildings with solar+storage potential are well-suited to being RHs and available population vulnerability indicators underrepresent the vulnerabilities of some communities, particularly in rural areas. **Conclusion:** Our analysis quantifies the potential of building solar+storage into existing buildings to support energy equity and everyday resilience in places that need it the most. Effective solar+storage RHs deployment and operation, however, requires additional deep community engagement.

Tuesday LT3

Compound Climate Events and Environmental Justice in California, 2018-2019

Brittany Shea[1], Ben Steiger[1], Robbie M. Parks[1], Vivian Do[1], Heather McBrien[1], Nina Flores[1], Milo Gordon[1], Gabriella Y. Meltzer[1], Joan A. Casey[2,1]
[1]Columbia University, New York, USA. [2]University of Washington, Seattle, USA

Abstract

Background/Aims: Climate-related disasters will likely occur more frequently. Considering the location and time of co-occurring climate disasters is critical, especially among the most vulnerable populations. We aimed to identify counties experiencing compound climate events and determine whether disparities in exposure exist. We examined three major climate events from 2018-2019 in California: disaster wildfires, anomalously high temperatures, and long power outages.

Methods: Based on specified criteria, we identified days that California counties were exposed to a wildfire disaster, an 8+ hour power outage, and anomalously high temperatures from 2018-2019. We will link the disaster to identify concurrent climate events across counties during our study period and compare the total number of climatic events (zero, one, two, or three events) across counties based on environmental and social vulnerability defined by the CDC/ATSDR.

Results: Of the 58 California counties, 57 faced >1 climate event. We identified 56 (97%) counties with at least one anomalously hot day, 33 (57%) counties with at least one wildfire disaster, and 24 (41%) counties with at least one 8+ hour outage. Imperial, a southeastern county, experienced the greatest total number of events, with 94 anomalously hot days (and 0 power outages and 0 wildfires). Ventura County in the southwest experienced 91 total events, the second highest total number of events in our dataset, with 55 power outages, 32 anomalously hot days, and 4 wildfire disasters.

Conclusion: Almost every county in California was exposed to at least one climate-related event during 2018-2019. Identifying counties with the highest exposure to compound events and counties with the highest vulnerability will help determine outreach and resource allocation.

Uncaptioned visual

Tuesday LT3

Present and Future Risk and Burden of Gastrointestinal and Respiratory Emergency Department Visits Associated with Downpours and Dry Spells Among Older Adults in Michigan, Ohio, and Pennsylvania

Carina Gronlund, Madeline Somers, Peter Larson, Krista Latta, Marie O'Neill
University of Michigan, Ann Arbor, USA

Abstract

Background: Extreme precipitation (EP) (e.g., downpours or heavy snowfall) and drought are increasing in the Upper and Northeastern U.S., but impacts on older adults are unclear. We estimated associations between precipitation--magnitude and duration--and gastrointestinal and respiratory emergency department (ED) visits in Medicare recipients age 65+ (N = 5.1 million ED visits) in 30 Michigan, Ohio, and Pennsylvania counties and rates in present and future climate conditions.

Methods: For each season and diagnosis, we regressed daily ED visit counts by ZIP code on daily population-at-risk offsets, precipitation and temperature from 4 km gridded data (Oregon State University PRISM), county, and time trends. Using cumulative distributed-lag-non-linear models with a 20-lag-day exposure history, we modeled precipitation in 3 ways: 1) magnitude (mm), 2) an indicator for > 25.4 mm (EP), or 3) consecutive days of 0 mm (dry spell). EP burden was calculated for 2006-2013 observations and 2071-2099 (National Environmental Public Health Tracking Network) climate projections.

Results: Warm season risk of gastrointestinal visit was 1.16 (95% CI:1.05, 1.26) times higher and respiratory visit was 1.26 (95% CI: 1.16, 1.37) times higher at the 99.5th vs. 75th percentile of precipitation. Cold season precipitation effects were higher at 0 mm but lower following EP days. Spring season effects were null for gastrointestinal visits but higher following both 0 mm and EP days for respiratory visits. The influence of dry spells varied by season, with, e.g., the lowest cold-season ED visit risk occurring after a 10-day-long dry spell. Annual burden of EP-associated ED visits increased from 4.8 to 6.0 per 10,000 persons from 2006-2013 to 2071-2099.

Conclusions: Effects of precipitation on ED visit risk in older adults varies by magnitude, number of consecutive days, season, and visit cause. Without measures to reduce extreme precipitation impacts, ED visit rates may rise in this region.

Tuesday LT3

Cooling School Settings: A Review of Current Heat Mitigation Strategies and Related Health and Energy Savings Estimates around Learning Environments

Blean Girma[1], M.Teresa Herrera[2], Kate Weinberger[3], Perry Sheffield[1]

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Abstract

Heat is an insidious, mostly invisible and inequitable exposure, and is increasing due to climate change. Heat exposure is a particular concern in urban areas, where temperatures are elevated due to the urban heat island (UHI) effect. Based on a review of literature, efforts to mitigate the health effects of UHIs have employed a range of strategies including real-time data surveillance, preventive education and information, built environment alteration, heat alert systems implementation, and provision of cooling centers. Built environment interventions are an important strategy to address historical and ongoing environmental injustice. This review promotes that - in heat mitigation efforts - priorities should be made for applying modifications to the built environment surrounding schools to reduce ambient temperature and which could mitigate the harmful impacts of heat on children’s health. We then illustrated and compare two theoretical schools – to estimate the impacts on student health and healthcare and energy costs. Our intention is to bridge the silos of green urban design and pediatric health to best protect children against increasing ambient temperatures. With mounting evidence of the legacy of environmental injustice contributing to differential heat exposure in historically marginalized communities, these small-scale built environment interventions become even more salient components of the toolbox for change.

Tuesday LT3

High Ambient Temperature Associations with Children and Young Adult Injury Emergency Department Visits in NYC

Blean Girma[1], Bian Liu[2], Leah Schinasi[3], Jane Clougherty[4], Perry Sheffield[1]
[1]Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, New York, USA. [2]Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, USA. [3]Department of Environmental and Occupational Health and Urban Health Collaborative, Dornsife School of Public Health, Drexel University, Philadelphia, USA. [4]Department of Environmental and Occupational Health, Dornsife School of Public Health, Drexel University, Philadelphia, USA

Abstract

Background Injury is a significant health burden for children and young adult and may be an increasing concern in a warming climate. Research reveals many impacts to children's health associated with hot weather and heatwave events, including a growing literature on the association between high ambient temperature and injury, which may vary by intent such as injury resulting from violence. However, little is known about how this association varies across different types of injury and subgroups of young people. We examined relationships between warm season ambient temperature and intentional and unintentional injury among children and young adults in New York City (NYC). **Methods** Within a case-crossover design, our study observed injury-related ED visits from an administrative dataset. Injuries were categorized as unintentional or intentional injuries during the warm season (May - September) in NYC from 2005 to 2011 among patients (0, 1-4, 5-9, 10-14, 15-19, 20-25 years old (y.o.)). Conditional logistic regression models with distributed lag non-linear functions were used to model the cumulative odds ratio (OR) injury-related ED visit over 0-5 lag days. Analyses were stratified by age group and sex to understand how associations vary across young people of different age and sex. **Results** There were a total of 572,535 injury-related ED visits. The largest effect of elevated temperature (daily minimum 77°F vs 48°F) was for unintentional injury among 5-9 y.o. (OR 1.32, 95% CI 1.23, 1.42) and for intentional injury among 20-25 y.o. (OR 1.42, 95% CI 1.22, 1.66). Further stratified analyses revealed that the highest risk of unintentional injury was among 5-9 y.o. males and 20-25y.o. males for intentional injury. **Conclusion** We demonstrate elevated odds of approximately 30% of an ED visit for injury (unintentional and intentional across most age groups) between the coolest days of the warm season to some of the warmest.

Tuesday LT3

Community perceptions of climate change in two rural municipalities of Kavre district in Nepal: an exploratory qualitative study.

Ishwar Tiwari, Stephen Hodgins, Shelby Yamamoto
University of Alberta, Edmonton, Canada

Abstract

Introduction: Kavre district is highly vulnerable to climate change impacts, including erratic rainfall, droughts, floods, and landslides. Assessing community climate change perceptions can offer opportunities to explore climate change awareness, local beliefs about climate change, experiences with adverse climate change impacts, and coping mechanisms, which are crucial in enhancing community problem-solving and decision-making capabilities to build resilience. This study explores the perceptions and lived experiences of the community, particularly women, concerning climate change, consequent adverse impacts on agriculture and health, and ongoing adaptation activities in response to climate change.

Methods: We used a qualitative descriptive approach to explore the community climate change perceptions (n=48) in two rural municipalities of the district. Purposive and snowball sampling techniques were used to recruit participants. Four research assistants with a background in public health and oriented to climate change and health literature conducted all interviews using an interview guide. All interviews were audio-recorded and transcribed verbatim in the local language (Nepali). Data were analyzed in NVivo 1.7 using thematic analysis.

Results: There were three main themes related to community perceptions about climate change: (i) the need for climate change awareness focused on local explanations of climate-relevant issues, (ii) perceived climate change-related impacts, and (iii) potential climate-relevant behaviours and actions.

Conclusion: The study provides insights into how rural communities in the Kavre district perceive climate change. Communities face severe consequences, mainly related to the environment and agriculture, due to regional variability in climate. These findings can support the development of interventions to address the needs of women's and children's health, which are essential to reducing health risks exacerbated by climate change and promoting well-being.

Tuesday LT3

Precipitation, social vulnerability and neglected parasistic infections in California

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Abstract

BACKGROUND: Intestinal parasites such as Cryptosporidium spp and Giardia intestinalis are waterborne pathogens with high global prevalence; studies of seasonality, temperature, and environmental changes suggest that both the global distribution of these and similar parasites and both human and animal infections are likely to affected by climate change. Although parasitic infections are relatively uncommon in the United States, studies have found higher prevalence of neglected parasitic infections in low-income communities, which may also be more vulnerable to climate-related health risks, including impacts on water systems. In this study, we aim to assess how in county-level prevalence of cryptosporidiosis and giardiasis in California may relate to both precipitation and area-level socioeconomic characteristics.

METHODS: County-level yearly confirmed cryptosporidium and giardiasis infections were collected from the California Department of Health from 2001-2021, and data on precipitation and global climate norms were collected from the National Oceanic and Atmospheric Administration (NOAA) over the same time period and the same geography. We intend to model the association between both yearly precipitation and a calculated Standardized Precipitation Index (SPI) score, and yearly community-level giardia and cryptosporidium incidence. We also intend to stratify our models by Social Vulnerability Index (SoVI), a measure of the social vulnerability to environmental hazards of American communities compiled by the Hazards and Vulnerability Research Institute at the University of South Carolina.

RESULTS AND CONCLUSIONS: This exploratory analysis of both environmental and social effects on human parasite infection may provide motivation for further research and policy development around public health preparedness related to climate change and environmental health. Although an ecological study may not evaluate causal effects, positive associations between precipitation and parasitic infections in California and may lead to further study of the pathways to exposure, such as water system and soil contamination, that may put communities at higher risk of disease.

Uncaptioned visual

Tuesday LT4

The association between neighborhood socioeconomic and racial characteristics and source-apportioned PM2.5 levels across the contiguous U.S.

Pablo Knobel[1], Inhye Hwang[1], Edgar Castro[2], Perry Sheffield[1], Luisa Holaday[3], Liuhua Shi[4], Heresh Amini[5], Joel Schwartz[2], Maayan Yitshak-Sade[1]

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Abstract

Background: Several studies found differences in fine particulate matter (PM2.5) exposure associated with neighborhood racial and economic composition. However, most focused on total PM2.5 mass rather than its chemical components and their sources. In this study, we describe the ZIP code characteristics associated with higher levels of fourteen PM2.5 chemical components attributed to source categories that drive the disparities in exposure levels nationally and regionally.

Methods: We obtained annual mean predictions of fourteen PM2.5 chemical components from spatiotemporal models and socioeconomic and racial predictor variables from the 2010 U.S. Census and the American Community Survey 5-year estimates. We used non-negative matrix factorization to attribute the chemical components to five source categories (soil/crustal dust, industrial combustion, metal processing industry/agricultural, coal/oil combustion/biomass burning, and motor vehicle). We fit generalized nonlinear models to assess the associations between the neighborhood predictors (poverty, home ownership-occupancy, non-Hispanic Black, and education attainment up to 9th grade) and each PM2.5 source category in urban areas in the United States 2010 (n=24,546 zip codes).

Results: We observed higher PM2.5 levels in ZIP codes with higher proportions of Black individuals, lower education, and lower socioeconomic status. Racial exposure disparities were mainly attributed to industrial, metal processing, and motor vehicle sources. Economic disparities were mostly attributed to soil, metal processing, and motor vehicle sources. Finally, we found that racial disparities in exposure to most PM2.5 source categories were more pronounced in western states. Economic disparities in exposure to soil and motor vehicle particles were also more pronounced in western states. The association between education and PM2.5 source categories also differed by region.

Conclusion: Racial, socioeconomic and geographic inequalities in exposure to PM2.5 and its components are driven by systematic differences in component sources that can inform air quality improvement strategies.

Tuesday LT4

Assessing Cumulative Environmental Impacts on Native American and Alaska Native Community Health Outcomes through a Decolonizing Transdisciplinary Perspective

Kathleen Torso[1], Anne Weaver[2], Kristen Rappazzo[2], Lynne Messer[3], Danelle Lobdell[2]
[1]ORISE at US EPA, Chapel Hill, USA. [2]US Environmental Protection Agency, Chapel Hill, USA. [3]Portland State University, Portland, USA

Abstract

Background/Aims: Native American tribes and Alaska Native Villages (NAT/ANV) are disproportionately burdened by cumulative environmental injustices. Scholars have highlighted the need to examine cumulative environmental factors on health outcomes for Indigenous communities, including NAT/ANV. Their work also exemplifies the benefit of pursuing such research through community-engaged participatory research approaches inclusive of decolonizing and transdisciplinary methodologies.

Methods: A transdisciplinary research methodology provides a framework for integrating multiple disciplines and community knowledge. When working with NAT/ANV communities, it is important to follow decolonizing methodologies, which highlight and integrate Indigenous ways of knowing throughout the research process. Blending these methodologies produces a holistic research perspective to assess cumulative environmental stressors through the integration of multiple disciplines and knowledge systems. This perspective is best implemented through a community-engaged lens inclusive of the following approaches: Indigenous research methodology, Two-Eyed Seeing, and bi-directional learning to promote knowledge co-production. The fundamental tenets of Indigenous research methodology (relationship, respect, relevance, responsibility, reciprocity) provides guidance for ethical collaboration with Indigenous communities. Two-Eyed Seeing is an approach for blending Western and Indigenous knowledge systems and bi-directional learning promotes such integration through teaching and learning from all partners involved.

Results: A decolonizing transdisciplinary perspective informed a community-engaged study design to examine cumulative environmental impacts on NAT/ANV health outcomes (e.g., determined by community). The study design will be piloted collaboratively between U.S. Environmental Protection Agency and willing NAT/ANV communities. The collaborative team will implement this study design through the guiding principles of Indigenous research methodology, Two-Eyed Seeing, and bi-directional learning.

Conclusion: Grounding this community-engaged study design in a decolonizing transdisciplinary perspective is intended to strengthen EPA and NAT/ANV relationality and opportunities for knowledge co-production. These efforts aim to improve NAT/ANV community decision making on interventions protective of health, cultural practices, and welfare.

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Tuesday LT4

Characterizing the spatial distribution of United States Environmental Protection Agency outdoor air quality monitors within historically redlined areas

Adrien Wilkie[1], Monica Jimenez[1], Christine Gray[2], Kristen Rappazzo[3], Thomas Luben[3]
[1]Oak Ridge Institute of Science and Education (ORISE) Research participant at the U.S. Environmental Protection Agency, Research Triangle Park, USA. [2]Duke Global Health Institute, Duke University, Durham, USA. [3]U.S. Environmental Protection Agency, Office of Research and Development, Research Triangle Park, USA

Abstract

Background: Starting in the mid-1930s, the Home Owners' Loan Corporation (HOLC) ranked urban neighborhoods as least to most desirable in terms of perceived mortgage stability based on the racial, ethnic, and religious characteristics of the residents. This racist practice, redlining, led to disparities in proximity to environmental pollutants in these areas. We aim to characterize the spatial distribution of outdoor ambient air quality monitors within historically redlined areas during three relevant time periods for linking environmental health data.

Methods: We accessed the United States Environmental Protection Agency's Air Quality System (AQS) database to determine locations of outdoor air quality monitors within the contiguous US for three time windows: 1) currently active sites as of mid-2022; 2) sites with continuous operation from January 1, 2000 to December 31, 2009; 3) sites with continuous operation from January 1, 2010 to December 31, 2019. Utilizing Mapping Inequality's HOLC polygon shapefile, AQS sites were assigned HOLC grades A (Best), B (Still desirable), C (Declining), or D (Hazardous) for the three time periods of interest.

Results: There are currently 4,649 active AQS sites within the contiguous US – an increase from 2010-2019 (n=3,803) and 2000-2009 (n=3,042). Among the three time periods evaluated, approximately 8% of AQS sites are located within HOLC areas (any grade) with an increasing proportion of sites located in worsening grade category (e.g., for currently active sites, of the 410 sites located within any HOLC grade, 3.9% are in grade A while 47.3% are in grade D).

Conclusions: Relative coverage of operating AQS sites within HOLC grades C and D has increased over time. Publicly available AQS data may be used by concerned citizens, local and state regulatory agencies, and environmental health researchers to further evaluate how an almost 90-year-old racist policy continues to impact environmental exposures and health disparities today.

Number of operating Air Quality System sites within the contiguous United States stratified by HOLC grade for three time-windows

n	Currently Active Sites	2010-2019 Active Sites	2000-2009 Active Sites
Total AQS Sites	4,649	3,803	3,042
Not in HOLC	4,239	3,488	2,774
HOLC	410	315	268
A: Best	16 (3.9)	14 (3.4)	13 (3.2)
B: Still desirable	49 (12.0)	44 (10.7)	46 (11.2)
C: Declining	151 (36.8)	109 (26.6)	92 (22.4)
D: Hazardous	194 (47.3)	148 (36.1)	117 (28.5)

n=number; percent provided for HOLC grades among HOLC total

AQS = Air Quality System

Tuesday LT4

Colorado EnviroScreen: an environmental justice mapping tool

David Rojas-Rueda
Colorado State University, Fort Collins, USA

Abstract

Background/Aims

Environmental justice (EJ) is a key component of environmental epidemiology. Authorities constantly need to map and identify EJ issues in their communities. This project aimed to develop an EJ mapping tool for the state of Colorado.

Methods

The tool development included several steps: 1) initial community engagement (interviews and survey), 2) tool design, 3) indicator selection and data extraction, 4) tool development and beta version (R shiny application), 5) tool review by community members (interviews and survey), 6) tool update and translation, and 7) tool launch and dissemination.

Results

A total of 198 engagements happened during the two community engagement activities. A composite index was created, including 35 EJ indicators at three geographical dimensions (county, census tracts, and census block group), grouped into five categories (environmental exposures, environmental effects, climate risks, sensitive populations, and vulnerable populations). The indicators and categories were combined in a component score and displayed in an interactive map, histograms, and table. An R shiny application presenting the environmental justice mapping tool was developed in English and Spanish.

Conclusion

An EJ mapping tool in English and Spanish was developed for the state of Colorado based on community members' and stakeholders' priorities and needs. Colorado Departments of energy, transport, environment, and public health have used the tool to support policy development and project funding allocations.

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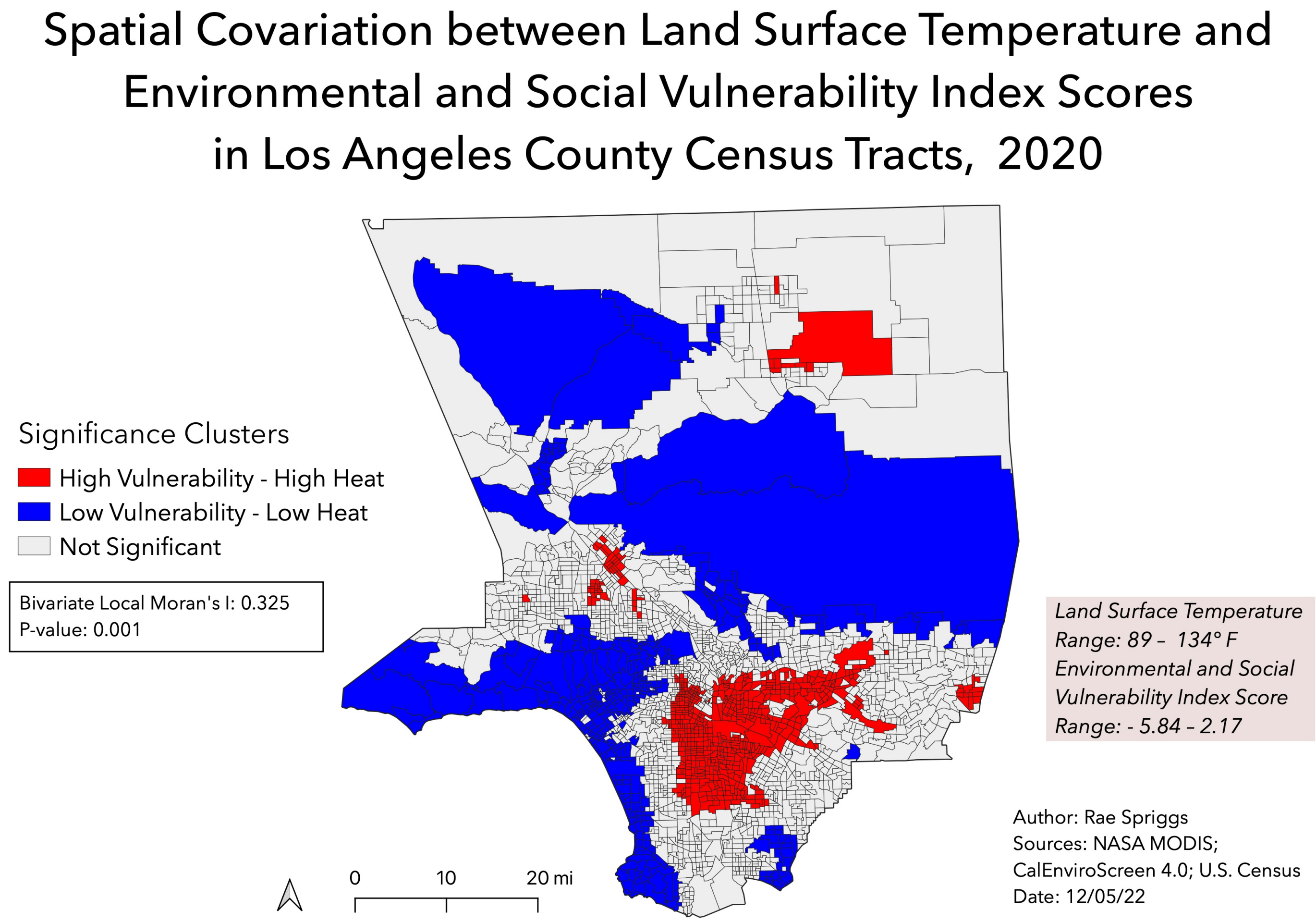
Tuesday LT4

Identifying Socially Vulnerable Communities Most Impacted by Extreme Heat Exposure in Los Angeles County, CA

Raenita Spriggs, Joel Capellan, Anne Nigra
Columbia University, New York, NY, USA

Abstract



Background: Climate change is increasing population exposure to extreme heat, which is associated with heat-related illness and mortality. This study explores whether communities that have high socioeconomic and environmental vulnerability are also overburdened by extreme heat. Our objectives were to a) develop an “Environmental and Social Vulnerability Index” reflecting overall racial/ethnic composition, socioeconomic vulnerability, and pollution burden in Los Angeles County census tracts, and b) evaluate the spatial covariation between the newly developed Environmental and Social Vulnerability Index and daytime land surface temperature as a proxy for extreme heat exposure.

Methods: We extracted median household income and racial/ethnic composition from the 2020 census, the overall pollution burden score from CalEnviroScreen, and average daytime land surface temperatures (September 6, 2020) from MODIS for N = 2,495 Los Angeles County census tracts. We used principal component analysis in GeoDa to develop an Environmental and Social Vulnerability Index score composed of the pollution burden score percentile, median household income, and proportion of people of color. To evaluate the spatial covariation between the Environmental and Social Vulnerability Index score and land surface temperatures, we employed Bivariate Local Moran’s I.

Results: Our Bivariate Local Moran's I value of 0.325 (p-value = 0.001) indicates high spatial autocorrelation between Environmental and Social Vulnerability Index scores (range: - 5.84 – 2.17) and daytime average land surface temperatures (range: 89 - 134 F) across Los Angeles County. Census tracts in the high-high clusters were found in South Central and Southeast LA (Compton, South Gate, Huntington Park, Commerce) and Northeast LA (Palmdale).

Conclusion: Neighborhoods experiencing high environmental and social vulnerability are also overburdened by extreme heat exposure. Developing community resilience centers in high-high cluster neighborhoods could be an effective strategy to mitigate heat impacts for the most vulnerable populations. Future analyses should explore other factors that capture social vulnerability.

Tuesday LT4

Evaluating Air Pollution Disparities in Nova Scotia, Canada with Satellite Remote Sensing and Low-Cost Sensor Monitoring

Aline Maybank, Alexandra Del Favero-Campbell, Kelvin Fong
Dalhousie University, Halifax, Canada

Abstract

Background

In Canada, air pollution is linked to over 15,000 annual premature deaths. Air pollution is also associated with multiple morbidities, including cardiovascular and pulmonary disease. Despite strong evidence of air pollution's impact on health, there are gaps in quantifying air pollution disparities in locales such as Nova Scotia, Canada, where there is a history of environmental inequity. Therefore, we investigate air pollution disparities to inform the current extent of environmental injustice.

Methods

We employ two approaches to study air pollution disparities in Nova Scotia: satellite remote sensing and air quality monitoring. For satellite remote sensing, we use Google Earth Engine to assess ambient air pollution (e.g., NO2, SO2) levels. Since remote sensing can be limited in temporal resolution, we also leverage a network of air quality sensors (i.e., PurpleAir) to assess fine particulate matter (PM2.5) levels. We link these pollutant levels to Canadian Census data to evaluate air pollution's relationships with sociodemographic variables such as income, indigenous identity, and visible minority status. We communicate our findings via maps and interactive graphs.

Results

There are large gaps in air pollution monitoring in rural areas, with most sensors concentrated in the capital city of Halifax. Preliminary findings suggest higher air pollutant levels in regions with industrial sources than in urban or rural areas.

Discussion

Air pollution disparities persist in a province that has relatively low average air pollution levels. Since even low levels of air pollution are linked to health effects, exposure disparities can lead to health disparities. By identifying areas of higher air pollution levels or increased frequency of air pollution spikes using different assessment methods, our findings inform areas for targeted interventions and policies to minimize air pollution's public health burden.

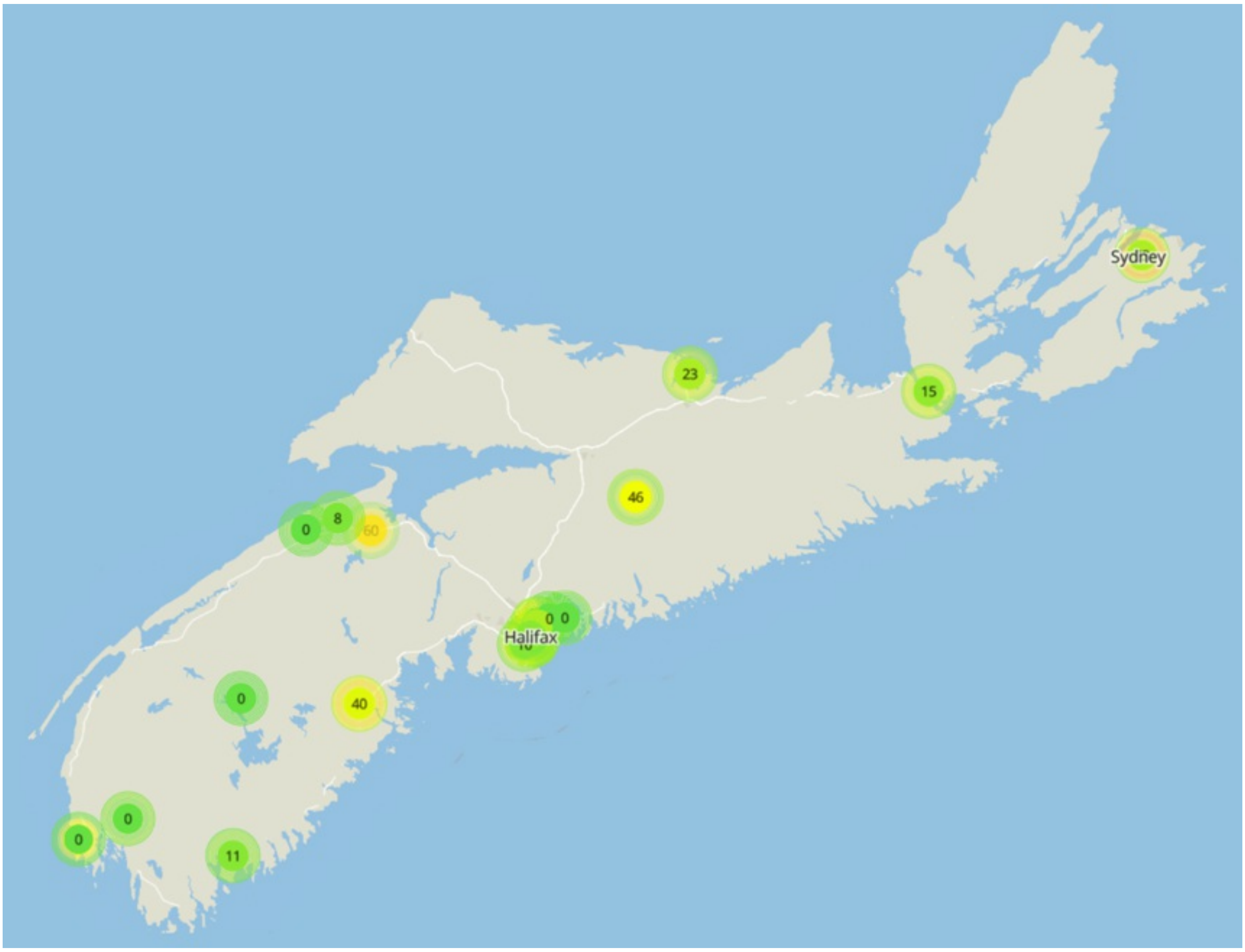


Figure. Map of Public PurpleAir Sensors in Nova Scotia, Canada on December 9, 2022

Tuesday LT4

'White Roads Through Black Bedrooms': Association between redlining and historical traffic-related air pollution in the US

Misbath Daouda[1], Xiarong Shan[2], Lucas Henneman[2], Joan A. Casey[1]

[1]Columbia University Mailman School of Public Health, New York, USA. [2]Dept. of Civil, Environmental, & Infrastructure Engineering George Mason University, Fairfax, USA

Abstract

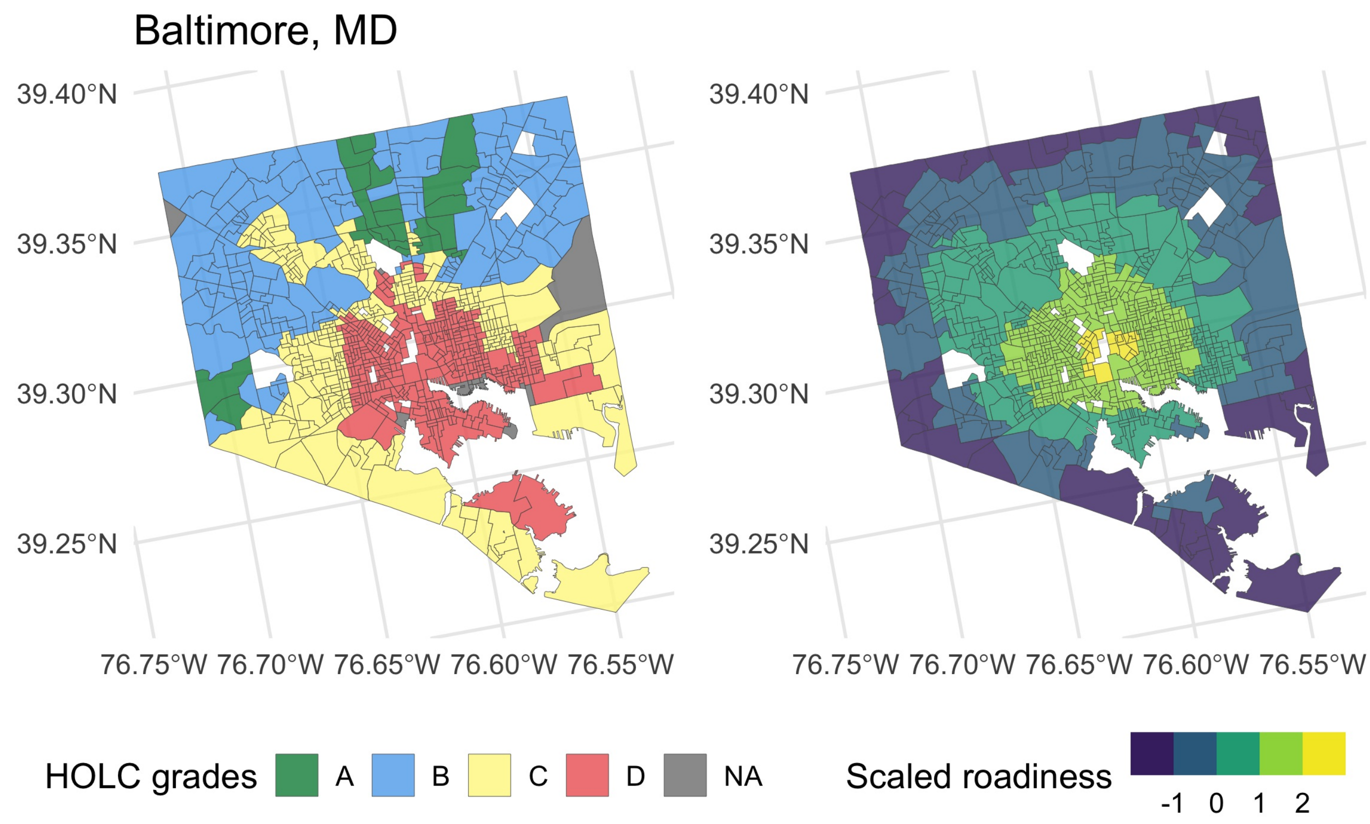


Figure 1. Redlining and 'roadiness' in Baltimore, MD (1940).

Background/aims:

Several studies have reported an association between redlining (determined by Home Owner Loan Corporation (HOLC) grades) and present-day air pollution in the United States. However, the role of redlining in the distribution of historic traffic-related air pollution (TRAP) prior to and after the completion of the Highway Act of 1956, which led to a 41,000-mile rapid expansion of the US highway system, has not been investigated. We aimed to 1) evaluate the association between HOLC grades and TRAP in 1940 and 2) determine the extent to which HOLC grades and racial/ethnic composition were predictive of

highway siting as part of the Highway Act.

Methods

We obtained 1940 HOLC grades and demographic characteristics at the enumeration district (ED) level. We generated 1940 ED-level estimates of the contribution of roadways to TRAP using a reduced complexity exposure model. The resulting “roadiness” metric, which was shown to correlate highly with TRAP concentrations in a long-term nationwide analysis, was scaled by its national standard deviation (SD). Linear mixed models with a random intercept for city were employed for overall and stratified analyses. Analyses related to highway siting required archival work and are currently underway.

Results

Across 11,060 metropolitan EDs, redlined EDs (the lowest HOLC grade) had the highest average percentage of Black residents (19.4%), the lowest median home value ($3440) and the highest average roadiness (0.40 SD). Compared to EDs with the best HOLC grade, roadiness in redlined EDs was 0.62 (95% CI: 0.56, 0.69) SD higher. The magnitude of the association differed by regions with the strongest association found in the Northeast.

Conclusion

Our study provides evidence that structural racism in federal policy is associated with the disproportionate siting of traffic-related infrastructure and TRAP.

Tuesday LT4

Barriers to Alaska Native Tribes' Shellfish Toxin Testing: Perspectives from Environmental Managers

Hugh Roland[1], Jacob Kohlhoff[2], Sneha Hoysala[3], Kari Lanphier[2], Christopher Whitehead[2], Matthew Gribble[1]

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Abstract

Background

Subsistence shellfish harvesting is central to coastal Alaska Native culture. However, consumption of non-commercial shellfish puts Alaska Native communities at elevated risk of exposure to paralytic shellfish toxins since state toxin monitoring programs only test commercial shellfish. To fill gaps in toxin monitoring and address related health disparities, tribes across Alaska have created toxin testing programs. In light of missing data encountered in monitoring, we initiated this social science study to understand barriers to community data collection and testing and related outreach and education.

Methods

We conducted 30 interviews of environmental managers responsible for Tribes' toxin testing, as well as others with relevant expertise (of 43 individuals invited), during the Southeast Environmental Conference hosted by the Central Council of Tlingit and Haida Indian Tribes of Southeast Alaska and the Sitka Tribe of Alaska from August 29 to September 3, 2022. Questions included open-ended and Likert-scale responses. Interview data was thematically coded and analyzed with multiple coders.

Results

Participants ranked limited funds, staffing, and supplies as the largest barriers to Tribes' testing, followed by risk perception-related challenges with community engagement and participation. In qualitative responses, participants described communities' remote settings contributing to these challenges. Additionally, participants felt that smaller and more remote communities were overlooked in environmental programming and general service provision necessary to support testing. Participants ranked the Tribal network as the most important factor supporting testing. Environmental managers involved in data management also perceived shifts in where and when toxin exposures occur and linked shifts to environmental changes, including warmer temperatures and shifting seasonality.

Conclusion

Participants' perceptions of barriers to Tribes' toxin testing may inform community-based environmental research and toxin testing and exposure prevention. Further research might assess community members' risk perceptions, diets, and harvesting practices to better understand exposures and model risks.

Tuesday LT4

Applying the Community Assessment for Public Health Emergency Response (CASPER) toolkit methodology to neighborhood surveys in environmental justice communities in Los Angeles, California

Elizabeth Kamai[1], Jennifer Lentz[2], Joe Lyou[2], Cynthia Babich[3], Felipe Aguirre[4], Gabriel Carrillo[5], Jesse Marquez[6], Ricardo Pulido[6], Carrie Tayour[7], Jill Johnston[1]

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Abstract

Background

Environmental justice (EJ) communities in Los Angeles (LA), California are disproportionately burdened by pollution sources including major freeways, truck traffic, refineries, ports, railyards, smelters, industrial operations, and Superfund sites. There are several regulatory policies aimed at reducing pollution in these communities but few metrics of whether they effectively address the environmental and health concerns of residents. The purpose of this project was to conduct rapid, household-level environmental health surveys in EJ communities using the CDC Community Assessment for Public Health Emergency Response (CASPER) Toolkit methodology.

Methods

A coalition of nonprofits, academic researchers, public health officials, and community-based EJ organizations developed household-level surveys tailored to four communities in LA. Survey teams of trained community members collected data between Fall 2021 and Summer 2022. Survey results were shared with community members, policymakers, and stakeholders.

Results

Community members conducted a total of 818 interviews, which represented 90,860 households. The most frequently reported health concerns across the four communities were allergies, high blood pressure/heart problems, anxiety or depression, and diabetes. More than 2/3 of households identified outdoor air pollution, particularly from nearby truck traffic and local industries, as an environmental concern. Other neighborhood-specific concerns included contaminated land, illegal dumping, acid use at local refineries, and lack of green space. Feedback from local stakeholders on the survey results were mixed. For some, the results validated their lived experiences. Others were frustrated that cross-sectional, household-level data could neither be directly compared to rates of diseases in LA nor provide causal links between exposures and outcomes.

Conclusion

Advantages to conducting a CASPER survey include standardized methodology, speed of execution, and relatively low resource use, facilitating rapid research in EJ communities. These surveys provide

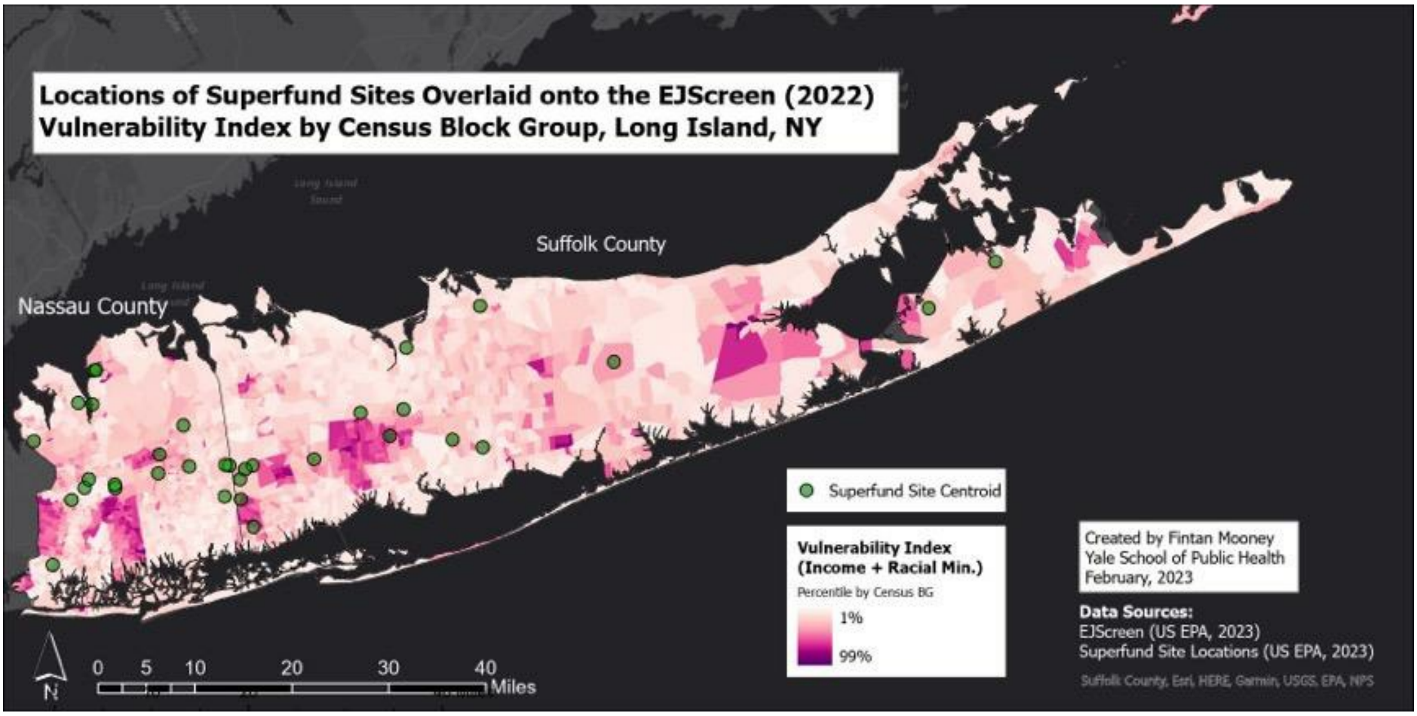
quantitative evidence validating the lived experiences of households in EJ communities and key baseline measures against which future surveys can be compared.

Tuesday LT4

A Geospatial Analysis of Demographic Characteristics and Environmental Burdens in Communities Near Superfund Sites, Long Island, New York

Fintan Mooney, Jill Kelly, Joshua Warren, Vasilis Vasiliou, Nicole Deziel
Yale School of Public Health, New Haven, USA

Abstract



Background: Nassau and Suffolk Counties of Long Island, New York, have over 30 federal Superfund sites (i.e., hazardous waste sites). Superfund sites may contribute to increased cancer risk and health inequities in nearby communities due to potential drinking water contamination and air pollutant emissions. Structural differences in neighborhood concentration of environmental hazards may be driving racial and income health disparities. We assessed proximity to Superfund sites on Long Island in relation to community demographics and presence of other environmental burdens.

Methods: Data were obtained from the U.S. Environmental Protection Agency’s Environmental Justice Screening and Mapping Tool (EJScreen) and included proximity to Superfund sites (operationalized through EJScreen’s inverse distance weighting score), presence of other environmental hazards, and sociodemographic variables from the U.S. Census American Community Survey. Data were obtained for 2022 at the census block level. Bivariable statistical tests were performed overall and by county to evaluate demographic characteristics and presence of additional environmental hazards in relation to proximity to Superfund sites.

Results: Preliminary findings show that areas closer to Superfund sites (above median proximity) have a statistically significantly higher proportion of racially minoritized groups, lower English proficiency, and a lower proportion of high school graduates; the magnitude of associations were higher in Suffolk versus Nassau Counties. Moreover, communities near Superfund sites have statistically significantly higher proportions of old housing units; proximity to hazardous waste facilities; and ambient fine particulate matter concentrations.

Conclusion: Our findings suggest that socially vulnerable populations in Long Island are at increased risk for the potentially adverse environmental exposures associated with Superfund sites. The health risks of

living near Superfund sites may be compounded by proximity to other environmental hazards. This study underscores the need for a more comprehensive exposure assessment of at-risk populations living near Superfund sites on Long Island.

Tuesday LT4

Assessing Occupational Justice in the State of Michigan

Abas Shkembi[1], Sung Kyun Park[2,1], Jon Zelner[2], Richard Neitzel[1]
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Abstract

Workplaces present a tremendous variety of hazards (e.g., physical, chemical, psychosocial). While exposures to environmental hazards such as air pollution can be considerable, occupational exposures are often orders of magnitude greater than environmental exposures and present concordantly higher disease risk to communities. Of particular susceptibility to these higher risks are low-wage and racial/ethnic minority workers, who are more likely to work in hazardous workplaces. Thus, occupational exposures should not be discounted in assessments of environmental justice. This descriptive study sought to examine the state of occupational justice in Michigan, collectively with environmental justice. Six novel occupational indicators for each census tract in Michigan were constructed: one chemical hazard (exposure to contaminants); three physical hazards (exposure to hazardous equipment, hazardous conditions, and noise exposure); and two biological hazards (exposure to disease/infections and physical proximity to other workers). Frequency of exposure was assessed via the Department of Labor's ONET and combined with tract-level data of total employment count by major occupational groups to create a weighted frequency score for each Michigan tract. This data was combined with metrics of environmental hazards and vulnerable populations from the EPA EJScreen. Results showed that the percentage of racial/ethnic minorities and low-income individuals across Michigan is positively associated with higher frequency of exposure to hazardous occupational exposures. A cumulative "OEJ" index score which incorporates measures of occupational hazards alongside environmental exposures and vulnerable population characteristics was developed to identify the most vulnerable communities in Michigan. This index highlights that occupational exposures should be considered in assessments of environmental justice in Michigan, that EJ screening tools such as should consider incorporating such measures, and reaffirms the 8th principle of environmental justice of all workers' right "to a safe and healthy work environment without being forced to choose between an unsafe livelihood and unemployment".

Uncaptioned visual

Tuesday LT5

Predictors of early life residential mobility in urban and rural Pennsylvania populations

Cassandra Clark[1,2], Joshua Warren[3], James Saiers[4], Xiaomei Ma[5], Michelle Bell[4], Nicole Deziel[1]
[1]Yale School of Public Health, Department of Environmental Health Sciences, New Haven, USA. [2]Yale Cancer Center, New Haven, USA. [3]Yale School of Public Health, Department of Biostatistics, New Haven, USA. [4]Yale School of the Environment, New Haven, USA. [5]Yale School of Public Health, Department of Chronic Disease Epidemiology, New Haven, USA

Abstract

Background. Exposure assessments in perinatal and pediatric epidemiology commonly use residential address at birth to assign exposure. However, expectant parents have a high rate of residential mobility, which can introduce exposure misclassification. Factors predicting mobility may vary by urbanicity.

Methods. We examined and compared predictors of early-life residential mobility between urban and rural children within a registry-based population of 400 Pennsylvania children diagnosed with leukemia for whom birth and diagnosis addresses were available. Urbanicity was defined using the Rural-Urban Commuting Area code for the birth residence. Residential mobility between birth and diagnosis was defined as: whether a child moved, distance moved, and whether the child changed census tracts. Factors associated with these metrics were compared across urban/rural populations using chi-square, t-tests, and logistic regression.

Results. A greater proportion of rural subjects moved (66.7%) and moved further on average (median: 3.5km) than suburban (60.7%, 0.3km) or urban (57.1%, 0.5km) subjects. Comparable proportions of urban and suburban/rural children changed census tracts upon moving (173 [48.5%] and 20 [46.5%], respectively). Within urban populations, moving was associated with race, educational attainment, using food stamps, census tract-level income, and a higher (i.e., more vulnerable) Social Vulnerability Index (all $p<0.01$). Specifically, urban Black mothers were 5.03 times more likely to move than white mothers (95% CI: 1.70-14.92), and mothers using food stamps were 2.64 times more likely to move than mothers who did not (95% CI: 1.67-4.17). Conversely, moving in suburban/rural populations combined was not statistically significantly associated with any factor.

Conclusions. We identified several factors associated with early-life residential mobility in urban children, though patterns in the suburban/rural population are less clear. Our results suggest that residential mobility occurs differentially both within and across urban/rural populations, which has implications for spatial exposure assessment methods using birth address in regional studies.

Tuesday LT5

Geospatial big data and GeoAI in environmental epidemiology

Yimeng Song, Michelle L. Bell
Yale University, New Haven, USA

Abstract

BACKGROUND: Rapid advances in geoinformatics and machine learning have not only led to the creation of massive amounts of geospatial big data and analytical/predictive frameworks, but have also raised concerns about the application of these data and techniques to environmental epidemiological studies. Many efforts have been made to utilize geospatial big data and GeoAI to identify environmental exposure patterns and conduct environmental health studies.

METHODS: We review current efforts of geospatial big data and GeoAI in improving accuracy, resolution and dimensionality of the information used and reducing model uncertainty in environmental-health analysis. We are particularly interested in how the fusion of multiple-source data and the appropriate use of advanced GeoAI technologies can improve our understanding of important issues in environmental epidemiology. We also discuss the advances, challenges, and opportunities of geospatial big data and GeoAI in examining the spatial relationship between environments and health.

RESULTS: Specifically, we focus on (1) the role of fine spatio-temporal resolution remote sensing imageries and advanced machine learning frameworks in the various environmental factors mapping, disaster monitoring, as well as socioeconomic dynamics sensing, (2) the use of user-generated geotagged data (e.g., social media data, mobile phone data) in modeling human spatial pattern, socioeconomic activities, and conducting dynamic human-environment exposure assessment, (3) the use of Internet behavioral information and natural language processing technologies for real-time and multi-scale measurement of population health and well-being, (4) the incorporation of new sensor-based data sources and computer vision technologies to enrich quantitative environmental metrics.

CONCLUSION: This thematic review helps fill the knowledge gap of recent advances in applying geospatial big data and GeoAI in environmental epidemiology. With careful utilization of these technologies, we will be capable of better understanding the intricate interactions between physical environments and human health.

Tuesday LT5

A novel framework for particulate matter exposure assessment in a multi-site clinical trial: The BREATHE Study (Bronchiolitis Recovery and the Use of High Efficiency Particulate Air Filters)

Ethan Walker[1], Sara Cox[1], Jennifer Faiella[1], Dave Jones[1], Paul Smith[1], Taylor Stewart[1], Linda Fu[2], Jeannette Lee[3], Kelly Cowan[4], Erin Semmens[1]
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Abstract

Background/Aims:

Air pollution exposure is a risk factor for adverse respiratory outcomes, particularly in vulnerable populations including children. In the BREATHE Study (Bronchiolitis Recovery and the Use of High Efficiency Particulate Air [HEPA] Filters), our primary aim is to assess the efficacy of portable air cleaners with HEPA filters at reducing respiratory symptom burden among infants recently hospitalized with bronchiolitis. As a part of the BREATHE study, we developed methods to remotely assess fine particulate matter ($PM_{2.5}$) concentrations inside participant households. Here, we report on data collection methods, equipment setup prior to the study, and quality control procedures.

Methods:

Exposure assessment for BREATHE will utilize 2 low-cost sensors (PAII-SD, PurpleAir, Inc, USA) to measure indoor $PM_{2.5}$ at each study household. To facilitate real-time, remote data access by the research team and minimal hands-on setup by study participants, we paired the 2 PurpleAir sensors for each household with a portable Wi-Fi hotspot (Solis Lite, Skyroam, Inc, USA). Prior to the study, each PurpleAir sensor was collocated with a Federal Equivalent Method instrument (BAM 1020, Met One Instruments, USA) for at least 48 hours in an indoor laboratory to assess sensor performance and quality assurance. During collocation, we implemented daily, automated data extractions to ensure sensors remained online and assess data quality.

Results:

We have collocated 400 PurpleAir sensors with a BAM reference monitor in preparation for the BREATHE study. In preliminary analysis, the median difference between hourly (n=23,704 hours) mean $PM_{2.5}$ (PurpleAir relative to BAM) during collocation was -2.3 µg/m3 (25th percentile = -5.8, 75th percentile = 0.6), with a Pearson correlation coefficient of 0.95.

Conclusions:

We have developed a framework for remote, real-time $PM_{2.5}$ exposure assessment for implementation in a 17-site clinical trial. This framework will serve as a model for use in future field studies.

Tuesday LT5

Development of a long-term time-weighted exposure metric that accounts for missing data, and associations with neurodevelopment through 24 years of age in the Seychelles Child Development Study

Sally Thurston[1], Gary Myers[1], Donald Harrington[1], Daniel Mruzek[1], Heather Adams[1], Conrad Shamlaye[2], Edwin van Wijngaarden[1]

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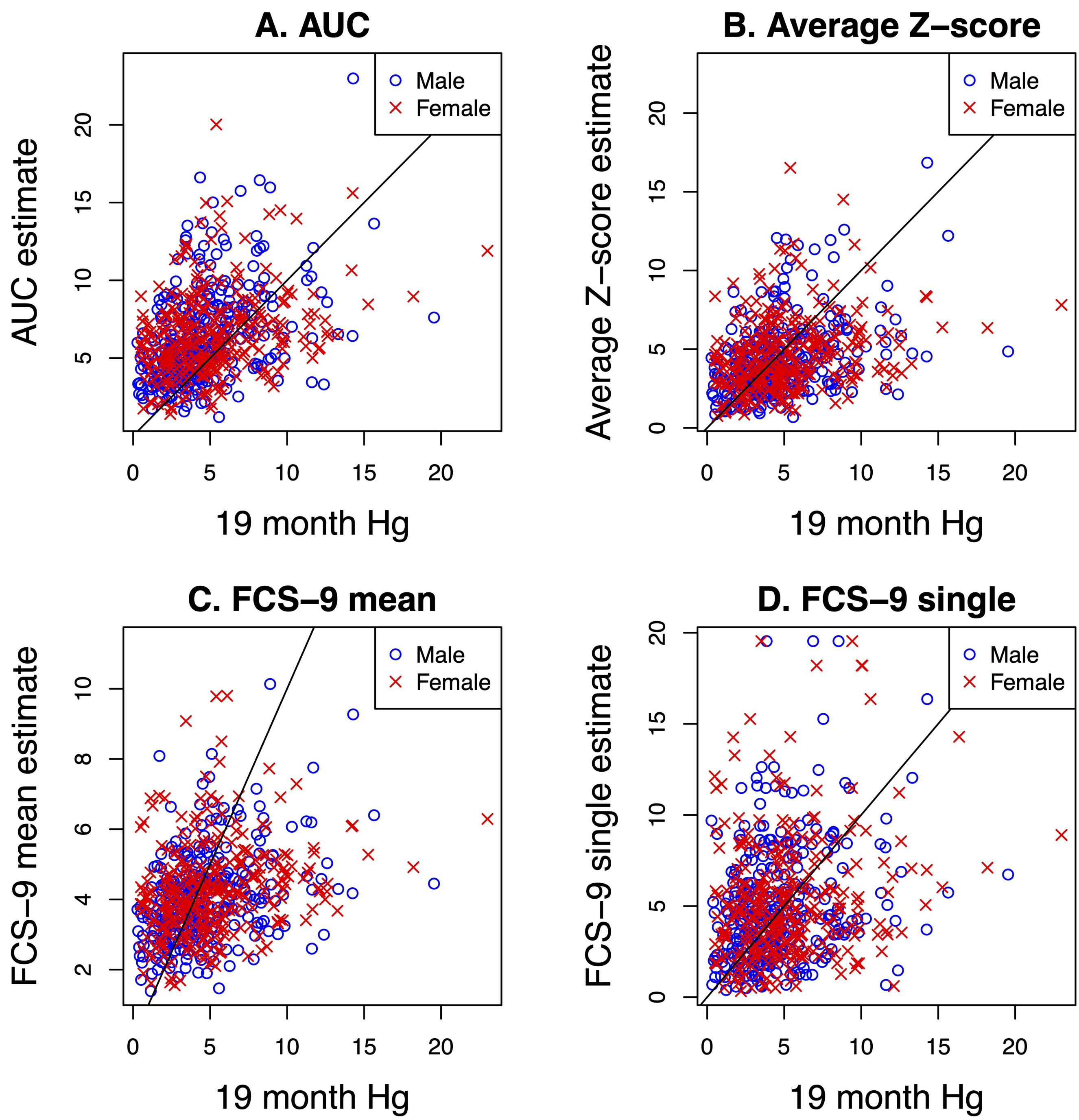
Abstract



Background/Aims: Some studies of toxicant associations collect repeated measures of participants' exposure over an extended time with the goal of determining a long-term exposure metric. This is challenging when exposure is measured at irregular intervals and has missing values.

Methods: We developed a long-term exposure measure using data on postnatal mercury (Hg) from the Seychelles Child Development Study (SCDS) Main Cohort as a model. In this cohort (n=779), we incorporated participants' postnatal Hg measurements at seven ages: three in childhood (6-66 months) and four in early adulthood (17-24 years). We imputed subject-specific missing values using age- and sex-specific Hg means and the participant's Hg values at similar ages based on average Z-scores. We then compared observed to imputed Hg values to assess the accuracy of our method. We compared this to the accuracy using implicit Hg values from an overall average or an area under the curve (AUC) metric, and to Fully Conditional Specification (FCS), an alternative method of imputing missing data. Finally, we created time-weighted average Hg exposure measures and examined their covariate-adjusted associations with 85 neurodevelopmental outcomes measured from 9-24 years in the SCDS (n=312-550).

Results: Imputed values from our average Z-score method were closer to observed Hg values than other methods (Figure 1). There were 14 statistically significant associations between time-weighted average Hg and neurodevelopmental outcomes. Thirteen were with 17-24 year outcomes and all were adverse.

Conclusion: Our method for imputing missing exposure was more accurate than other approaches and is applicable to any study with longitudinal exposure measures. Our time-weighted approach to combine multiple exposure measures is less sensitive to differences in ages within and between participants than an overall average or AUC metric. Its application to the SCDS suggest that postnatal Hg exposure may be adversely associated with neurodevelopment in early adulthood.

Tuesday LT5

Quantifying the physical presence of road infrastructure and traffic in US cities — The Community Severance Index

Jaime Benavides, Marianthi-Anna Kioumourtzoglou
Dept. of Environmental Health Sciences, Columbia University Mailman School of Public Health, New York City, USA

Abstract

Background: Traffic-related exposures, such as air pollution and noise, have a detrimental impact on human health in urban areas. However, there remains a critical research and knowledge gap in understanding the impact of community severance, a measure of the physical separation imposed by road infrastructure and motorized road traffic. To date, the few studies of community severance have focused on qualitative, survey-based assessments and spatial domains of just a few streets. We aimed to characterize community severance at high spatial resolution in New York City (NYC).

Methods: We used built environment data related to the physical presence of road infrastructure and road traffic from different sources, including road network density from the US-EPA and road traffic intensity from ESRI, at census block group level. We use principal components pursuit (PCP) to decompose the raw data matrix into a low-rank matrix to identify consistent patterns and a sparse matrix to isolate unique values not explained by the patterns. After running PCP, we ran factor analysis (FA) on the low-rank matrix to determine the community severance index. To assess robustness, we compare the resulting profile with running FA directly on the raw data matrix.

Results: We identified a profile representing community severance in the pattern recognition process using PCP and FA. This profile was positively associated with road infrastructure variables such as road network density and road traffic intensity. We identified a similar pattern using FA on the raw data. The estimated community severance index tends to be higher near the main roads in the city and decreases in more walkable areas.

Conclusions: This preliminary work shows the usefulness of applying pattern recognition techniques to identify a profile varying coherently with our conceptualization of community severance. Next steps include extensive sensitivity analyses to assess the robustness of the results.

Tuesday LT5

Feasibility and Accuracy of In-home Monitoring of $PM_{2.5}$ using Low-Cost Sensors

Kirsten Koehler[1], Megan Wood[1], Timothy Green[1], Ana Rule[1], Nadia Hansel[2], Nirupama Putcha[2], Gregory Kirk[1], Sarath Raju[2], Christian Jenkins[1], Misti Zamora[3], Abhirup Datta[1], Colby Buehler[4], Drew Gentner[4], Meredith McCormack[2]
[1]Johns Hopkins University, Baltimore, USA. [2]Johns Hopkins Medicine, Baltimore, USA. [3]University of Connecticut, Farmington, USA. [4]Yale University, New Haven, USA

Abstract

Although American adults spend most of their time indoors, long-term monitoring of indoor $PM_{2.5}$ concentrations has been infeasible due to the cost and maintenance requirements of gravimetric sampling (the gold standard). Lower-cost $PM_{2.5}$ sensor technology, like the PurpleAir monitors, has improved feasibility. PurpleAir monitors overestimate ambient $PM_{2.5}$ concentrations in the US, but few studies have evaluated their accuracy for indoor monitoring. We included indoor monitoring data from six BREATHE Center studies in Baltimore, MD (N=193 weekly samples in 117 homes) that included both PurpleAir monitors and gravimetric samples for one-week durations. The accuracy of the internal calibrations, published ambient air calibrations, and calibrations using baseline filter concentrations to correct data collected 3-6 months later were evaluated. The median weekly gravimetric $PM_{2.5}$ mass concentration was 27 µg/m^3 and values were approximately lognormally distributed with the highest concentration exceeding 330 µg/m^3. PurpleAir internal calibration estimates were biased substantially high (slope of linear regression = 2.08), but calibrations were able to reduce these biases (slopes reduced to 0.75 - 1.12). We also evaluated whether individuals would be assigned to the correct exposure groups (e.g. quartiles of exposure based on gravimetric concentration) when the PurpleAir is used (see Sankey plot; Figure 1). Participants from the various studies (indicated by numbers) were generally spread among the four quartiles of exposure. Given the strong correlation between the gold standard concentrations and the PurpleAir data, even without any extra calibration, the majority of participants were assigned to the correct quartile of exposure (76%). Due to the linearity of the calibrations, only 7% of participants moved quartiles using calibrated data. PurpleAir monitors are relatively low-cost, easy to deploy, and show promise for long-term assessment of home $PM_{2.5}$ exposures.

Figure 1: Partitioning of participants from studies 1-6 to quartiles of $PM_{2.5}$ exposure by gravimetric concentration (gold standard) and PurpleAir estimates.

Tuesday LT5

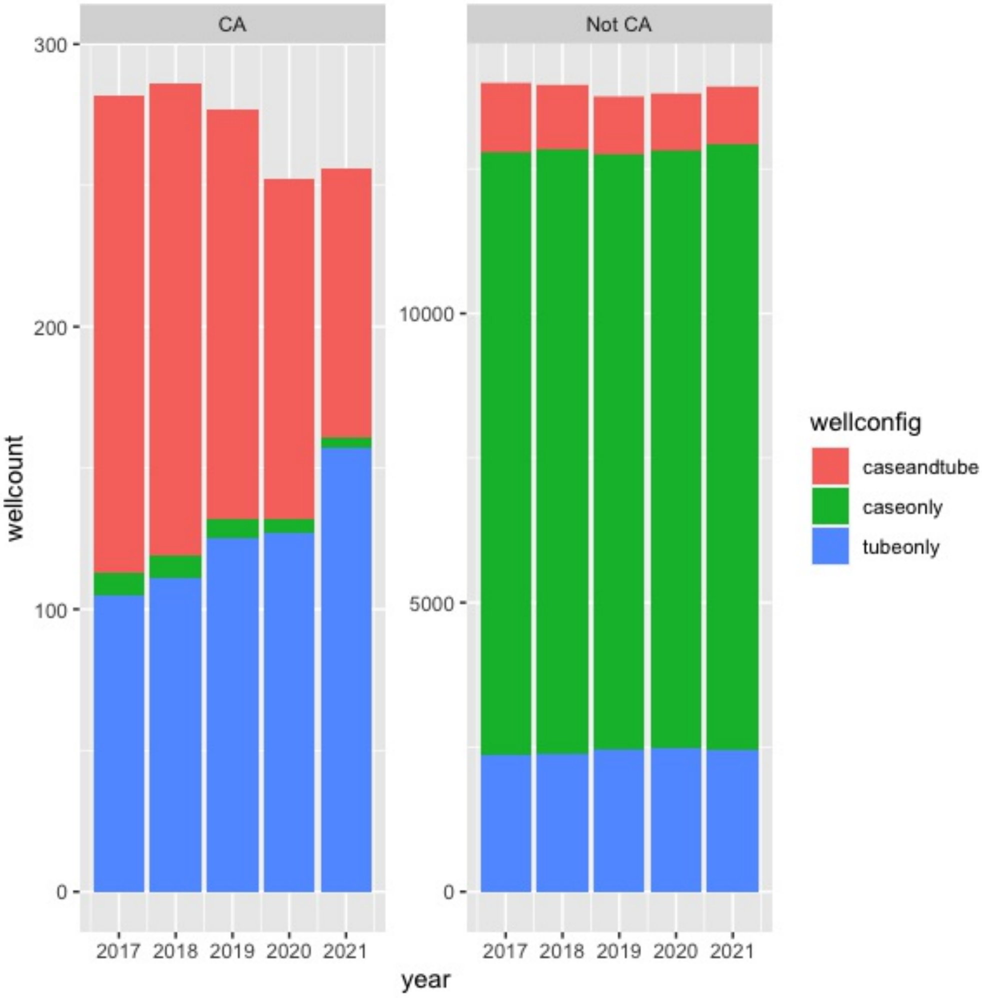
Exposures to health hazards from underground gas storage – available data, barriers, and solutions to enable further research

Jonathan Buonocore[1], Parichehr Salimifard[2], Brian Sousa[3], Mahala Lahvis[3], Joseph Allen[3]
[1]Boston University, Boston, USA. [2]Oregon State University, Corvallis, USA. [3]Harvard T.H. Chan School of Public Health, Boston, USA

Abstract

Underground gas storage (UGS) is a crucial node of the gas transmission and distribution system. Around 10-20% of gas produced in the U.S. passes through a UGS facility. These facilities are often sited on the periphery of urban areas in repurposed oil & gas fields, or in depleted aquifers. These facilities can be prone to leaks, including catastrophic leaks from well failure; these events which can have serious consequences for both climate and for public health. When the Aliso Canyon UGS facility in Porter Ranch, CA leaked, it released 99,368 metric tons of gas. Around 5,790 households were evacuated during the 118-day leak. There was evidence that people were exposed to benzene, toluene, ethyl benzene, and xylene (BTEX), mercaptans, and other compounds present in the leaked gas, along with PM2.5 from the efforts to plug the well. People in the area experienced symptoms including nausea, dizziness, vomiting, and eye, nose, and throat irritation. Populations around a storage well that failed in Cambria County, Pennsylvania in November of 2022 experienced similar symptoms after that well began leaking.

The well failure at Aliso Canyon stemmed from a single-point-of-failure well design, meaning for a portion of the well, a single barrier separated gas from the environment. Here, we evaluate the current prevalence of this well design in the existing U.S. UGS fleet and demonstrate that little changes have occurred in the UGS fleet outside of California. Additionally, we use UGS as a case study of the oil & gas “midstream” infrastructure (encompassing mainly pipelines, storage, other infrastructure for transmission and distribution) to discuss the obstacles and challenges to performing robust exposure assessment around and epidemiological studies around oil & gas midstream infrastructure, and potential paths forward.



CA
Not CA
300
200
100
0
10000
5000
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2017
2018
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2020
2021
year
wellconfig
caseandtube
caseonly
tubeonly

Tuesday LT5

Using Novel Fine Scale Air Pollution Exposure Assessment Methods to Estimate Health Benefits of Vehicle Electrification in New York City

Jonathan Buonocore[1], Muskaan Khemani[1], Brian Naess[2], Catherine Seppanen[2], Kat Lau[3], Frederica Perera[3], Ananya Roy[4], Saravanan Arunachalam[2]
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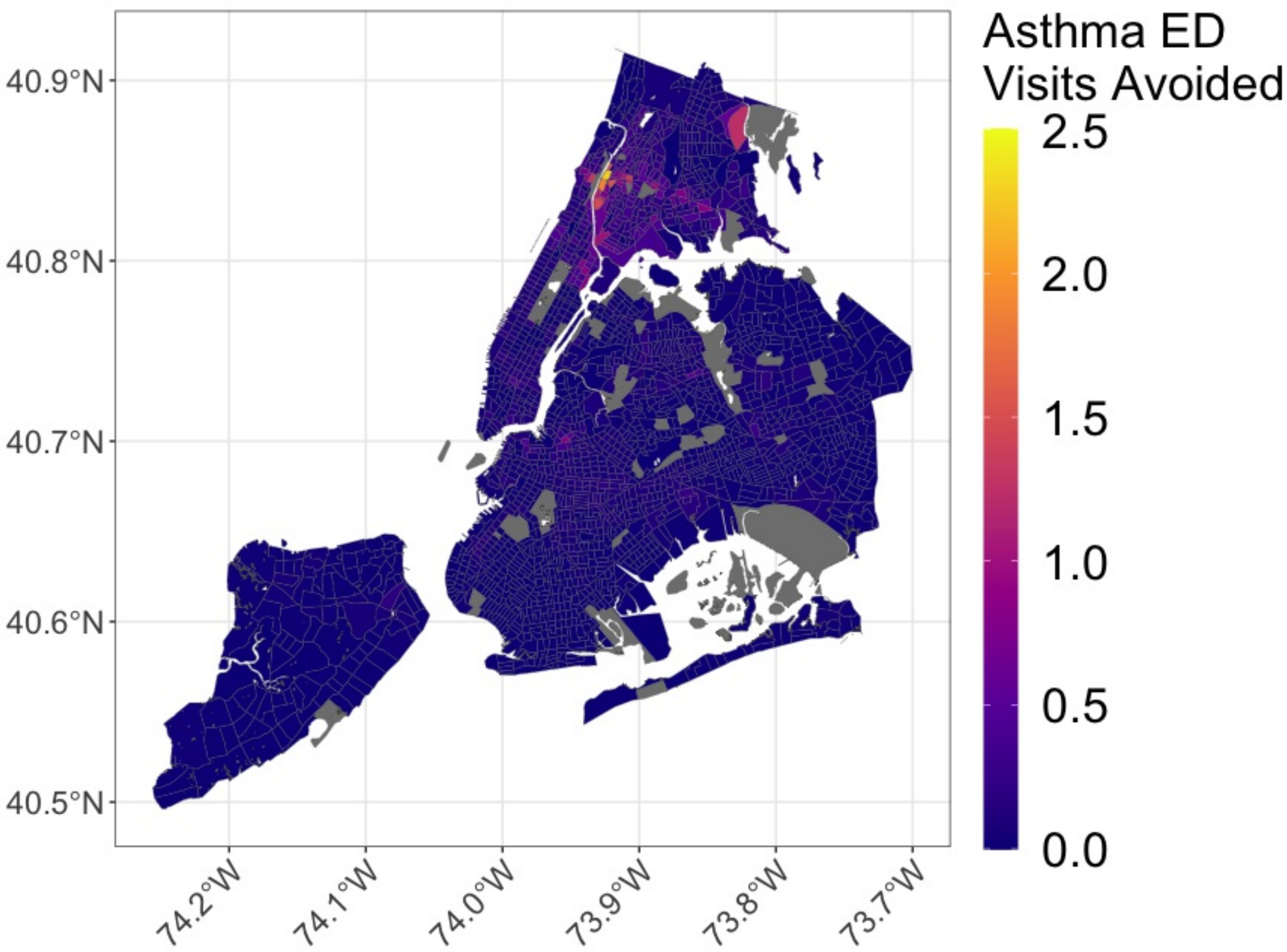
Abstract

Vehicle electrification is a strategy that has been proposed to reduce greenhouse emissions along with air pollutants. Vehicle electrification may also have environmental justice benefits by alleviating air pollution near roadways. Here, we apply a novel exposure assessment framework – the Tract level Air Pollution Policy Assessment Tool (TRAPPA) – alongside the Benefits Mapping and Analysis Program in R (BenMAPR) to evaluate changes in air pollution exposure and consequent health benefits that would result from electrifying medium and heavy-duty vehicles in New York City. We find that a 100% conversion to electric vehicles by 2040 would result in approximately 248 deaths and 173 childhood asthma emergency department visits avoided annually. Up to 68% of the asthma ED visits avoided could occur in tracts that are >85% non-white, and half of the asthma ED visits avoided could be in census tracts with average per capita income under $20,000 per year. The TRAPPA air pollution exposure modeling framework could be used in environmental justice applications to understand localized impacts of air pollution sources, and can be used to better understand patterns of exposure to transportation related air pollution near roadways, and other applications where understanding of local-scale air pollution patterns are important for robust exposure assessment.



Asthma ED
Visits Avoided
2.5
2.0
1.5
1.0
0.5
0.0
40.9°N
40.8°N
40.7°N
40.6°N
40.5°N
74.2°W
74.1°W
74.0°W
73.9°W
73.8°W
73.7°W

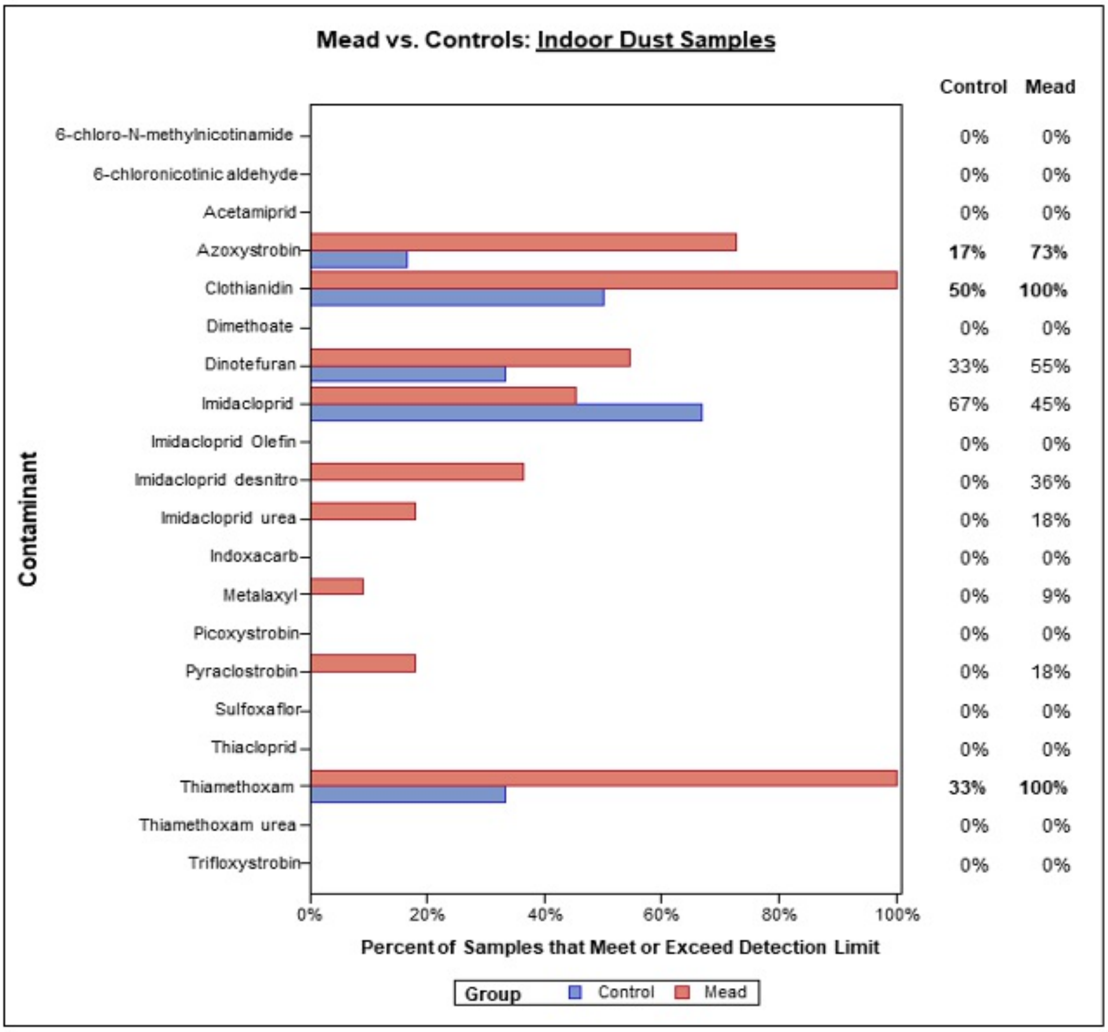
Tuesday LT5

Environmental sampling of residential air and dust resulting from AltEn plant environmental contamination in Saunders County, Nebraska

Jabeen Taiba, Muhammad Zahid, Eleanor Rogan
University of Nebraska Medical Center, Omaha, USA

Abstract

Pesticide exposure, primarily neonicotinoids, has been associated with various adverse human health outcomes. Epidemiological studies demonstrated that the general population is exposed to pesticides through diet and indoor dust. In Saunders County, Nebraska, there is environmental contamination from the AltEn ethanol plant that used seed coated with fungicides and insecticides, including neonicotinoids. Eighty-four thousand tons of toxic wet cake were piled outdoors and, for two years, sold as fertilizer contaminated with toxins exceeding 1,000 times the US EPA limits. Furthermore, clothianidin and thiamethoxam levels of 427,000 ppb and 85,100 ppb were recorded in the AltEn waste. To evaluate the potential for human exposure through airborne contamination, University of Nebraska Medical Center researchers conducted air and surface sampling of residences in or near Mead and control towns. Residential air and surface sampling was conducted by using SASS® 2300 Wetted-Wall Air Sampler and Ghost wipes with a 4 x 4-inch template, respectively, in eleven Mead houses and six control houses in Kennard and Omaha. Indoor and outdoor air was sampled, and analyzed for 21 target chemicals, using mass spectrometry with UPLC separation in the Water Sciences Laboratory, University of Nebraska-Lincoln. Descriptive statistics included mean, standard deviation, median, interquartile range, and range for all contaminants above the detection limit. Fisher’s Exact Test assessed associations between detection limit groups and Mead/control groups. Pesticides were mainly detected in dust samples and showed significant association between the detection limit group and Mead/control group, including Azoxystrobin, Clothianidin, and Thiamethoxam. Among air samples, Thiamethoxam showed significant association between the detection limit group and Mead/control group. Overall, level of contamination in Mead houses was significantly higher than in the controls. Using pesticide detection rates in residential settings can help identify highly contaminated areas and prioritize contaminant disposal activities, enhance policy actions, and protect public health.



Mead vs. Controls: Indoor Dust Samples
Control Mead
6-chloro-N-methylnicotinamide 0% 0%
6-chloronicotinic aldehyde 0% 0%
Acetamiprid 0% 0%
Azoxystrobin 17% 73%
Clothianidin 50% 100%
Dimethoate 0% 0%
Dinotefuran 33% 55%
Imidacloprid 67% 45%
Imidacloprid Olefin 0% 0%
Imidacloprid desnitro 0% 36%
Imidacloprid urea 0% 18%
Indoxacarb 0% 0%
Metalaxyl 0% 9%
Picoxystrobin 0% 0%
Pyraclostrobin 0% 18%
Sulfoxaflor 0% 0%
Thiacloprid 0% 0%
Thiamethoxam 33% 100%
Thiamethoxam urea 0% 0%
Trifloxystrobin 0% 0%
Contaminant
0% 20% 40% 60% 80% 100%
Percent of Samples that Meet or Exceed Detection Limit
Group Control Mead

Tuesday LT5

Evaluation of ambient industrial metal emissions and internal dose measured using a toenail biomarker

Joyce Lin[1], Kaitlyn Lawrence[2], Braxton Jackson[3], Dale Sandler[2], Aisha Dickerson[1], Lawrence Engel[4], Ana Rule[1]
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Abstract

Background/Aims: The US Gulf region is heavily reliant on the oil and gas, chemical, and agricultural industries and has some of the highest density of EPA toxic release inventory sites per square mile in the country. We sought to characterize metal exposures from predicted industrial emissions in a cohort of US Gulf State residents using a toenail metal biomarker.

Methods: We measured toenail concentrations of arsenic, chromium, lead, manganese, mercury, and selenium using inductively coupled plasma mass spectrometry in 413 non-smoking men in the Gulf Long-term Follow-Up Study (2011-2013) following the 2010 Deepwater Horizon oil spill. Point sources of industrial metal emissions were identified using the National Emissions Inventory (NEI) and mapped to geocoded participant residential addresses. For each metal, we assessed associations between toenail metal concentration and inverse-distance weighted predictions of NEI emissions, as well as the number of emissions sites and volume of metal emissions within 3, 5, and 10 km radial buffers of the residencese using multivariable linear regression. Models were adjusted for personal, oil spill, and neighborhood-level metal exposure risk factors.

Results: We observed significant associations between predicted industrial metal exposures and toenail metal concentration for lead. For every one-unit increase in number of lead emissions sources within 3, 5, and 10 km of the residence, we observed 23% (95% CI: 3.3, 38), 9% (95% CI: 0.006, 17), and 8% (95% CI: 3.4, 13) increases in toenail lead concentration. Inverse distance weighted estimates and volume of reported emissions were not associated with toenail metal concentrations for any of the metals tested.

Conclusion: The number of lead emissions sites near the residence was positively associated with toenail lead concentrations. Commonly used inverse distance weighting and radial buffer approaches do not appear to be associated with internal metal dose as measured using toenails in this population.

Tuesday LT5

Application of Specific Tools and Procedures for Including Occupant Experience of the Indoor Environment into Objective Epidemiological Explorations

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Abstract

Assessing occupant experiences in the indoor environments of buildings, especially homes, are most often in the form or complaints. The effort is fraught with challenges and uncertainty because of the need for information beyond measuring physical characteristics of the structure and routine epidemiological considerations. The inclusion of specifics about the occupant's experiences and needs raises the concerns of crossing into the forbidden area of subjective, anecdotal (non-scientific) information. Close engagement with building occupants also increases the risk of unintentionally becoming entangled in the psychological dynamics of the subjects. However, avoiding these subjective and anecdotal categories unnecessarily eliminates important, sometimes critical, details for a successful exploration of the indoor environment, especially for homes. This presentation introduces principles of occupant inclusion, specific tools for obtaining that information, an applying it to both benefit the occupant and researcher.

One particularly informative tool was developed by Claudia Miller now at the University of Texas, San Antonio, and Nicholas Ashford at MIT in 1988. The Symptom Star can be used to compare the reported impact on ten body systems before an exposure event with after the event. Conversely, the comparison can compare changes after the event to before. The Symptom Star is one of five sections or a larger tool the Quick Environmental Exposure Sensitivity Inventory, statistically validated, peer reviewed and published in 1987.

Qualification for the use of the tool can be screened with the Brief Environmental Exposure Sensitivity Inventory, published in 2021. Combined with an exposure history designed for medical doctors by a medical doctor, the use can expand to clinical interventions as a follow-up to epidemiological findings.

Tuesday LT5

Detecting the Construction Stages of Unconventional Oil and Gas Development via Multi-platform High-resolution Remote Sensing Images in Pennsylvania

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Abstract

Unconventional oil and gas development is a growing environmental concern in the United States, with multiple health outcomes associated with its development. Accurately assessing the acute health effects of exposure to these developments requires precise information on construction timelines, including the start and end dates of drilling and treatment stages. However, records from state agencies often lack the necessary details to fully reconstruct the timeline. This incomplete construction timelines can bias the exposure assessments that underestimate actual levels. To address this issue, we developed a computer vision method that automatically detects construction stages in high-resolution remote sensing images. We analyzed images from multiple platforms, including Sentinel 1A/B, Sentinel 2A/B, and PlanetScopes. A training dataset is composed of images concurrent with official construction records. We extracted 104 features from each image to capture changes in texture caused by construction activities and used platform-specific machine learning models to classify images into drilling, treatment, and no active construction categories. We evaluated the performance of our model in Pennsylvania using ten-fold cross-validation and achieved prediction accuracies of 89.8%, 92.7%, and 98.5% for drilling, treatment, and no active construction, respectively. Our method can help reconstruct complete construction timelines and improve exposure assessments for health studies on the acute health effects of unconventional oil and gas development.

Tuesday LT6

Fine particulate matter metal composition with oxidative potential and oxidative stress biomarkers among pregnant women in Los Angeles

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Abstract

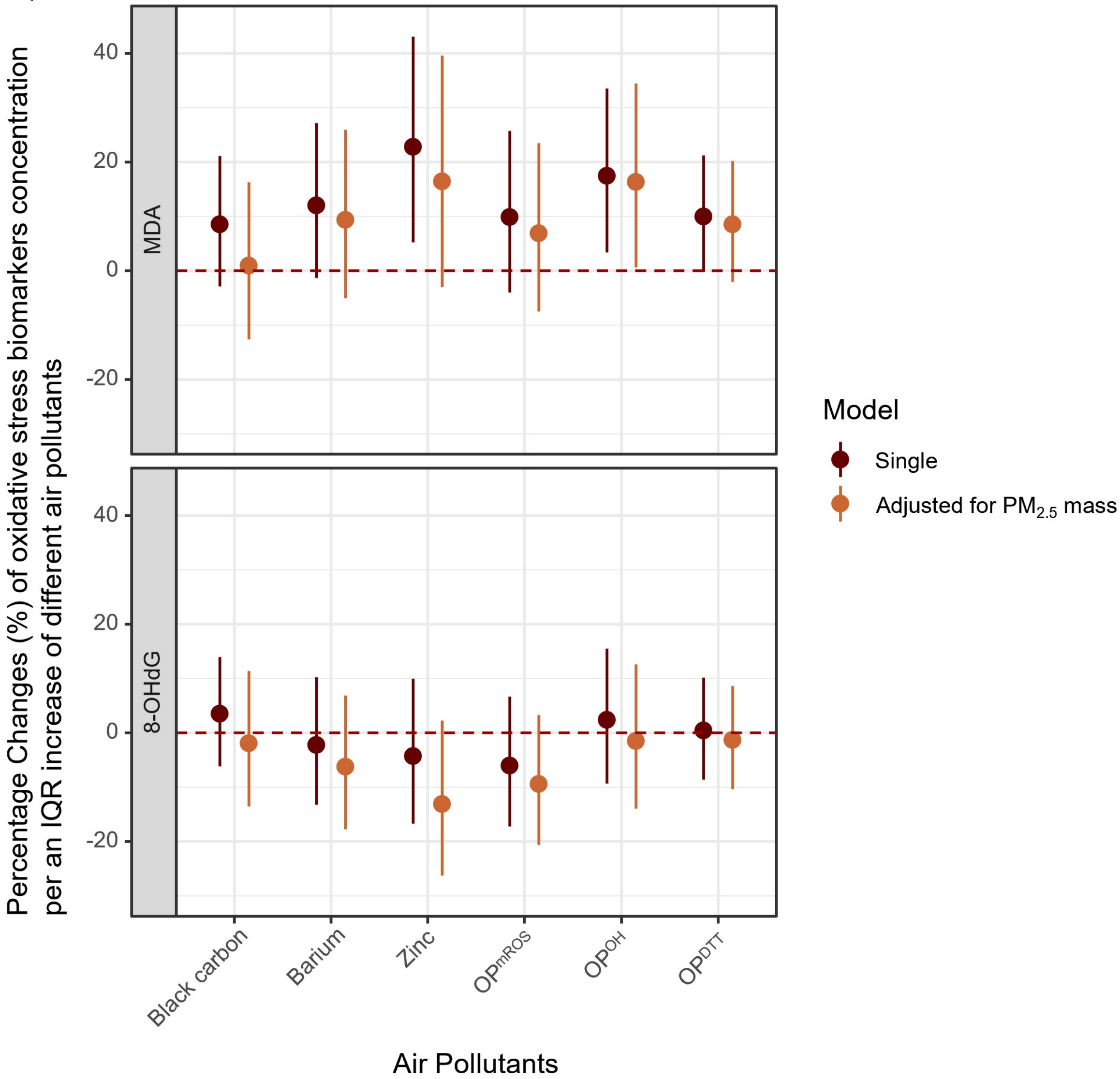
Background/Aims Oxidative stress generation has been suggested as one of the main mechanisms by which particulate matter exposure from traffic may contribute to adverse pregnancy outcomes. Few epidemiological studies to date have evaluated speciated fine particulate matter ($PM_{2.5}$) exposures or employed biomarkers. Here, we investigate whether measures of ambient air $PM_{2.5}$ oxidative potential or brake and tire wear derived metal exposures affect levels of oxidative stress biomarkers in the urine of pregnant women.

Methods We measured two oxidative stress biomarkers -malondialdehyde (MDA) representing lipid peroxidation and 8-hydroxy-2’-deoxyguanosine (8-OHdG) indicating DNA damage - in up to three urine samples collected during pregnancy in 156 women during 2016-2019 enrolled at antenatal clinics of University of California Los Angeles. We employed land use regression models with cokriging to estimate average $PM_{2.5}$ mass and $PM_{2.5}$ components related to brake (barium) and tire wear (zinc), oxidative potential (including 2-hour modeled ROS based on measured concentrations of $PM_{2.5}$ iron and $PM_{2.5}$ copper (OP^{mROS}), hydroxyl radical formation (OP^{OH}), and dithiothreitol loss (OP^{DTT})) as well as black carbon during the 4 weeks prior to the date of urine sample collection. Using linear mixed models, we estimated the percentage change (%) and 95% confidence interval (CI) for MDA and 8-OHdG with each exposure measure (continuous, scaled by the interquartile range (IQR)).

Results Per IQR increase of brake and tire wear markers (barium and zinc) and oxidative potential (OP^{mROS}, OP^{OH} and OP^{DTT}) was associated with 10%-23% higher MDA but not 8-OHdG levels, and these changes were robust to adjustment for $PM_{2.5}$ mass. 8-OHdG increases were associated with black carbon and $PM_{2.5}$ mass only in the second sample collection (18-29 gestational week) of pregnancy samples.

Conclusion Our findings provide evidence for oxidative stress being a potential mechanism for adverse pregnancy outcomes attributed to traffic related air pollution exposures.

Figure Linear mixed model for percentage changes and 95% confidence interval (CI) for concentration of oxidative stress biomarkers according to continuous (per IQR) PM2.5-metal/ ROS exposures. Adjusted for maternal age, maternal race/ethnicity, maternal education, maternal employment status, maternal smoking status before pregnancy, pre-pregnancy BMI, parity, season of conception, healthy eating index (HEI) score, and sample collection time.

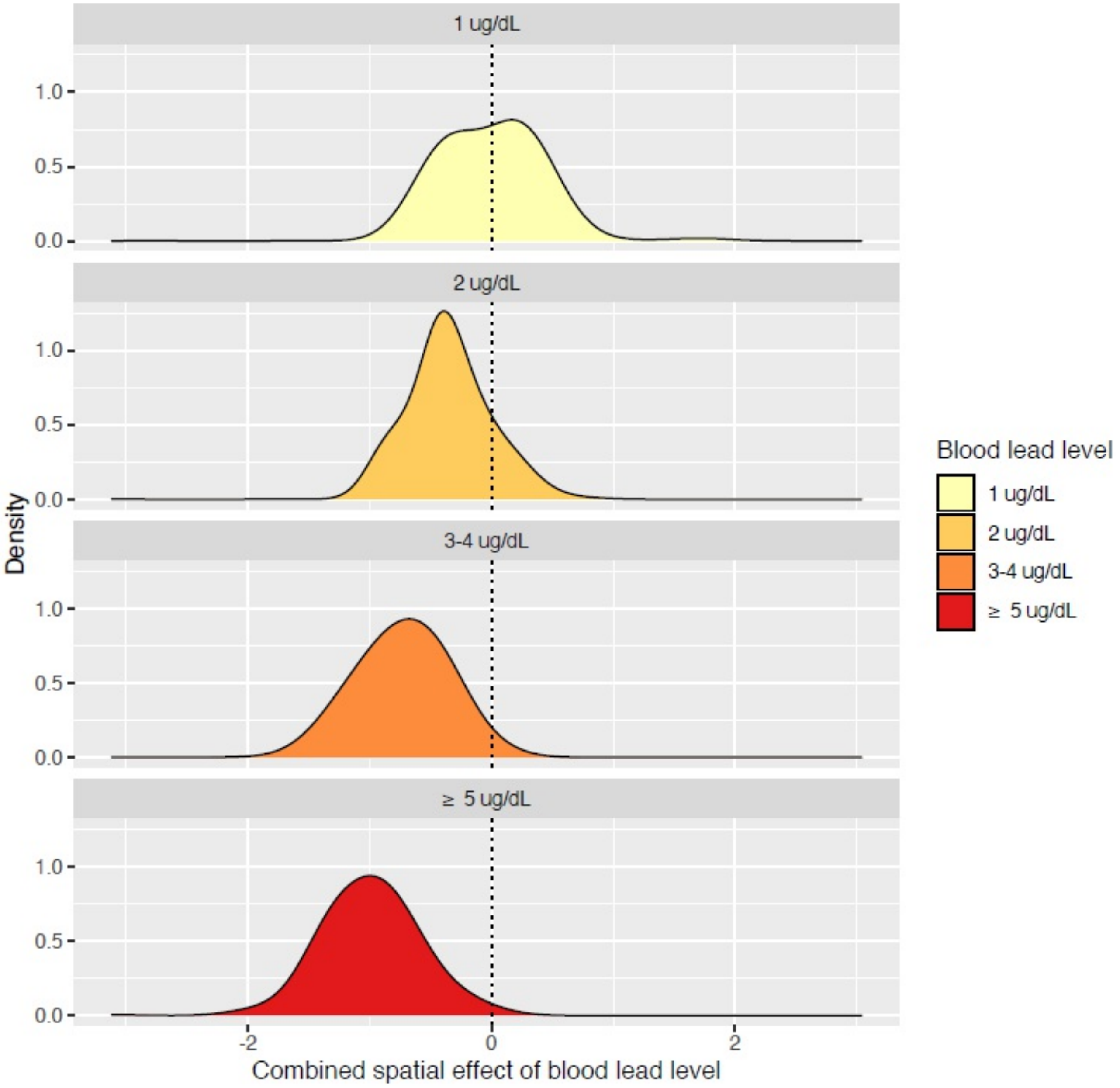


Tuesday LT6

Early childhood lead exposure and cognitive outcomes: Where children live matters

Mercedes Bravo[1], Daniel Kowal[2], Dominique Zephyr[3], Joseph Feldman[2], Katherine Ensor[2], Marie Lynn Miranda[4]
[1]Duke University, Durham, USA. [2]Rice University, Houston, USA. [3]University of Notre DAme, South Bend, USA. [4]University of Notre Dame, South Bend, USA

Abstract



Exposure to lead during childhood is detrimental to children’s health and development. The extent to which the association between lead exposure and cognitive outcomes varies across geography is not known.

Estimate associations between blood lead levels (BLLs) and 4th grade end-of-grade (EOG) standardized test scores in reading and mathematics in North Carolina (NC) using models that allow associations between BLL and EOG to vary across the study area.

We link individual-level EOG standardized test score data for NC public school students in 4th grade (2013-2016) with NC detailed birth records and blood lead surveillance data (n=77,466). Spatially varying coefficient models (SVCM) provide a study area-wide estimate of the association between BLL and EOG test scores, as well as census tract-specific estimates of the association. Models adjust for birthweight, child sex, and maternal race, educational attainment, smoking during pregnancy, and marital status. Reading and math scores are modeled separately.

The average BLL across the 77,466 students in the analysis dataset was 2.87 μg/dL. BLLs were categorized as: 1 μg/dL (reference level), 2 μg/dL, 3-4 μg/dL and ≥ 5μg/dL. BLLs of 2 μg/dL, 3-4 μg/dL and ≥ 5μg/dL were associated with overall decrements in reading EOG test scores of -0.36 (-0.53, -0.19), -0.74 (-0.91, -0.57), and -1.01 (-1.22, -0.79), respectively. Statistically significant tract-specific adjustments for BLLs of 2 μg/dL, 3-4 μg/dL and ≥ 5μg/dL in reading EOG test scores ranged from -0.60 to 1.84, -0.70 to 1.24, -7.10 to 0.96, and -10.0 to 0.96, respectively. Results for mathematics EOG scores were similar to those for reading EOG scores.

The association between BLLs and EOG scores exhibits considerable heterogeneity across NC. These results emphasize the importance of preventing and mitigating lead exposures everywhere, with special attention to locations where the cognitive impact is elevated.

Tuesday LT6

Arsenic In The Brain: A Review of Arsenic Exposure and Neuropsychiatry in North America

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Abstract

Background: Arsenic is a toxicant that affects almost every organ, including the brain. There is significant epidemiological evidence suggesting that chronic arsenic exposure, such as via drinking water, increases the risk of mood disorders. Although all forms of arsenic, including inorganic and methylated arsenicals, accumulate in many parts of the brain, most studies focus on arsenic exposure and its physical complications. This has left its adverse effects on mental health well-being largely and inadequately studied, especially within North America, where areas can reach levels on par with Taiwan and China.

Methods: Through a review of the current literature, we investigated the link between arsenic exposure and mental health burden within North America.

Results: Refining our search to human-based studies based in North America between the years 2000 and 2022, we found 14 studies that focused on this potential effect. Our review included population studies of any age group and with any type of arsenic exposure, including via drinking water or soil exposure. We focused on evaluating work concentrating on mental health as a primary focus and did not include studies that included mental health as a supplement to other diseases, such as cancer. Among the studies found, the majority focused on cognitive dysfunction and learning and intelligence impairments, with many more recent studies focusing on links to Alzheimer's Disease.

Discussion: The effect of arsenic exposure on mood disorders remains an understudied topic. Few focused on the biological mechanisms and connections to other psychiatric disorders, such as depression. More epidemiological research is needed to investigate the potential link between arsenic exposure and its mental health burden. Studies based in North America would help determine whether current regulations for arsenic are sufficient to prevent arsenic-induced neurotoxicity. Such studies would help initiate the development of potential interventions to alleviate arsenic-mediated neuropsychiatric deficits.

Tuesday LT6

Use of Biomarkers of Metals and Machine Learning to Improve Prediction Performance of Cardiovascular Disease Mortality

Samuel Fansler, Kelly Bakulski, Sung Kyun Park, Xin Wang
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Abstract

Background: Prediction models based on conventional risk factors are available for use in primary prevention. Whether including additional environmental risk factors improves cardiovascular disease (CVD) prediction is unclear. We attempted to improve CVD prediction performance beyond conventional CVD risk factors by including metals measured in urine and blood and by using machine learning methods.

Methods: Our sample comprised of 7,085 US adults aged 40 years or older from the National Health and Nutrition Examination Survey 2003-2016 cycles, linked with the National Death Index through December 31, 2019. Participants were randomly split into a 50/50 training dataset used to construct the prediction models and testing dataset used as validation to assess prediction performance. Relative to the conventional risk factors (age, sex, race/ethnicity, smoking status, systolic blood pressure, total and high-density lipoprotein cholesterol, antihypertensive medications, and diabetes), we compared models with an additional 17 metal concentrations. Blood metals were lead, mercury, and cadmium. Urinary metals were cesium, molybdenum, thallium, cobalt, barium, lead, cadmium, mercury, uranium, tungsten, antimony, total arsenic, dimethylarsonic acid, and arsenobetaine. We used Cox proportional hazards models, elastic-net (ENET) penalized Cox models, and survival random forest and assessed prediction with Harrell's concordance index (C-index).

Results: In our combined study sample, 420 participants died from CVD during a mean 8.8 years of follow-up. The best prediction performance was observed in the Cox proportional hazards model with only conventional risk factors (C-index=0.845). In the ENET model, the conventional risk factor C-index of 0.828 improved to 0.830 by adding linear terms and to 0.832 by adding linear, quadratic, and pairwise interaction terms for metals. No essential improvement was observed for random forest models.

Conclusions: Overall, CVD mortality prediction using conventional risk factors was high and adding urinary and blood metals did not improve prediction performance in this large and diverse sample.

Tuesday LT6

Magnesium, calcium, potassium, and cadmium and risk of stroke among never smokers in a Danish case-cohort study.

<u>Tesleem Babalola</u>[1], Victoria Fruh[2], Gregory Wellenius[2], Thomas Webster[2], Koren Mann[3], James Harrington[4], Clara Sears[5], Anne Tjonneland[6,7], Ole Raaschou-Nielsen[6,8], Birgit Claus[2], Jaymie Meliker[1]
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Abstract

Background: Recent meta-analyses have suggested marginal protection for stroke from calcium (Ca), magnesium (Mg), and potassium (K) intake, but results were borderline statistically significant. Two studies observed stronger protective associations using a combined intake score. We aimed to study individual and combined intake of Mg, Ca, and K on risk of stroke, stratified by urine cadmium (Cd), a cardiovascular risk factor.

Methods: We conducted a case-cohort study among never-smoking participants of the Danish Diet Cancer and Health Cohort, a prospective study of individuals 50 – 64 years old recruited from 1993-1997. We randomly selected 1135 subcohort members and identified 502 incident stroke cases between enrollment and 2015. We calculated combined dietary intake (CDI) scores from Ca, K, and Mg food frequency questionnaire intakes. We also estimated the adjusted hazard ratio (aHR) for stroke by quartiles of each mineral intake and a combined dietary intake (CDI) score of all three minerals using Cox-proportional hazard models, stratifying by urine Cd concentration (cut point at median; <0.02mg/g creatinine).

Results: The aHR of total stroke events in the highest quartile (Q4) compared to the lowest quartile (Q1) was 0.80 (95% CI: 0.58,1.08) for dietary Ca intake and 0.78 (95% CI: 0.56,1.08) for dietary Mg intake. Similarly, the fourth quartile (Q4) compared to the first quartile (Q1) was 0.86 (95% CI: 0.62,1.19) for dietary K intake and 0.78 (95% CI: 0.56,1.07) for the CDI score of all three minerals. The results were not materially different based on urine Cd stratification.

Conclusion: Ca, K, and Mg were not associated with incident stroke, although the direction of the association was consistent with reported literature. A measure of combined intake of Ca, Mg, and K did not yield an appreciable association with stroke prevention, nor did stratifying analyses by urine Cd.

Tuesday LT6

Adiposity and Arsenic Methylation among Pregnant Women in Rural Northern Bangladesh: Are Associations Confounded by One-carbon Metabolism Micronutrient Status?

Tyler J. S. Smith[1], Ana Navas-Acien[2], Sarah Baker[3], Caryn Kok[1], Kate Kryczynski[1], Walter Goessler[4], Alexander van Geen[5], Elizabeth L. Ogburn[6], Hasmot Ali[7], Towfida J. Siddiqua[7], Kerry Schulze[3], Keith P. West, Jr.[3], Alain B. Labrique[3], Christopher D. Heaney[1,3,8]

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Abstract

BACKGROUND/AIMS: Arsenic methylation, which converts inorganic arsenic (iAs) to monomethyl (MMA) and dimethyl (DMA) arsenicals, can modify associations between arsenic exposure and certain diseases. Arsenic methylation has been associated with adiposity and one-carbon metabolism (OCM) micronutrient status, which are both related to diet. We therefore assessed whether associations between adiposity and arsenic methylation were confounded by micronutrient status.

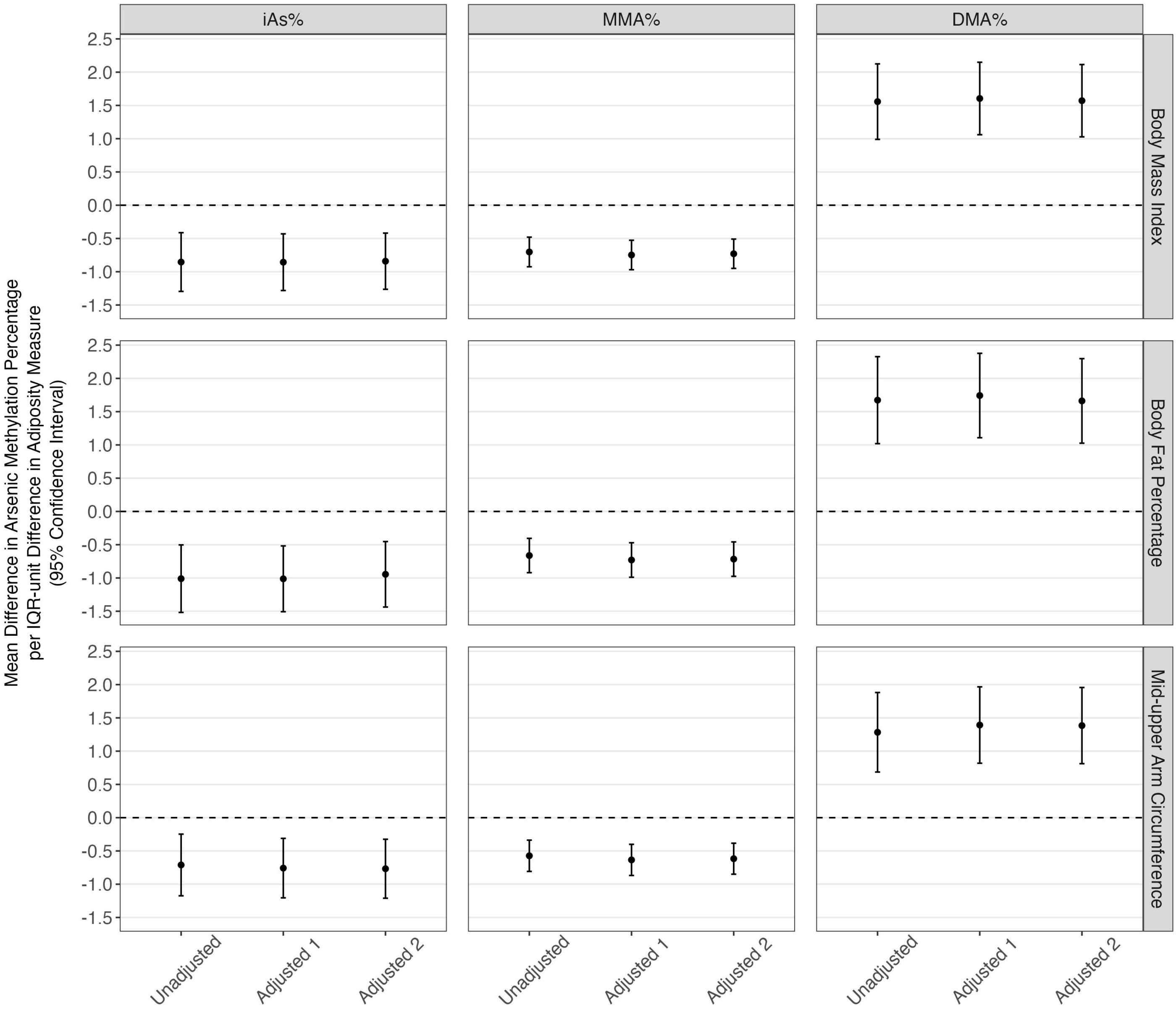
METHODS: We enrolled pregnant women (n=784) (median [IQR] gestational week: 14 [13-15]) in Gaibandha District, Bangladesh, 2018-2019. Adiposity measures at enrollment included body mass index (BMI), body fat percentage estimated from subscapular and triceps skinfolds, and mid-upper arm circumference (MUAC). Urinary arsenic at enrollment was speciated by HPLC-ICPMS. Arsenic methylation was assessed by urinary iAs, MMA, and DMA divided by their sum and multiplied by 100 (iAs%, MMA%, and DMA%). Drinking water arsenic (wAs) was measured by ICPMS. Plasma biomarkers of micronutrient status (folate, homocysteine, vitamin B12) were measured by immunoassays. We fit linear models of iAs%, MMA%, and DMA% by BMI, body fat, or MUAC, adjusting for wAs, age, gestational age, and plasma biomarkers.

RESULTS: In complete cases (n=766; 97.7%), median (IQR) iAs%, MMA%, and DMA% were 12.1 (9.4, 15.2), 6.6 (5.3, 8.3), and 81.0 (77.0, 84.6), respectively. Before and after adjustment, BMI, body fat, and MUAC were negatively associated with iAs% and MMA% and positively associated with DMA%. For instance, the unadjusted mean difference (95%CI) per IQR-unit difference in BMI was -0.85 (-1.30, -0.41) for iAs%, -0.70 (-0.93, -0.48) for MMA% and 1.56 (0.99, 2.12) for DMA%. The corresponding adjusted mean difference (95%CI) was -0.84 (-1.26, -0.42) for iAs%, -0.73 (-0.95, -0.51) for MMA% and 1.57 (1.03, 2.11) for DMA%.

CONCLUSIONS: Associations between adiposity and arsenic methylation persisted after adjustment for micronutrient status. Adiposity may alter arsenic methylation and consequently modify associations between arsenic exposure and disease.

Adiposity and Arsenic Methylation among Pregnant Women in Rural Northern Bangladesh

Are Associations Confounded by One-carbon Metabolism Micronutrient Status?



Adjusted 1 models included drinking water arsenic, age, and gestational age.
Adjusted 2 models also included biomarkers of one-carbon metabolism micronutrient status: plasma folate, vitamin B12, and homocysteine.

Tuesday LT6

Associations between a metal mixture and infant Negative Affectivity: Effect modification by prenatal cortisol and infant sex

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Abstract

Co-occurring in utero chemical and non-chemical exposures (e.g. non-essential metals and stress) interact in complex ways that influence the offspring's neuropsychological development. We evaluated the joint association between prenatal exposure to a metal mixture (As, Ba, Cd, Cs, Cr, Pb, and Sb) and third trimester maternal cortisol, while also considering the sexually dimorphic nature of these associations on infant negative affectivity – a measure of neuropsychological development. We hypothesized that the effect of the metal mixture on negative affect and related temperament features would be enhanced by increased cortisol in a sex-specific manner. This study utilized data from a longitudinal pregnancy cohort, PRogramming of Intergenerational Stress Mechanisms (PRISM). Analyses included 226 mother-infant pairs with complete data on prenatal urine metals, third trimester hair cortisol, infant negative affect assessed using the Infant Behavior Questionnaire-Revised (IBQ-R) completed when infants were aged 6 months. Outcomes included the global measure of negative affect and four sub-domains – Fear, Sadness, Distress to Limitations, and Falling Reactivity. Weighted Quantile Sum (WQS) regression with repeated holdout validation was used to investigate joint associations among the prenatal metal mixture, cortisol, and fetal sex in relation to each negative affect parameter. Modifying effects of prenatal cortisol and fetal sex were examined using 2- and 3-way interactions. Significant 3-way interactions were demonstrated with four of the five IBQ-R parameters: negative affectivity, fear, sadness, and distress to limitations. Specifically, girls born to mothers with higher cortisol had significantly higher scores of negative affectivity (β=0.18; 95% CI: 0.10, 0.26), fear (β=0.20; 95% CI: 0.08, 0.32), sadness (β=0.27, 95% CI: 0.17, 0.37), and distress to limitations (β=0.22; 95% CI: 0.12, 0.32), with greater exposure to the metal mixture. These findings underscore the need to examine higher-order interactions to better elucidate the effects of prenatal exposures.

Tuesday LT6

Topological network properties of resting-state functional connectivity patterns are associated with metal mixture exposure in adolescents.

Azzurra Invernizzi[1], Elza Rechtman[1], Elena Colicino[1], Stefano Renzetti[2], Claudia Ambrosi[3], Lorella Mascaro[4], Alessandra Patrono[2], Daniele Corbo[2], Giuseppa Cagna[2], Abraham Reichenberg[1], Cheuk Tang[1], Donald Smith[5], Donatella Placidi[2], Roberto Lucchini[6], Robert Wright[1]
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Abstract

Background: Exposure to neurotoxic metal adversely impact cognitive, motor, and behavioral development. Only few studies have addressed the underlying brain mechanisms of metal-associated developmental outcomes. Furthermore, metal exposure occurs as a mixture, yet often consider only a single exposure. In this cross-sectional study, we investigated the relation between exposure to neurotoxic metals and topological brain metrics, such as global, local efficiency and centrality measures, in adolescents.

Methods: In 193 participants (53% females, ages: 13-25 years) enrolled in the Public Health Impact of Metals Exposure (PHIME) study, we measured concentrations of five metals (manganese, lead, zinc, copper and chromium) in biological matrices (blood, urine, hair, and saliva) and acquired resting-state functional magnetic resonance imaging scans. Using graph theory metrics, we computed caudate eigenvector centrality (EC) and efficiency (global:GE; local:LE) in 111 brain areas (Harvard Oxford Atlas). Weighted quantile sum (WQS) regressions were used to examine association between metal mixtures and each graph metric (GE, LE or EC), adjusted for sex and age.

Results: We observed significant negative associations between the metal mixture and GE and LE (βGE = -0.004, 95% CI [-0.006, -0.002]; βLE= -0.011, 95% CI [-0.02, -0.003]). Blood lead (18%) and hair chromium (17%) contributed most to this association. The metal mixture was positively associated with EC in the caudate (βEC = 0.625, 95% CI [0.144, 0.825]). Blood manganese (24%) and copper (11%) contributed most to the mixture association.

Conclusions: Our results suggest that exposure to the metal mixture during adolescence reduces the efficiency of integrating information in brain networks at both local and global levels. Results further suggest these associations are due to combined join effects to different metals, rather than to a single metal.

Tuesday LT6

Sex-specific associations between co-exposure to multiple metals and externalizing symptoms in adolescence

Kristie Oluyemi[1,2,3], Elza Rechtman[1], Azzurra Invernizzi[1], Chris Gennings[1], Stefano Renzetti[4], Alessandra Patrono[4], Giuseppa Cagna[4], Abraham Reichenberg[5], Donald R. Smith[6], Roberto G. Lucchini[4,7], Robert O. Wright[1], Donatella Placidi[4], Megan K. Horton[1]

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Abstract

Introduction and Aim: Adolescent externalizing disorders such as attention-deficit/hyperactivity disorder (ADHD), account for the majority of youth referrals to mental health services, increase risk for later-life psychopathology, and are more commonly expressed among males. Although associations between adolescent metal exposure and externalizing symptoms are well established, little is known regarding modification of these associations by sex. In this study, we hypothesized that sex moderates the association between metal mixture exposure and externalizing problems during adolescence, with males being more vulnerable to increased externalizing problems following metal exposure.

Methods: Among 148 adolescents (13-25 years; 83 females) enrolled in the Public Health Impact of Metals Exposure (PHIME) study in Brescia, Italy, we measured four metals (manganese (Mn), lead (Pb), copper (Cu) and chromium (Cr)) in four biological matrices (blood, urine, hair, and saliva) using inductively coupled plasma mass spectrometry (ICP-MS). Externalizing problems were assessed using the Child Behavior Checklist (CBCL) or Adult Behavior Checklist (ABCL). We used a sex-stratified interaction weighted quantile sum (WQS) regression model to examine the moderating effect of sex on associations between the metal mixture and externalizing problems. Models were adjusted for age and socioeconomic status.

Results: Higher metal concentrations were differentially associated with externalizing problems in males compared to females ($\beta = 0.649$ [95% CI 0.059, 1.24]). Metals with the highest weights in males included saliva lead (6.4%), hair chromium (6.1%), and blood nickel (5.1%). Metals with the highest weights in females included urine manganese (3.2%), blood lead (2.8%), and hair manganese (2.7%).

Conclusions: This study supports the hypothesis that sex-specific vulnerabilities to mixed metal exposure during adolescence may play a role in sex differences observed in various mental health disorders. Our sex-stratified interaction WQS modeling approach may help identify sex-specific vulnerabilities to metal mixtures, and thereby help to inform public health interventions for at-risk populations.

Tuesday LT6

Associations of Toenail Arsenic, Cadmium, Lead, Manganese, and Mercury with Attention and Memory in the Gulf Longterm Follow-up (GuLF) Study

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Abstract

Background/Aims: There is a great concern for the potential exacerbation of neurobehavioral deficits related to prolonged low-level exposure to toxic metals. Residents of the Gulf region live proximal to industrial activity and may be uniquely vulnerable to neurotoxicity from chronic metal exposure.

Methods: We measured toenail concentrations of arsenic (As), cadmium (Cd), lead (Pb), manganese (Mn), and mercury (Hg) using inductively coupled plasma mass spectrometry in 413 non-smoking men from the Gulf Long-term Follow-Up (GuLF) Study to assess cross-sectional associations with performance on tests of sustained attention (Continuous Performance Test) and memory (Digit Span Test). We evaluated associations between an interquartile range (IQR) increase in toenail metals and neurobehavioral performance using multivariable linear regression adjusting for confounders identified in the literature: education, age, smoking, marital status and alcohol consumption. Results were stratified by race.

Results: We found inverse associations between toenail As, Pb, and Mn and tests of sustained attention. An IQR increase in each of these metals was associated with significant decreases in percentage of correct responses on the Continuous Performance Test by -0.50% (Mn) and -0.65% (As). Deficits were more pronounced in Black participants (As: -1.6%, Pb: -1.3%, Mn: -1.5%). On the Digit Span Test, participants scored -0.21 (95% CI: -0.40, -0.02) lower for each IQR increase in toenail Mn concentration. Black participants exhibited more pronounced deficits (-0.35; 95% CI: -0.57, -0.14). Hg and Cd were not associated with attention or memory in this study.

Conclusion: Our findings suggest associations between toenail As, Pb, and Mn toenail concentration and attention and memory deficits in men from the GuLF Study. Attention and memory deficits were greater in Black participants compared to White participants. Further research is warranted to confirm these findings given the cross-sectional design of the study and the sub-clinical nature of the neurobehavioral test outcomes.

Tuesday LT6

Associations Between Brake and Tire Wear-Related $PM_{2.5}$ Metal Components, Particulate Oxidative Stress Potential, and Autism Spectrum Disorder in Los Angeles County

Karl O'Sharkey[1], Qi Meng[1], Sanjali Mitra[1], Seung-a Paik[1], Jonathan Liu[1], Michael Jerrett[1], Yifang Zhu[1], Susanne Paulson[1], Jiaqi Shen[1], Scott Weichenthal[2], Ting Chow[1], Beate Ritz[1]
[1]UCLA, Los Angeles, USA. [2]McGill University, Montreal, Canada

Abstract

Background: Autism spectrum disorder (ASD) is a developmental disorder characterized by issues with communication, learning, and restricted or repetitive behaviors. In California, the prevalence of ASD has been increasing over time and is not fully explained by expanding case definition and greater screening. Fine particulate matter with aerodynamic diameter ≤ 2.5 microns ($PM_{2.5}$) from traffic sources has previously been identified as a risk factor for ASD. However, few studies have investigated $PM_{2.5}$ exposure related to brake and tire wear. Here we assessed the association of $PM_{2.5}$ metals as markers of brake and tire wear, black carbon (BC), and related markers of oxidative potential, with ASD incidence.

Methods: The study population is composed of 102,535 singleton births (1,539 ASD cases) in Los Angeles County, born in 2017, followed through 2020. Estimates of prenatal $PM_{2.5}$, two metal tracers (barium for brake and zinc for tire wear), BC, and three markers of related oxidative potential (OP, including modeled reactive oxidative species based on measured iron and copper from PM2.5 (OP^{mROS}), hydroxyl radical formation (OP^{OH}), and dithiothreitol loss (OP^{DTT}) exposure were obtained with a co-kriging model using a land use regression model as an external drift. Logistic regression was used adjusting for key covariates, in addition to a stratification analysis by maternal race.

Results: This study found that while adjusting for $PM_{2.5}$ mass, barium (OR=1.13; 95% CI:1.03, 1.24), OP^{mROS}(1.15; 1.07, 1.24), and OP^{OH}(1.11; 1.01, 1.22) were associated with increased odds of ASD. Additionally, the association between barium exposure and ASD was strongest among Blacks (OR=1.21; 95% CI: 0.91, 1.61), and multi-race/Other participants (1.56; 1.17, 2.08).

Conclusion: Results indicate that prenatal exposure to $PM_{2.5}$ metal markers of brake and tire wear exposures and particulate components that contribute to oxidative stress, increase the risk of ASD, particularly in the offspring of Black and multi-race participants.

Tuesday LT6

Early Life Arsenic Exposure, Metabolomics, and Gestational Diabetes Mellitus

Ahlam Abuawad[1,2], Anne Hoen[1], David Kirchner[3], Susan Sumner[3], Ana Navas-Acien[2], Mary Gamble[2], Margaret Karagas[1]

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Abstract

Background. Globally, 94 million people are exposed to high levels of arsenic (As) in drinking water. Ingested inorganic arsenic (InAs) is methylated to mono- (MMAs) and di-methylated arsenic species (DMAs). One-carbon metabolism (OCM) is a biochemical process involved in As methylation that depends on micronutrients (e.g., choline). A study of three Bangladeshi cohorts found an inverse association between urinary %MMAs and BMI that was attenuated following adjustment for plasma choline. Additionally, data on the potential risks of As exposure on gestational diabetes mellitus (GDM) are emerging. **Objectives.** To evaluate the association between urinary As exposure/methylation with blood OCM metabolites during pregnancy, and the association between OCM metabolites and GDM. **Methods.** We leveraged data from New Hampshire Birth Cohort participants at 24-28 weeks gestation, including maternal As species, OCM metabolites (measured using the Biocrates P180 metabolite panel), and GDM (defined by administered glucose challenge and oral glucose tolerance test results) (n=410). Linear and logistic regression models were used to investigate the associations between As exposure/species and OCM metabolites, and between OCM metabolites and glucose intolerance/GDM, respectively. **Results.** Total As (µg/L), %InAs, %MMAs, and %DMAs were 4.7, 10.9, 9.1, and 79.9, amongst participants with normal glucose levels (n=297), and 6.5, 12.5, 9.2, and 78.3 amongst participants with glucose intolerance/GDM (n=113), respectively. Total As was negatively associated with glycine, while As species were positively associated with several metabolites: both %InAs and %DMAs with phosphatidylcholines (PC) such as lysoPC(16:0) and PC aa 32:1, and %MMAs with glutamate and valine. Glutamate, lysoPC(16:0), and PC aa 32:1 were positively associated with occurrence of glucose intolerance/GDM. **Conclusions**. These results suggest that OCM-related nutrients may be involved in the association between As exposure/methylation and diabetes-related outcomes. This research contributes to the weight of evidence used to inform effective policies to reduce As exposure and improve health.

Prevalence of cardiovascular disease risk factors in communities at high risk of natural hazard events

Marina Sweeney[1], Kaitlyn Lawrence[2], Emily Werder[2], Xinlei Deng[2], Dazhe Chen[2], W. Braxton Jackson II[1], Kate Christenbury[1], Casey Zuzak[3], Lawrence Engel[4], Dale Sandler[2]
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Abstract

Background: Natural hazards have been linked to increased risk of cardiovascular disease (CVD), but little is known about the CVD-related health effects of living in regions prone to frequent natural hazards.

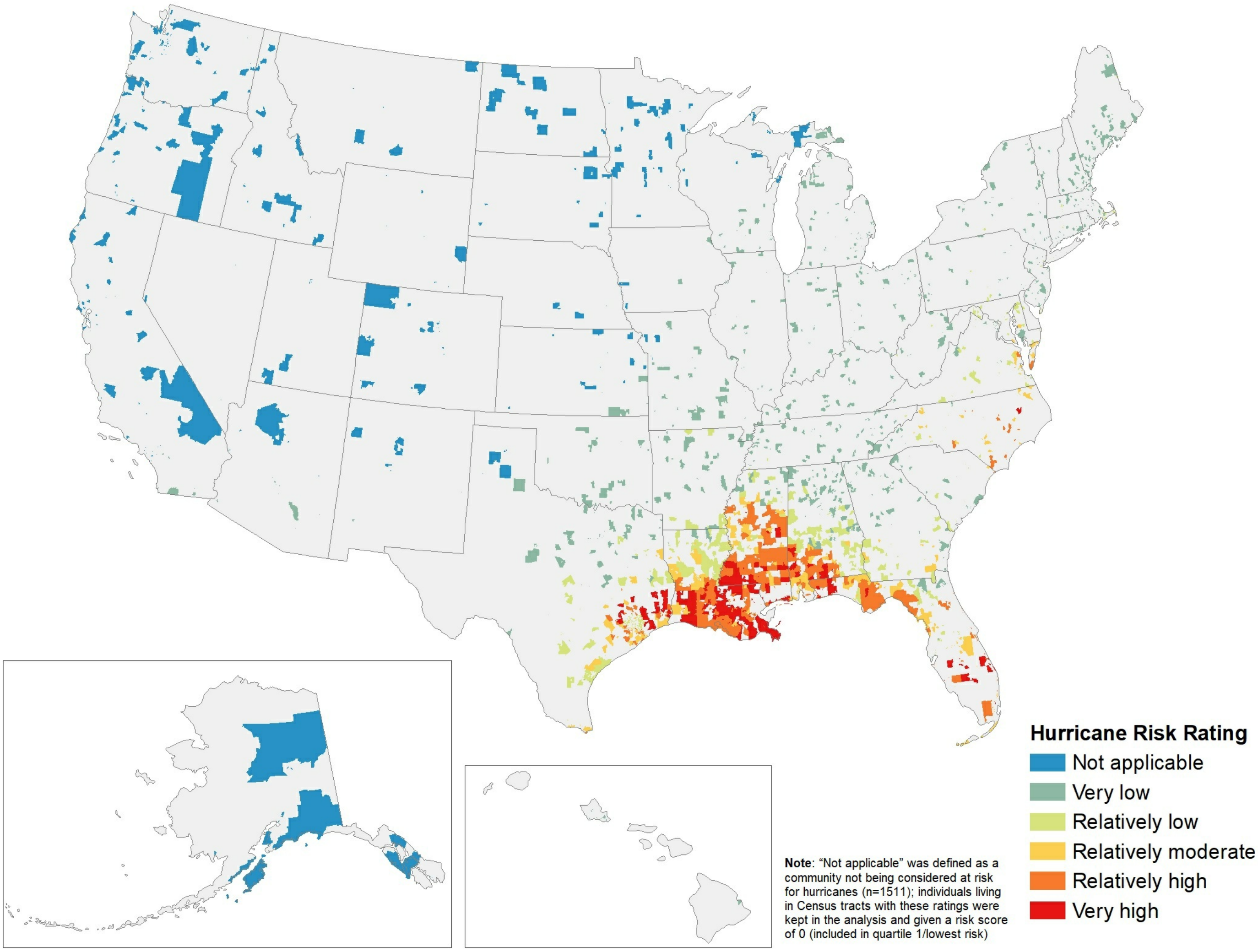
Aim: Evaluate associations between residence in hazard-prone regions and CVD risk factors

Methods: The National Risk Index (NRI) measures Census-tract-level risk of natural hazards based on expected annual losses, social vulnerability, and community resiliency. Hazard-specific risk scores include coastal flooding, hurricanes, and heat waves. NRI data were linked to enrollment addresses of GuLF STUDY participants. Physician-diagnosed hypertension and diabetes were self-reported at enrollment (n=29,595). Height, weight, and blood pressure were measured during a home visit (n=10,370) among participants living in the Gulf States. We used modified Poisson regression to estimate prevalence ratios (PRs) and 95% confidence intervals (CIs) for associations between NRI quartiles and BMI (kg/m2), hypertension (≥140/90 mmHg or medication use), and diabetes. Models were adjusted for sociodemographic, lifestyle, and health factors.

Results: Overall and coastal flood risk scores were not associated with CVD risk factors. Hurricane risk was associated with physician-diagnosed hypertension (Quartile 4 vs. Q1: PR=1.15, 95%CI: 1.09-1.22) and diabetes (Q4 vs. Q1: PR=1.28, 95%CI: 1.12-1.47). Heat wave risk was associated with physician-diagnosed hypertension (Q4 vs. Q1: PR=1.10, 95%CI: 1.04-1.16), measured hypertension (Q4 vs. Q1: PR=1.20, 95%CI: 1.08-1.33), and physician-diagnosed diabetes (Q4 vs. Q1: PR=1.15, 95%CI: 1.01-1.30). NRI scores were not associated with increased BMI.

Conclusions: Cardiovascular risk factors such as hypertension and diabetes were more common among individuals living in areas with greater risk of experiencing hurricanes and heat waves, although residential selectivity may contribute to this finding. Given climate-change related increases in these hazards and the adverse impact of heat waves on individuals with CVD, our findings support the need for prevention programs designed to mitigate adverse health impacts of cumulative disasters.

Figure: Hurricane Risk Rating for GuLF STUDY Participants at Enrollment at the U.S. Census Tract Level (n=29,595)



Note: "Not applicable" was defined as a community not being considered at risk for hurricanes (n=1511); individuals living in Census tracts with these ratings were kept in the analysis and given a risk score of 0 (included in quartile 1/lowest risk)

Tuesday OS1

Association between solar radiation and poor mental health among Gulf coast residents

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Abstract

Background: Climate factors such as solar radiation could affect individuals with mood disorders. However, evidence evaluating links between solar radiation and mood disorders are mixed and vary by region.

Objective: To evaluate the association of solar radiation with depression and distress among residents living in the U.S. Gulf states where solar radiation is higher than the U.S. average.

Methods: We analyzed data from Gulf Long-Term Follow-up Study participants living in the five U.S. Gulf states who participated in a home visit exam (N=11,193). Participants completed validated mental health questionnaires including the Patient Health Questionnaire-9 for depression (score ≥10 = depressed) and Kessler Psychological Distress Questionnaire for distress (≥13) (N=11,119). We obtained solar radiation from the Daymet (v4) database (1-km grid). Average solar radiation exposure (SRAD) in the seven, 14, and 30 days before the home visit was linked to geocoded residential addresses and categorized into quartiles. We used generalized linear mixed models to estimate odds ratios (OR) and 95% confidence intervals (CI) for associations between solar radiation and depression/distress adjusting for temperature, relative humidity, season, and sociodemographic factors.

Results: Higher levels of SRAD in the past seven days were non-monotonically inversely associated with depression (ORQ2VSQ1 (95%CI): 0.81 (0.68, 0.98) and ORQ3VSQ1 (95%CI): 0.80 (0.65, 0.99)) and distress (ORQ2VSQ1 (95%CI): 0.75 (0.57, 0.99)). Higher levels of SRAD in the past 14 or 30 days were suggestively associated with decreasing frequency of distress (OR range for increasing quartiles of SRAD in the past 14 days = 0.85-0.73 and 30 days = 0.89-0.68).

Conclusions: Among individuals living in areas with high background solar radiation, higher short-term solar radiation exposure may reduce the likelihood of depression and distress. Associations varied by time period of exposure and type of mood disorder.

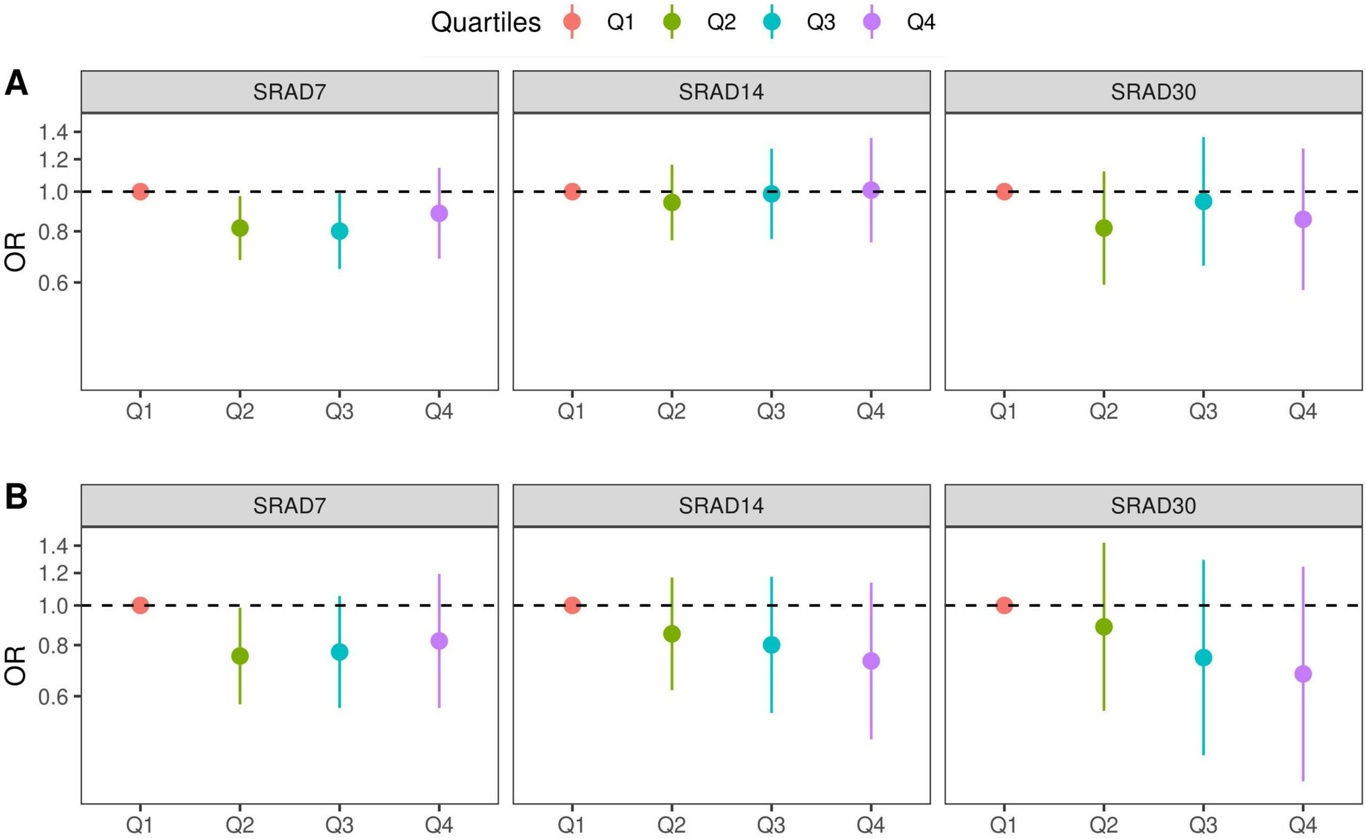


Figure 1. Association of depression and distress with quartiles of average solar radiation (SRAD) in the past seven, 14 and 30 days among GuLF study participants (N = 11,119). Panel A: depression; Panel B: distress.

Tuesday OS1

Influence of climate and environment on the efficacy of water, sanitation, and handwashing interventions on diarrheal disease in rural Bangladesh: a re-analysis of a randomized control trial

Anna Nguyen[1], Jessica Grembi[1], Marie Riviere[1], Gabriella Heitmann[1], William Hutson[2], Tejas Athni[1], Arusha Patil[1], Ayse Ercumen[3], Audrie Lin[4], Yoshika Crider[1], Andrew Mertens[4], Leanne Unicomb[5], Mahbubur Rahman[5], John Colford[4], Stephen Luby[1], Benjamin Arnold[6], Jade Benjamin-Chung[1]
[1]Stanford University, Stanford, CA, USA. [2]Washington University in St. Louis, St. Louis, MO, USA. [3]North Carolina State University, Raleigh, NC, USA. [4]UC Berkeley, Berkeley, CA, USA. [5]International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh. [6]UCSF, San Francisco, CA,, USA

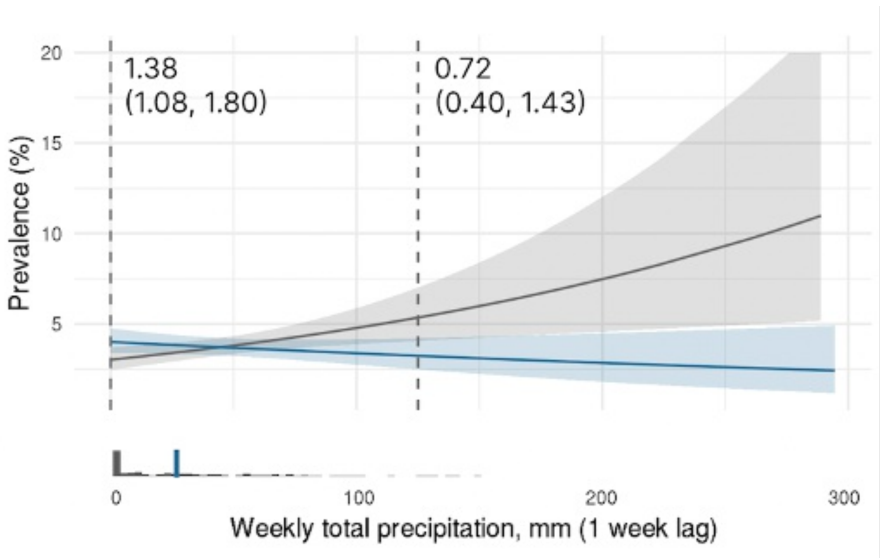
Abstract

Background: Diarrheal disease is a leading cause of childhood morbidity and mortality in rural Bangladesh. Various water, sanitation, and handwashing (WASH) interventions have been implemented in the region to reduce exposure to diarrhea-causing pathogens, but climatic factors may impact the effectiveness of these environmental interventions. However, few studies have examined the influence of climatic variables on WASH effectiveness and no prior studies have projected changes in intervention effectiveness under different climate change scenarios. Here, we aimed to determine if climate and environment modified the effect of low-cost, point-of-use WASH interventions on diarrhea and we predicted intervention effectiveness under climate change scenarios.

Methods: We analyzed data from a cluster-randomized trial in rural Bangladesh that measured diarrhea prevalence in children 0-2 years from 2012-2016. We matched remote sensing data on temperature, precipitation, humidity, and surface water to households by location and measurement date. We estimated prevalence ratios (PR) for WASH interventions vs. control stratified by environmental factors using generative additive models and targeted maximum likelihood estimation. We estimated intervention effects under predicted precipitation in the study region in 2050 for climate change scenarios from different Shared Socioeconomic Pathways (SSPs).

Results: WASH interventions more effectively prevented diarrhea under higher levels of total precipitation in the previous week and when there was heavy rain in the previous week (heavy rainfall PR = 0.38, 95% CI 0.23-0.62 vs. no heavy rainfall PR = 0.77, 0.60-0.98). We did not detect substantial effect modification by other environmental variables. WASH intervention effectiveness increased under most climate change scenarios; in a fossil-fueled development scenario (SSP5), the PR was 0.46 (0.44-0.48) compared to 0.67 (0.65-0.68) in the study.

Discussion: WASH interventions had the strongest effect on diarrhea under higher precipitation, and effectiveness may increase under climate change without sustainable development. WASH interventions may improve population resilience to climate-related health risks.



1.38
(1.08, 1.80)
0.72
(0.40, 1.43)
Prevalence (%)
20
15
10
5
0
100
200
300
Weekly total precipitation, mm (1 week lag)

Tuesday OS1

Identifying temperature thresholds associated with increased risk of heat illness and cardiorespiratory impacts in Alaska

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Abstract

Background: As climate change influences typical temperatures, heat events have become a growing public health concern. Uncharacteristically high temperatures may be especially threatening among unacclimated populations, including those in Northern regions where climate change will be dramatic. We estimated cardiorespiratory morbidity associated with summer days above heat index (HI) thresholds in three major population centers of Alaska – Anchorage, Fairbanks, and the Matanuska-Susitna Valley – for 2015-2019. **Methods**: A time-stratified case-crossover analysis was implemented to evaluate the associations between both acute and prolonged heat and cardiorespiratory and heat illness-related emergency department (ED) visits. Conditional logistic regression models were fit with three exposure metrics: 1) a single day, 2) two consecutive days, and 3) the absolute number of previous consecutive days above HI thresholds between 70-86°F. **Results**: Increased odds of heat illness-related ED visits were observed above HI thresholds as low as 70°F (OR: 13.84, 95% CI: 4.05, 47.29) and persisted for up to four days (OR: 2.43, 95% CI: 1.15, 5.10). Among the respiratory outcomes tested, asthma and pneumonia were positively associated with elevated HI. For both, the greatest impact occurred the day after an acute heat event. Generally, HI was more strongly associated with cardiovascular than respiratory outcomes, and prolonged elevated heat led to more severe health impacts. Each additional preceding day above 72°F was associated with a 6% increase in the odds of ischemia-related ED visits; the odds of myocardial infarction-related ED visits increased by 7% for each additional preceding day above 70°F. **Discussion**: This study reveals the dangers of elevated temperatures above even moderate thresholds in a region that has historically mild summertime temperatures. Only half of weather forecast offices in the U.S. have developed locally-relevant heat warning systems, but targeted public health efforts are necessary to protect unacclimated, vulnerable populations from future heat events.

Uncaptioned visual

Tuesday OS1

Wildfire-specific fine particulate matter and risk of emergency department visits in California, 2016-2019

Annie Chen[1], Rosana Becker[2], Keita Ebisu[1], Tarik Benmarhnia[2,3], Rupa Basu[1]
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Abstract

Background: Climate change has increased the frequency and severity of wildfires in recent years. Wildfire smoke has been associated with adverse respiratory effects, but the effects of wildfire-specific fine particulate matter ($PM_{2.5}$) on other health outcomes and vulnerable subpopulations are not fully understood. To manage air quality, California is divided into 15 air basins, which are areas with similar geographic and meteorological features. We examined associations between wildfire-specific $PM_{2.5}$ and air basin-level emergency department visits (EDVs) for various causes of admission in California during the wildfire season June-December 2016-2019.

Methods: Daily, zip code tabulation area (ZCTA)-level mean $PM_{2.5}$ concentrations attributable to wildfires were estimated using an ensemble machine learning model and aggregated to the air basin-level using population weighted averaging. A "smoke event day" was defined as an air basin-day with a wildfire-specific $PM_{2.5}$ concentration at or above the 98th percentile across all air basin-days. We conducted a two-stage time-series analysis (lags 0-14 days); air basin-level associations between smoke event days and EDVs were estimated using quasi-Poisson regression and combined into an overall effect estimate using a random effects meta-analysis.

Results: There were 257 smoke event days out of 12,840 air basin-days. Four of the air basins were excluded, since they did not have any smoke events during the study period. At lag 0, a smoke event day (threshold = 13.5 $\mu g/m^3$) was associated with EDVs for all respiratory diseases [relative risk (RR): 1.13, 95% CI: 1.05-1.21], asthma (RR: 1.57, 95% CI: 1.45-1.71), and chronic lower respiratory disease (RR: 1.13, 95% CI: 1.06-1.20). Some positive associations were observed at longer lags for cardiovascular outcomes. Mixed results were observed for mental health outcomes, depending on the disease subgroup.

Conclusion: Short-term exposure to wildfire-specific $PM_{2.5}$ was associated with adverse respiratory events, while cardiovascular impacts may be delayed compared to respiratory effects.

Tuesday OS2

Exposure to Phthalate Metabolites, Bisphenol A, and Psychosocial Stress Mixtures and Adverse Pregnancy Outcomes in the Atlanta African American Maternal-Child Cohort

Jasmin Eatman[1,2], Anne Dunlop[1], Dana Barr[1], Cherie Hill[3], Patricia Brennan[4], P. Barry Ryan[1], Parinya Panuwet[1], Kaitlin Taibl[1], Youran Tan[1], Donghai Liang[1], Stephanie Eick[1]

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Abstract

Background: Consumer products marketed towards women are common sources of exposure for phthalates and bisphenol A (BPA), which disrupt the endocrine system. Psychosocial stressors amplify the toxic effects of endocrine disruptors but information is limited among African Americans (AAs), who experience the highest rates of adverse pregnancy outcomes and are often exposed to the highest levels of chemical and non-chemical stressors. Here, we examined associations between an exposure mixture of phthalates, BPA, and psychosocial stressors with gestational age at delivery and birthweight for gestational age z-scores.

Methods: Participants were enrolled in the Atlanta African American Maternal-Child Cohort (N=251). Urinary measurements of eight phthalate metabolites and BPA were conducted in urine samples collected during early (8-14 weeks gestation) and middle (20-32 weeks gestation) pregnancy. Geometric average concentrations were adjusted for creatinine and were natural log transformed. Psychosocial stressors were measured using self-reported, validated questionnaires that assessed experiences of discrimination, gendered racial stress, depression, and anxiety. Linear regression was used to estimate individual associations and quantile g-computation was used to examine joint effects.

Results: In linear regression models, associations between phthalate metabolites and BPA with birthweight z-scores were generally stronger among those who experienced stress. Using quantile g-computation, a simultaneous increase in all phthalate metabolites and BPA was associated with a moderate reduction in birthweight z-scores (mean change per quartile increase =-0.22, 95% CI =-0.45, 0.01). Treatment of psychosocial stressors as additional exposures in the prenatal mixture produced a stronger effect on birthweight z-scores (mean change per quantile increase =-0.34, 95% CI =-0.61, -0.07). Overall, we found null associations between chemicals and psychosocial stressors with gestational age at delivery.

Conclusions: In a prospective cohort of AA mother-newborn dyads, we observed that increased prenatal exposure to phthalates, BPA, and psychosocial stressors were associated with adverse pregnancy outcomes.

Tuesday OS2

Associations between Prenatal Phthalate Exposure and Childhood Epigenetic Age Acceleration

Dennis Khodasevich[1], Nina Holland[1], Alan Hubbard[1], Kim Harley[1], Julianna Deardorff[1], Brenda Eskenazi[1], Andres Cardenas[2]
[1]University of California, Berkeley, Berkeley, USA. [2]Stanford University, Stanford, USA

Abstract

Background: Phthalates, a group of pervasive endocrine-disrupting chemicals found in plastics and personal care products, have been associated with a wide range of developmental and health outcomes. However, their impact on biomarkers of aging in children has not been characterized. We tested the influence of prenatal exposure to 11 phthalate metabolites on epigenetic aging in children at birth, 7, 9, and 14 years of age. We hypothesized that prenatal phthalate exposure will be associated with altered epigenetic age acceleration measures in early childhood, with associations varying by sex and timing of DNAm measurement.

Methods: Among 385 mother-child pairs from the CHAMACOS cohort, we measured DNAm at birth, 7, 9, and 14 years of age, and utilized general linear regression to assess the association between prenatal phthalate exposure and Intrinsic Epigenetic Age Acceleration (IEAA) at each timepoint. Additionally, quantile g-computation was utilized to characterize associations between the phthalate mixture and IEAA at each timepoint.

Results: We found a negative association between prenatal di(2-ethylhexyl) phthalate (DEHP) exposure and IEAA among males at age 7 (-0.575 years; 95% CI: -1.023 to -0.127), and a positive association between prenatal monoethyl phthalate (MEP) exposure and IEAA among males at birth (0.073 years; 95% CI: 0.010 to 0.136), while most other associations were nonsignificant or imprecise.

Conclusions: Our results suggest that prenatal phthalate exposure alters epigenetic age in children. Additionally, our findings suggest that the influence of prenatal exposures on epigenetic age may only manifest during specific periods of child development, and studies relying on DNAm measurements solely from cord blood or single time points may overlook potential biological effects.

Graphic Abstract:

Uncaptioned visual

Tuesday OS2

Associations of childhood phthalate exposures with bone health at age 12 years: The HOME Study

Taylor Etzel[1], Jordan Kuiper[1], Heidi Kalkwarf[2,3], Kimberly Yolton[2,3], Kim Cecil[2,3], Aimen Chen[4], Bruce Lanpher[5], Joseph Braun[6], Jessie Buckley[1]

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Abstract

Background and Objectives: Phthalate exposures during pregnancy and adulthood have been associated with altered bone mineral density (BMD), but no prospective studies have examined childhood phthalate exposures and BMD. We investigated associations of repeated childhood urinary phthalate biomarker concentrations with BMD at 12 years of age.

Methods: We used data from 206 mother-child pairs from a prospective pregnancy and birth cohort enrolled in Cincinnati, OH from 2003-2006. We measured nine phthalate metabolites in spot urine samples collected from children at up to seven time periods (ages 1, 2, 3, 4, 5, 8, and 12 years). At age 12, we performed dual energy x-ray absorptiometry and calculated height-adjusted and age-, sex-, and race-standardized whole body (excluding head) areal BMD z-scores. We estimated the covariate-adjusted associations per IQR increase of urinary phthalate metabolite concentrations at each time period with age 12 BMD z-scores using a multiple informants model. We estimated the overall effect of increasing all urinary phthalate biomarkers at each time period using quantile-based g-computation.

Results: Overall, we observed weak or null associations of urinary phthalate biomarker concentrations with BMD. Some phthalate biomarkers at ages 5 and 8, however, were associated with lower BMD at age 12. For example, an IQR increase of mono-isobutyl (MiBP) and mono-(3-carboxypropyl) phthalate (MCPP) at 5 and monobenzyl phthalate (MBzP) at 8 was associated with a -0.15 (95% CI: -0.29, -0.01), -0.31 (95% CI: -0.57, -0.04), and -0.18 (95% CI: -0.35, 0.00) z-score difference in age 12 BMD, respectively. Similarly, an IQR increase in all phthalate metabolites at ages 5 and 8 was associated with a -0.17 (95% CI: -0.37, 0.02) and -0.17 (95% CI: -0.37, 0.03) z-score difference in age 12 BMD, respectively.

Discussion: Phthalate biomarkers in children at ages 5 and 8 were weakly associated with lower BMD in early adolescence.

Tuesday OS2

Gestational exposure to phthalates and phthalate replacements and preeclampsia diagnosis: a longitudinal study

Erin E. McNell[1,2], Danielle R. Stevens[1], Emma M. Rosen[2], Suzanne Fenton[1], Antonia M. Calafat[3], Julianne Cook Botelho[3], Elena Sinkovskaya[4], Ann Przybylska[4], George Saade[5], Alfred Abuhamad[4], Kelly K. Ferguson[1]

[1]National Institute of Environmental Health Sciences, Durham, NC, USA. [2]University of North Carolina at Chapel Hill, Chapel Hill, NC, USA. [3]Centers for Disease Control and Prevention, Atlanta, GA, USA. [4]Eastern Virginia Medical School, Norfolk, VA, USA. [5]University of Texas Medical Branch, Galveston, TX, USA

Abstract

Background/Aims

Phthalates and their replacements are found in numerous consumer products. Gestational phthalate exposure may disrupt hormonal balance, contributing to pregnancy complications such as preeclampsia, a hypertensive disorder affecting 5-10% of pregnancies. Most studies assessing associations between phthalate exposure and preeclampsia utilize exposure biomarkers from a single timepoint, often in the 3rd trimester, which could miss the critical period of susceptibility or result in exposure misclassification. This study aims to investigate the prospective association between gestational exposure to phthalates and their replacements throughout pregnancy and diagnosis of preeclampsia.

Methods

The study population included 291 pregnant persons recruited between 2017-2020 within the Human Placenta and Phthalates Study. Urine samples were obtained at up to 8 visits between 12- and 38-weeks gestation. Urinary metabolites of phthalates and phthalate replacements were quantified at each timepoint. The geometric mean for each metabolite was calculated from repeated measures in early- (12-15 weeks), middle- (16-25 weeks), late- (26-38 weeks), and overall-gestation. Logistic regression models of preeclampsia were adjusted for maternal age, body mass index, race and ethnicity, education level, smoking, and study site.

Results

Participants identified predominantly as non-Hispanic Black (43%) and were widely exposed to phthalates and their replacements. Preeclampsia incidence was 8.6%. The adjusted odds ratios (OR) of preeclampsia were above the null but not statistically significant for several phthalate and phthalate replacement metabolites. Mono-ethyl phthalate illustrated a pattern of increasing OR from early (OR=0.87, 95% confidence interval [CI]=0.57, 1.32), to middle (OR=1.31, 95% CI=0.83, 2.06), to late (OR=1.39, 95% CI=0.91, 2.14) pregnancy.

Conclusion

This racially diverse, U.S.-based prospective cohort provides insight into the temporality of associations between gestational phthalate exposure and preeclampsia.

Disclaimer: The findings and conclusions in this report are those of the authors and do not represent the official position of the Centers for Disease Control and Prevention.

Tuesday OS2

Prenatal exposures to phthalates and life events stressors in relation to child behavior at age 4-6: a combined cohort analysis.

Emily Barrett[1], Drew Day[2], James Peng[3], Adam Szpiro[3], Christine Loftus[3], Kurunthachalam Kannan[4], Leonardo Trasande[4], Qi Zhao[5], Ruby Nguyen[6], Shanna Swan[7], Catherine Karr[3], Kaja LeWinn[8], Sheela Sathyanarayana[2], Nicole Bush[8]

[1]Rutgers School of Public Health, Piscataway, USA. [2]Seattle Childrens Hospital, Seattle, USA. [3]University of Washington, Seattle, USA. [4]New York University, New York, USA. [5]University of Tennessee Health Sciences Center, Memphis, USA. [6]University of Minnesota, Minneapolis, USA. [7]Icahn School of Medicine at Mount Sinai, New York, USA. [8]University of California-San Francisco, San Francisco, USA

Abstract

Introduction: Prenatal exposures to chemical and psychosocial stressors can impact the developing brain, but few studies have examined their joint impacts. We examined associations between prenatal phthalate exposures, stressful life events (SLEs) in pregnancy, and child behavior, hypothesizing that SLEs exacerbate adverse impacts of phthalates on behavior.

Methods: We used harmonized data from 1360 mother-child dyads from three cohorts comprising the ECHO-PATHWAYS consortium. Phthalate metabolites were measured in mid-pregnancy urine. When children were ages 4-6, mothers completed the Child Behavior Checklist (CBCL) and a recall query of 14 SLEs during pregnancy. Higher CBCL scores indicated more problem behaviors and a binary outcome variable was created based on a clinical cutoff of 84%ile. Primary models examined CBCL scores (continuous and binary) in relation to: (1) phthalate mixtures calculated through weighted quantile sums regression with permutation test-derived p-values; and (2) joint exposure to phthalate mixtures and SLEs (continuous) using interaction terms, adjusting for covariates. Secondarily, we evaluated associations between individual metabolites and CBCL scores and examined sex-specific associations.

Results: Higher prenatal exposure to phthalate metabolite mixtures was associated with increased odds of a clinically-relevant score for problem behaviors (OR=1.14, 95%CI:1.00,1.31), with stronger associations observed in boys (OR=1.28, 95%CI:1.04,1.65) vs. girls (OR:1.08, 95%CI:0.88,1.32). Associations were driven by MHXP, MEHP, and MCINP. We observed significant interactions whereby prenatal exposure to SLEs decreased strength of associations between phthalates and problem behaviors. Results of models examining individual metabolites were similar as were results of models examining continuous CBCL scores, though most CIs included the null. Associations were generally in the same direction in both sexes, but stronger in boys.

Discussion: We observed unexpected statistically significant interactions whereby greater gestational exposure to SLEs decreased harmful associations between phthalates and problem behaviors. Additional research is needed to replicate results, further evaluate confounding, and examine potential mechanisms.

Tuesday OS2

Prenatal exposure to phthalate mixtures and childhood respiratory health outcomes: A Study from the PROGRESS Cohort

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Abstract

BACKGROUND: Prenatal phthalate exposure can impact lung development and has been linked to the development of wheeze and asthma in childhood. We aim to examine associations between prenatal phthalate mixtures and childhood asthma and wheeze.

METHODS: We assessed 607 mother- child dyads enrolled in the Programming Research in Obesity, Growth, Environment, and Social Stressors birth cohort in Mexico City. We quantified 15 phthalate metabolites in 2nd trimester urine. Parental report of child "ever" and "current" (past 12 months) wheeze, and asthma were obtained using the validated Spanish version of the International Study of Asthma and Allergies in Childhood questionnaire at 48 and 72 months. Mixture effects were assessed using Quantile G- Computation (g-comp) and Bayesian Weighted Quantile Sum (BWQS) regression. Models were adjusted for maternal age and education, report of second hand smoke during pregnancy and child sex.

RESULTS: We found similar joint mixture effects of higher 2nd trimester phthalate metabolites and higher odds of wheeze at 48 and 72 months using both methods. The phthalate mixture was associated with higher odds of ever wheeze at 48 months (OR: 1.28, 95% CI: 1.05, 1.58) and (OR: 1.28, 95% Credible interval (Cr): 1.04, 1.60) using g-comp and BWQS respectively. We found similar patterns for ever wheeze at 72 months (g-comp, OR: 1.33, 95% CI: 1.00, 1.81) and (BWQS, OR: 1.36, 90% Cr: 1.03, 1.79); current wheeze at 48 months (g-comp, OR: 1.37, 90% Cr: 0.96, 1.97) and (BWQS, OR: 1.21, 90% Cr: 0.91, 1.64); and current wheeze at 72 months (g-comp, OR: 1.92, 90% Cr: 1.06, 3.51) and (BWQS, OR: 1.95, 90% Cr: 1.25, 3.13). We did not detect significant associations with asthma.

CONCLUSIONS: Prenatal exposure to phthalate mixtures were associated with higher odds of wheeze in children. Future directions include examining prenatal exposure to phthalate mixtures and childhood lung function.

Tuesday OS3

Relationship between children’s vulnerability to climate change and redlining in the Southeast United States

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Abstract

Background: The Southeast United States (U.S.) is one of the hottest climates and has some of the highest levels of concentrated childhood poverty in the U.S. The frequency and severity of extreme heat and particulate matter (PM) are expected to increase in the region due to climate change. However, little is known about the impacts of historical redlining, a racially discriminatory housing practice, on future or current cumulative children's environmental health burdens. This study investigates relationships between redlining and combined stressors for multiple dimensions of the environment, including projected temperatures from climate change, in Alabama, Florida, Georgia, and South Carolina.

Methods: We combined data on ambient PM2.5, historical maximum temperature, temperature projections tied to climate change, greenspace (normalized differential vegetative index [NDVI]), racial segregation, and child poverty. Multilevel linear regression and cluster analyses tested associations between Homeowners’ Loan Corporation grades (A through D) and multiple environmental stressors, including child poverty and future temperatures due to climate change.

Results: Relative to neighborhoods assigned A grades, grade D neighborhoods are associated with significantly higher historical maximum temperature (β=0.07 [95% CI: 0.03, 0.11]), average temperatures in 2080 (β=0.03 [0.00, 0.05]), summertime temperatures in 2080 (β=0.06 [0.03, 0.09]), and changes in summertime temperatures (β=0.006 [0.002, 0.01]). Historical long-term PM2.5 (β=0.24 [0.16, 0.32]) and NDVI (β = -0.06 [-0.08, -0.04]) were significantly worse in grade D neighborhoods relative to grade A neighborhoods. Racial segregation was independently associated with higher historical maximum temperature and 2080 average temperatures. Cluster analysis identified redlined neighborhoods with high childhood poverty that are most vulnerable to heat-related climate change impacts and joint exposure to adverse environmental conditions.

Conclusions: Redlining and segregation are associated with climate-related heat burdens and combined environmental stressors in the Southeast US. In the context of structural racism, the results of this study can inform targeted climate adaptation.

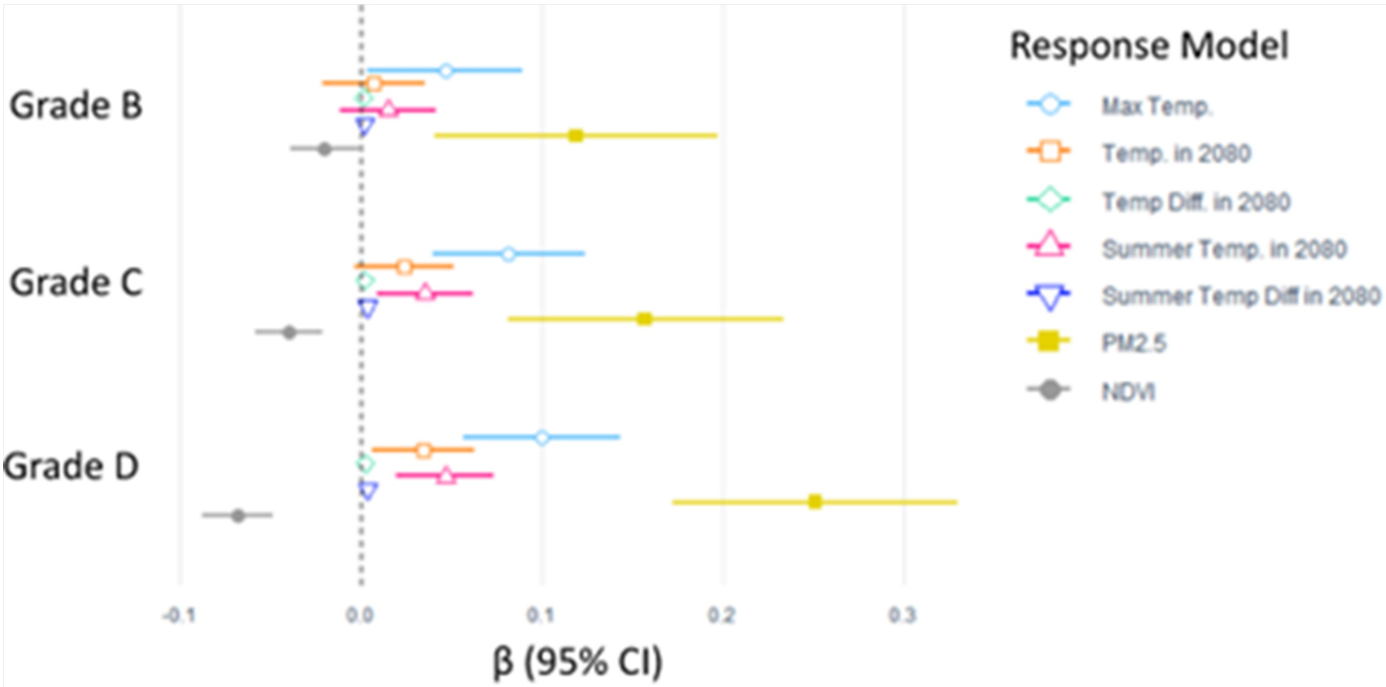

Figure. Adjusted associations between environmental factors and HOLC grades. Each regression coefficient corresponds to a separate model specific to each different environmental variable. Grade A is set as the reference group in each model.

Tuesday OS3

Association between historical redlining and current environmental quality in five North Carolina cities

Monica Jimenez[1], Danelle Lobdell[2], Alison Krajewski[2], Kristen Rappazzo[2], Christine Gray[3], Lynne Messer[4], Jyotsna Jagai[5], Dashel Nance[6], Eric Brown[6], Thomas Luben[2]
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Abstract

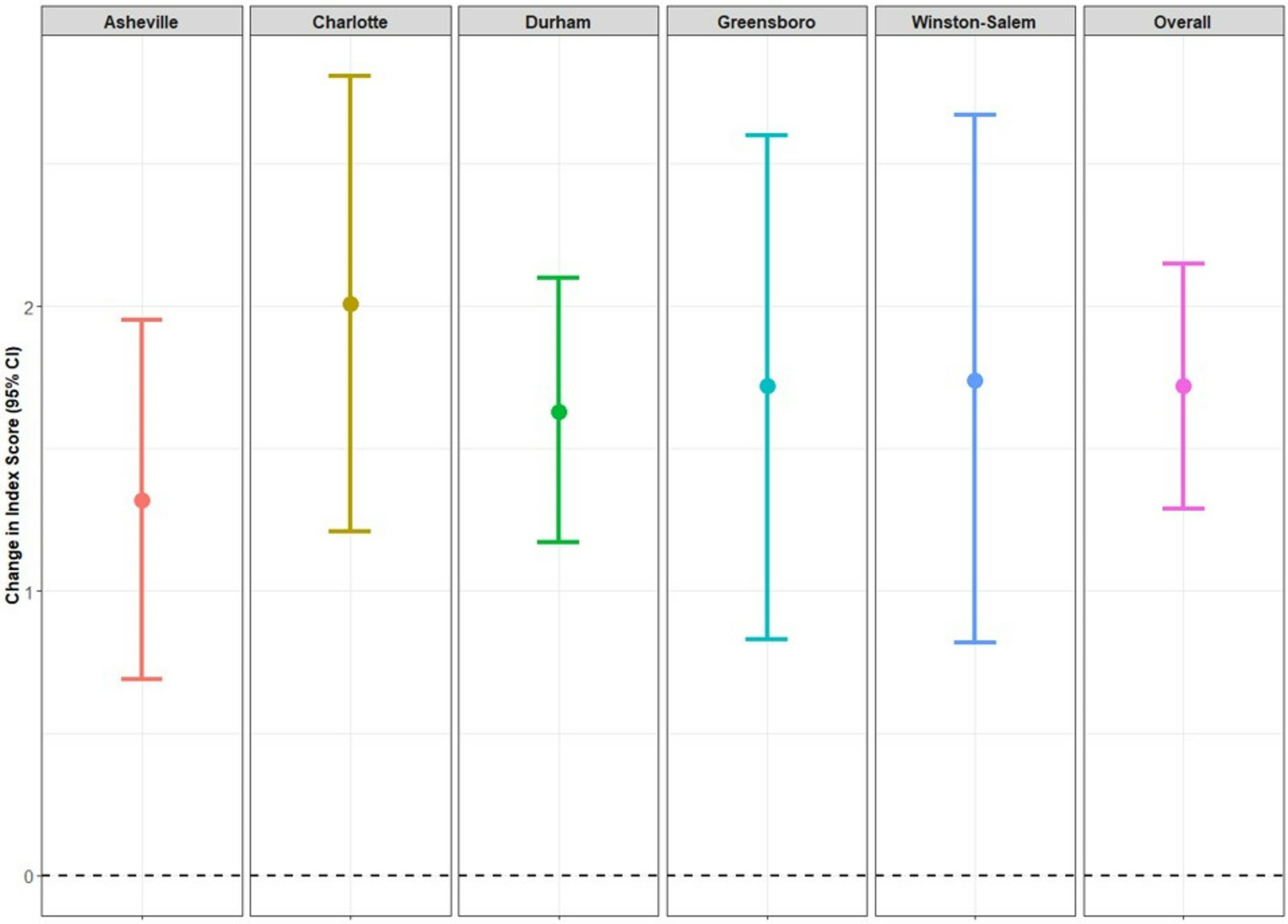

Figure 1. Change in environmental quality index score comparing redlined areas to desirable areas in five North Carolina (NC) cities (Asheville, Charlotte, Durham, Greensboro, Winston-Salem)

BACKGROUND

Environmental quality varies between neighborhoods, with lower environmental quality observed in neighborhoods with lower income levels and/or lower proportion of white residents. In the 1940’s, the Home Owners Loan Corporation created maps of neighborhood ratings considered high risk for mortgage lending, which denied residents, usually racial, ethnic, and religious minorities, the opportunity to become homeowners and accumulate wealth.

METHODS

We explored if designation as a redlined neighborhood in 1940 predicted more contemporary (2006-2010) census tract-level environmental quality in five North Carolina cities (Asheville, Charlotte, Durham, Greensboro, Winston-Salem). Environmental quality was characterized using EPA’s census tract-level Environmental Quality Index (EQI). The EQI is a composite measure of environmental quality that combines data from 5 domains (air, water, land, built, sociodemographic) to assign a score for each census tract. To create the exposure, a census tract shapefile layer was overlayed high-resolution digital maps of historical redlining. These maps include the 1940 neighborhood assignment of redlining ratings, which include Best, Still Desirable, Declining, and Hazardous. These ratings were combined to create a two-category exposure as follows: Best or Still Desirable (desirable) and Declining or Hazardous (redlined). Linear generalized estimating equation models estimated the associations between historical redlining ratings and environmental quality.

RESULTS

EQI scores assigned to census tracts with redlining ratings ranged from -2.93 to 2.59, where higher EQI scores (outcome) indicate lower environmental quality. When comparing redlined areas to desirable areas, we observed poorer overall environmental quality (1.72 change in index score [95% CI: 1.29, 2.15]).

CONCLUSION

These results suggest that one of the United States’ racist policies – redlining neighborhoods – is associated with poorer environmental quality 70 years later and may contribute to disparities in exposure to detrimental environments. We plan to use the results of these analyses to further study impacts of environmental justice on human health.

Tuesday OS3

Assessing Neighborhood Disadvantage and Health Disparities through a Spatial Lens: A Comparison of the CDC Environmental Justice Index, Racial Isolation, and Birth Outcomes in North Carolina

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Abstract

Background and Aim
In August 2022, the CDC released the Environmental Justice Index (EJI), which ranks environmental burden, social, and health vulnerability at the census tract level across the US. While the EJI includes racial composition, it does not fully capture concentrated neighborhood disadvantage. Our racial isolation (RI) index, in contrast, is a local, spatial measure specifically based on residential segregation.

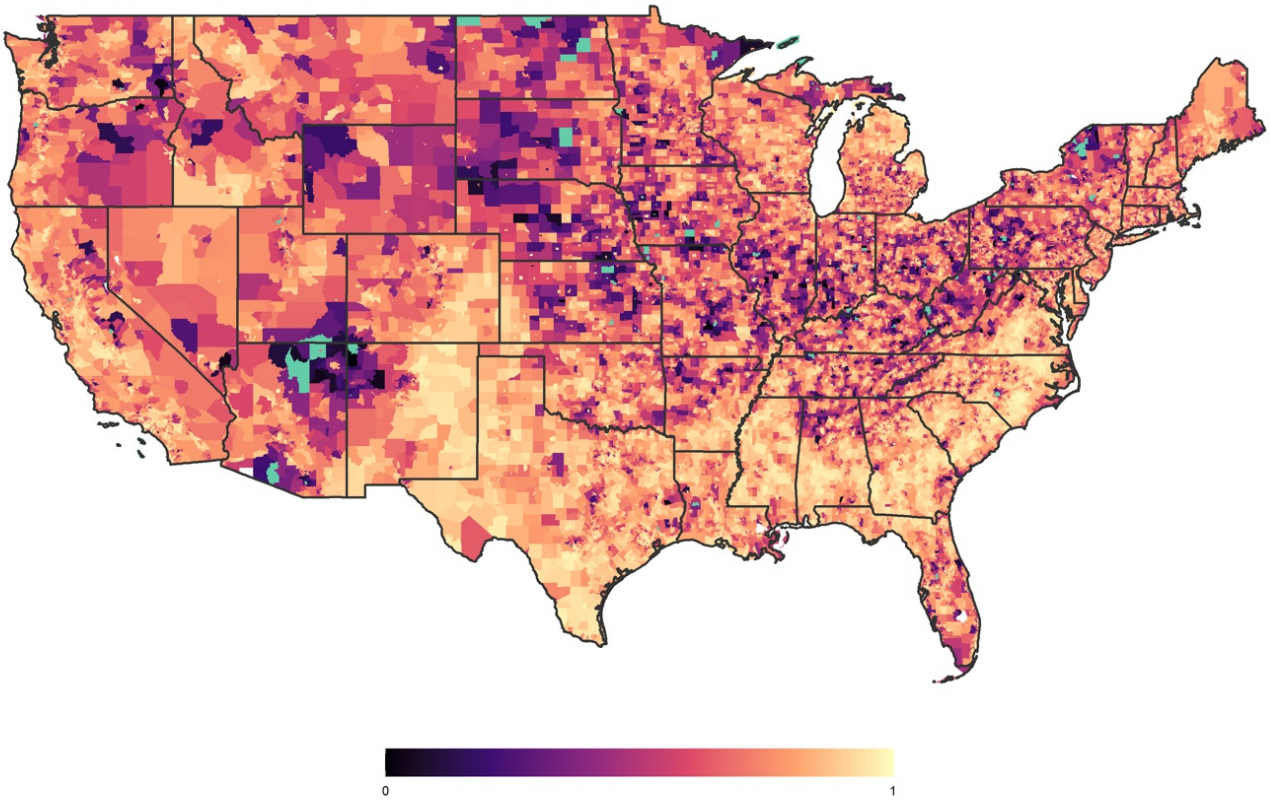
Methods
For the 72,246 continental US census tracts, we calculated our measure of RI of non-Hispanic black (NHB) and Hispanic individuals. We estimated pairwise correlations between the EJI and RI using global (Pearson) and local approaches to characterize how the relationships vary spatially. We assessed associations between EJI, RI, and birthweight percentile by assigning EJI/RI values based on maternal census tract of residence at time of birth from North Carolina detailed birth records for 2015-2019 (n=446,702). Race-stratified models included random effects at the tract-level, and adjusted for infant sex, smoking during pregnancy, mother's age, educational attainment, and marital status.

Results
The global correlation for EJI and RI was moderate (r=0.41). Nationally, the largest local correlations were observed in the southeast, southwest, and parts of the west coast, where RI and EJI are both high. In NC models co-adjusted for RI and EJI, an interquartile range (IQR=0.28) increase in RI was associated with a -2.4 (95% CI: -2.6, -2.2) decrease in birthweight percentile. Meanwhile, an IQR (0.47) increase in EJI was associated with a -0.76 (95% CI: -0.99, -0.53) decrease. In race-stratified models, the association between RI and birthweight percentile was most pronounced among NHB and Hispanic individuals [-1.08 (95% CI: -1.34, -0.82)], relative to non-Hispanic whites (NHW), who experienced a positive association [0.45 (95% CI: 0.20, 0.71)].

Conclusion
Our results support the use of RI as an analytically efficient alternative in environmental justice and health disparities research.

US local correlation: EJI (Overall) vs. RI NHB + Hispanics

Tracts in light blue represent a local correlation < 0



Tuesday OS3

ASSOCIATIONS OF HISTORICAL REDLINING AND URBAN HEAT ISLANDS IN PHILADELPHIA, PA, AND EFFECT MODIFICATION BY NEIGHBORHOOD GENTRIFICATION

Janelle R Edwards, Anneclaire J De Roos, Irene Headen, Michelle Kondo, Chén Kenyon, Loni Tabb, Leah H Schinasi
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Abstract

Background: Spatial inequities, such as disparities in greenspace and other built environment characteristics, create microclimates where some neighborhoods within cities are hotter than others. Historical redlining, introduced by the Homeowners Loan Corporation (HOLC) in 1938, graded neighborhoods from A-“best” to D-“hazardous” which indicated the risk for mortgage approval based on the neighborhood’s racial composition. Previous research indicates that historically “hazardous” neighborhoods may be associated with current increased land surface temperatures (LST), lower tree canopy cover, and other climate indicators, yet few studies have explored the extent to which associations vary across categories of neighborhood gentrification. **Methods:** We categorized hot neighborhoods in Philadelphia, PA in 2016 by calculating the difference between the LST of each census tract from the city-level average LST. We used 1938 HOLC grade maps and areal weighting to identify historically redlined neighborhoods. We identified census tracts that were ineligible to gentrify, were eligible but did not gentrify, and did gentrify between 1990-2000, by calculating changes in neighborhood sociodemographics using decennial Census data. We calculated associations between categorical redlining grades and the continuous measure of tract-level LST deviation, overall and stratified by gentrification categories. **Results:** The analysis included 384 Philadelphia census tracts, of which 140 (36.5%) had higher LSTs than the city’s mean. Census tracts subjected to historical redlining were hotter than average across the city (average LST deviation among tracts in HOLC D (hazardous) = 0.74^{O}F hotter (standard deviation= 2.62) vs HOLC A+B (best) mean = -4.4^{O}F cooler+4.44). Lastly, HOLC D (hazardous) census tracts that underwent gentrification had cooler LSTs (mean= -0.38^{O}F+2.10) compared to those that did not (mean= 1.05^{O}F+2.67). **Conclusion:** Our preliminary results suggest that micro-heat islands are related to a past indicator of structural racism (redlining) and that these relationships may be attenuated by contemporary gentrification processes.

Tuesday OS3

Equity Considerations for Climate and Health Research: A Review of the Literature on Disparate Health Impacts due to Hurricanes and Structural Determinants of Vulnerability

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Abstract

Background:

Understanding vulnerability to climate-related disasters, such as hurricanes, is crucial for targeting and identifying mitigation and adaptation measures. However, vulnerability assessments often focus on proximal factors and may obscure underlying drivers of health inequities. We sought to describe the existing literature on defining vulnerability to hurricanes and develop a framework to incorporate structural determinants of vulnerability.

Methods:

We conducted a literature search in the National Library of Medicine's MEDLINE/PubMed database. We identified peer-reviewed, population-based research articles assessing equity or vulnerability within the context of hurricane-related health impacts in the U.S., from January 2000 through October 2022. For each study, we determined whether the approach pre-specified vulnerable populations or characterized vulnerability empirically. We also abstracted data on the types of factors used to assess vulnerability to hurricanes (e.g., demographic, structural, etc.). Finally, we developed a framework to guide research on structural determinants of vulnerability to hurricanes.

Results:

The initial search resulted in 631 articles. After completion of the title screening, abstracts and full texts of the remaining articles (n=213) were screened and an additional set (n=92) were excluded. For the included studies (n=121), the majority (n=69) pre-specified vulnerable populations of interest, while the remaining 43% (n=52) empirically derived vulnerability. Among all studies, there were common categories of vulnerability, with some overlap: demographic (e.g., race/ ethnicity, age, etc.; n=81), spatial (e.g., census tracts, neighborhoods, etc.; n=26), and health status (n=17). Less common categories were outcomes (e.g., displaced; n=6), structural (n=5), and occupational (n=1). Studies on structural vulnerabilities revealed systemic issues of racism, governance, institutions, and infrastructure deficiencies, forming the basis of our conceptual framework.

Conclusions:

Most studies on hurricane vulnerability do not consider systemic, upstream factors that contribute to health inequities. Research to drive systemic interventions requires a shift in focus to structural determinants of vulnerability to climate-related disasters.

Tuesday OS3

Systemic Drivers of and Solutions for Environmental Injustice

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Abstract

BACKGROUND: Evidence has linked historical discriminatory practices with individual current environmental determinants of disease and disease outcomes. However, the importance of assessing cumulative impacts is increasingly recognized as critical for consideration of environmental justice. We conducted a study to assess the association between historical discriminatory practices and present-day cumulative impacts and understand the types of solutions communities use to combat environmental injustice.

METHODS: In the 1930s, the Home Owners' Loan Corporation created community maps to indicate the level of security for real-estate investments, using grades A (good) to D (poor), a practice known as redlining. We used a spatial weighting method to assign a redlining score to each census tract so that higher scores represented tracts with more “D” rated neighborhoods. Data on cumulative impacts was obtained from the U.S. Centers for Disease Control’s Environmental Justice Index. We used linear mixed effects regression models, with random intercepts for communities, to assess the relationship between the redlining score and cumulative environmental justice index. To determine how communities are currently addressing environmental injustice, we conducted a systematic review of the literature.

RESULTS: For every unit increase in the historical redlining score, we found a 0.36 (95% CI: 0.35, 0.37) unit increase in the present-day environmental justice index, with some regional variation. In a review of 149 articles describing solutions to address environmental injustice, we found that 41% did not address upstream drivers of inequitable burdens, potentially contributing to a mismatch between drivers and solutions. In articles that did address upstream drivers, 26% cite housing policies as a driver but only 7% of reviewed articles describe housing policy solutions.

CONCLUSIONS: We found evidence for an association between historical discriminatory practices and disproportionate cumulative impacts in communities. Research on solutions to address environmental injustice should consider structural factors to drive systemic change.

Tuesday OS4

Effect modification of greenness on the association between heat and mortality: a multi-city multi-country study

Hayon Michelle Choi[1], Whanhee Lee[2], Dominic Roye[3], Seulkee Heo[1], Aleš Urban[4,5], Alireza Entezari[6], Ana Maria Vicedo-Cabrera[7], Antonella Zanobetti[8], Antonio Gasparrini[9,10,11], Antonis Analitis[12], Aurelio Tobias[13,14], Ben Armstrong[9], Bertil Forsberg[15], Carmen Íñiguez[16], Christofer Åström[15], Chris Fook Sheng Ng[14,17], Ene Indermitte[18], Eric Lavigne[19,20], Fatemeh Mayvaneh[6], Fiorella Acquaotta[21], Francesco Sera[22], Hans Orru[18], Ho Kim[23], Jan Kyselý[4,5,24], Joana Madueira[25,26], Joel Schwartz[8], Jouni J K Jaakkola[27], Klea Katsouyanni[12], Magali Hurtado Dia[28], Martina S. Ragettli[29,30], Masahiro Hashizume[14,17], Mathilde Pascal[31], Niilo Ryti[27], Noah Scovronick[32], Samuel Osorio[33], Shilu Tong[34,35,36,37], Xerxes Seposo[14], Yasushi Honda[14,38,39], Yoonhee Kim[40], Yue-Liang Leon Guo[41,42], Yuming Guo[43], Michelle L. Bell[1]

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Abstract

Abstract

Background

Identifying how greenspace impacts the temperature-mortality relationship in urban environments is crucial, especially given climate change and rapid urbanization. However, the effect modification of greenspace on heat-related mortality has been typically focused on a localized area or single country. This study examined the heat-mortality relationship among different greenspace levels in a global setting.

Methods

We collected daily ambient temperature and mortality data for 452 locations in 24 countries and used Enhanced Vegetation Index (EVI) as the greenspace measurement. We used distributed lag non-linear model to estimate the heat-mortality relationship in each city and the estimates were pooled adjusting for city-specific average temperature, city-specific temperature range, city-specific population density, and gross domestic product (GDP). The effect modification of greenspace was evaluated by comparing the heat-related mortality risk for different greenspace groups (low, medium, and high), which were divided into terciles among 452 locations.

Findings

Cities with high greenspace value had the lowest heat-mortality relative risk of 1·19 (95% CI: 1·13, 1·25), while the heat-related relative risk was 1·46 (95% CI: 1·31, 1·62) for cities with low greenspace when comparing the 99th temperature and the minimum mortality temperature. A 20% increase of greenspace is associated with a 9·02% (95% CI: 8·88, 9·16) decrease in the heat-related attributable fraction, and if this association is causal (which is not within the scope of this study to assess), such a reduction could save approximately 933 excess deaths per year in 24 countries.

Interpretation

Our findings can inform communities on the potential health benefits of greenspaces in the urban environment and mitigation measures regarding the impacts of climate change.

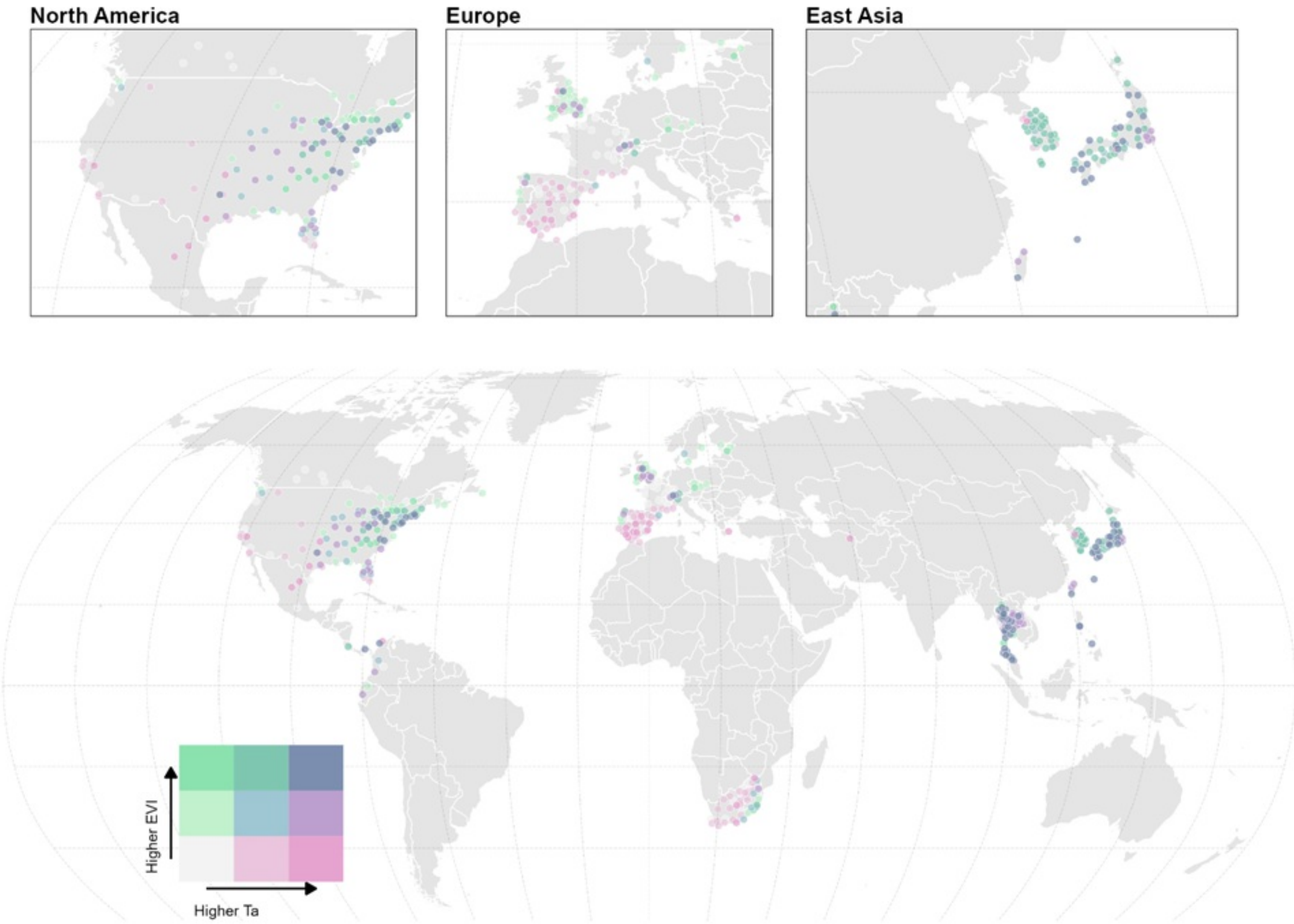

Figure 1. Map of the 452 locations included in the analysis with temperature and EVI

Tuesday OS4

Residential Green Space Exposure and Markers of Psychosocial Stress and Depressive Symptoms in a North American Preconception Cohort Study

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Abstract

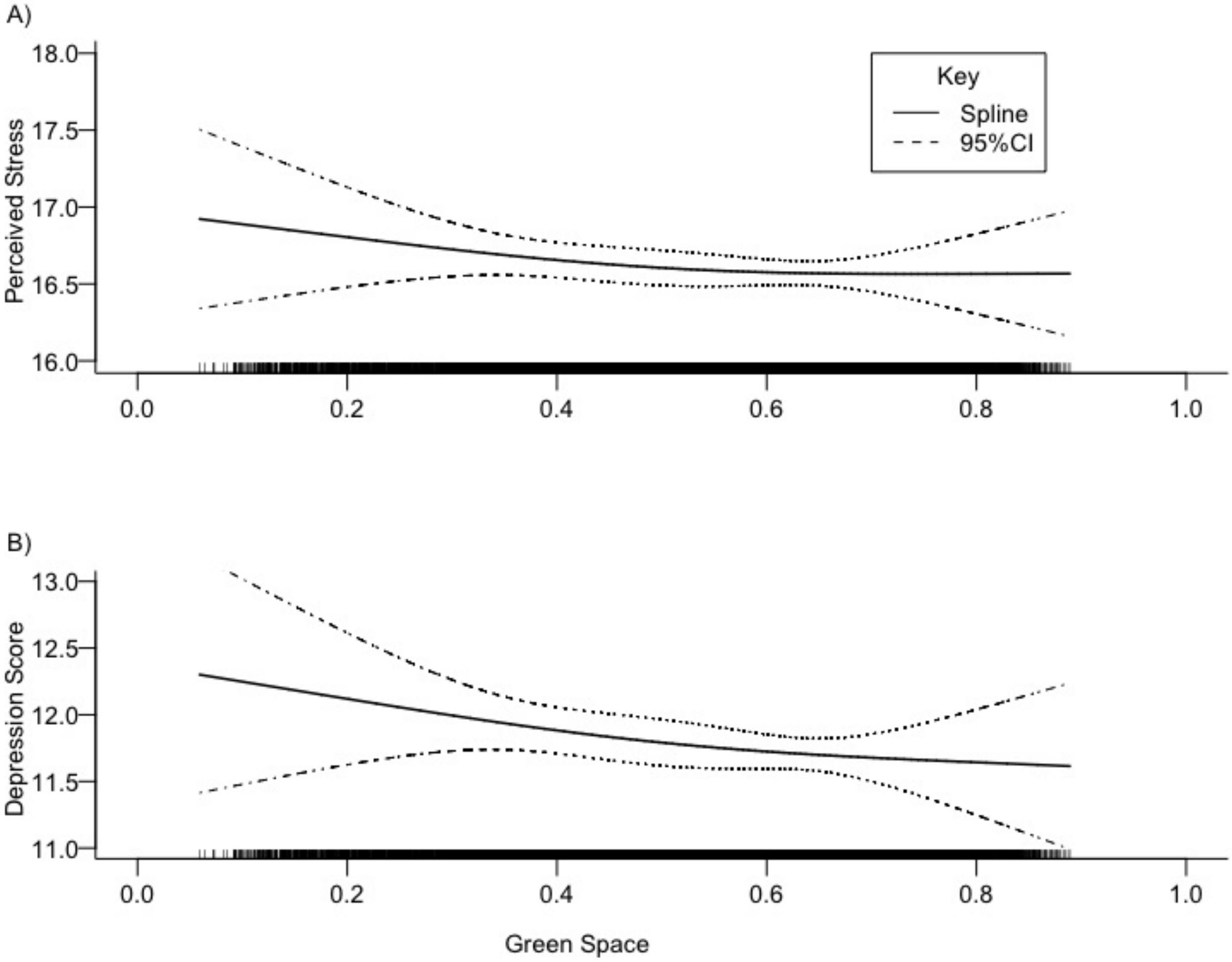
Background/Aims: Recent studies suggest that greater exposure to natural vegetation (greenspace) is associated with better mental health. However, there is limited research on green space and mental health in the preconception period, a critical window of exposure in the life course. We investigated the cross-sectional association between green space and psychosocial stress and depression in a cohort of pregnancy planners.

Methods: In a large North American preconception cohort (Pregnancy Study Online [PRESTO]), we used 30m resolution Landsat satellite imagery to estimate baseline residential green space exposure defined as Normalized Difference Vegetation Index (NDVI) in a 250m buffer. From 2013 to 2021, self-identified females aged 21-45 years who were trying to conceive without the use of fertility treatment completed an online baseline questionnaire that included the 10-item Perceived Stress Scale (PSS) and the Major Depression Inventory (MDI). We evaluated the association between greenness and markers of psychosocial stress and depressive symptoms using restricted cubic splines and generalized linear models, adjusting for individual and neighborhood sociodemographic characteristics.

Results: Our analytic sample included 9,814 participants (mean age = 30 years.) We observed non-linear associations between green space and markers of psychosocial stress and depressive symptoms (Figure 1). In fully adjusted models, participants living in the second green space quartile had a -0.32 lower PSS score (95% CI: -0.64, 0.01) than those living in the lowest quartile. Similarly, participants living in the second green space quartile had a -0.47 lower MDI score (95% CI: -0.96, 0.02) than those living in the lowest quartile. Splines suggested that above an NDVI of 0.4, there was no clear evidence of additional improvement in PSS and MDI scores.

Conclusions: Higher green space exposure was non-linearly associated with beneficial preconception mental health symptomatology among pregnancy planners, highlighting the importance of the built environment.

Fig 1. Restricted cubic splines for the fully adjusted associations in the PRESTO cohort (N=9,814)



Tuesday OS4

Contributions of social and physical environmental factors to racial and ethnic disparities in birth outcomes in Los Angeles County from 2017 to 2019.

Shiwen Li, Lara Cushing, Roch Nianogo, Jonathan Liu, Michael Jerrett, Beate Ritz
UCLA, Los Angeles, USA

Abstract

Background

Few studies have assessed the contributions of environmental factors to racial/ethnic disparities in adverse birth outcomes. We decomposed the contributions of social and physical environment to the disparities in Los Angeles (LA) County.

Method

We linked birth records from 2017-2019 in LA county to census block group social environmental factors including unemployment rate, educational attainment, poverty rate, and linguistic isolation, and physical environmental factors including ambient fine particulate matter (PM2.5), extent of impervious surfaces (e.g. roads, parking lots, rooftops), and drinking water contamination. We generated composite scores separately for social and physical environmental factors using principal component analysis. We performed mediation analysis using g-computation to assess environmental factors in explaining the racial/ethnic disparities in preterm birth (PTB) and term-birth low birth weight (TLBW) comparing non-Hispanic Black (‘Black’) or Hispanic (‘Latinx’) with non-Hispanic White (‘White’) children. Potential confounders we adjusted for included child sex, smoking during pregnancy, parity, maternal age, pre-pregnancy body mass index, adequacy of prenatal care, maternal education, payment source for prenatal care, and maternal birthplace. We applied multilevel models with random intercept for block group.

Results

Black-White mean predicted probability differences for PTB and TLBW were 0.041 (95% CI: 0.033, 0.048) and 0.024 (0.020, 0.028). Latinx-White differences were 0.034 (0.028, 0.039) and 0.011 (0.008, 0.014). For PTB, social environment contributed 0% (-13%, 13%) of the Black versus White and 12% (3%, 23%) of the Latinx versus White disparities, while physical environment contributed 13% (5%, 21%) and 3% (-1%, 7%), respectively. For TLBW, social environment contributed 22% (10%, 36%) of Black versus White and 22% (5%, 40%) of Latinx versus White disparities, while physical environment contributed 2% (-7%, 11%) and 1% (-6%, 9%), respectively.

Conclusions

Our study suggests that improving social and physical neighborhood environments could reduce Black/Latinx versus White disparities in PTB and TLBW.

Tuesday OS4

Is home where the heat is? comparing residence-based with time-weighted dynamic measures of exposure to microclimate indicators in San Diego, California

Michael Garber[1,2], Gabriel Carrasco-Escobar[3,2], Anais Teyton[2], David Rojas-Rueda[1], Marta Jankowska[4], Tarik Benmarhnia[2]
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Abstract

Background: Urban heat is an increasing public-health issue, and features of the built and natural urban environment can exacerbate heat. Measures of exposure to micro-heat islands in general and microclimate indicators specifically (e.g., land-surface temperature, measures of greenness or measures of impervious surfaces) are typically modelled based on the place of residence, yet individuals spend much of their time outside of their residence, so considering an activity-space-based approach may be useful.

Objective: In this study, we compared various measures of microclimate exposure as defined using place of residence compared with those defined using an activity-space-based approach.

Methods: We obtained 9 microclimate indicators (including land-surface temperature, measures of greenness, measures of impervious surface and measures of evapotranspiration) via satellite imagery at a spatial resolution between 30 and 250 meters for San Diego County, California. A diverse study population of 599 participants wore GPS devices for an average of 14 days in San Diego County. We measured static exposure to each indicator by drawing a 200-meter buffer around their inferred home location and summarizing exposure values within that buffer. We measured dynamic exposure by drawing a 200-meter buffer around the participant’s activity paths (keeping the longitudinal dimension via sequential GPS pings), extracting exposure values within those longitudinal buffers, and weighting exposure values by the amount of time the individual spent traveling in that location. We also compared correlations across socio-demographic characteristics and mobility patterns.

Results: In general, the static measures had high agreement with the dynamic measures. The average Pearson correlation over the measures was 0.86 (standard deviation [SD]=0.10), and the average Spearman correlation was 0.81 (SD=0.11).

Conclusions: In this study population, time-weighted activity-space-based measures of microclimate exposure were not appreciably different from those considering place of residence alone.

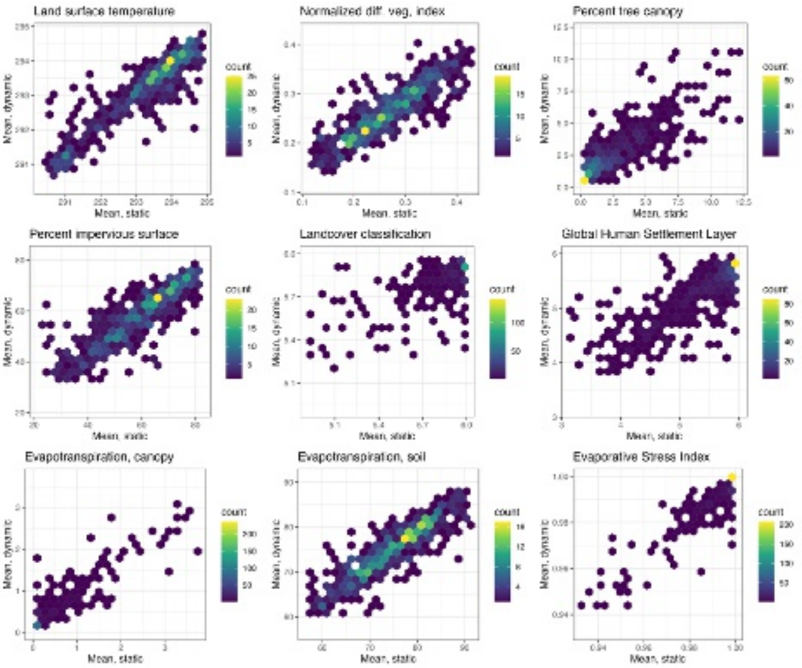

Figure. A hex plot comparing means for each measure.

Tuesday OS4

Associations of GPS-derived walkability and objectively-measured sleep in the Nurses' Health Study 3 Mobile Health Substudy

Cindy Hu[1], Grete Wilt[1], Charlotte Roscoe[2,1], Brent Coull[1], Susan Redline[3,4], Peter James[1,5], Jaime Hart[6,1]

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Abstract

Background: Environmental exposures, including neighborhood walkability, have been associated with sleep. However, prior investigations relied on self-reported sleep and many assign walkability based solely on residential address, which doesn't account for mobility. Using smartphone GPS activity-space data to estimate walkability and objective sleep from Fitbit wearables, we examined the association between walkability and sleep in the Nurses' Health Study 3 (NHS3) Mobile Health Substudy.

Methods: From 2018 to 2020, 500 individuals in NHS3 participated in the Substudy, in which minute-level GPS data and objective sleep duration and efficiency measures were collected via a custom smartphone application and Fitbit respectively, for four 7-day periods across a year to capture seasonal variability. Census-tract walkability [2018] was calculated by summing z-scores of population density (2015-2019 American Community Survey), business density (2018 Infogroup), and intersection density (2018 TIGER/Line road shapefiles). We calculated average daily walkability exposure during the wake period preceding main sleep periods using GPS geolocations recorded at 10-minute intervals. We restricted to individuals with 3 days of 8 hours of wake period data with subsequent sleep records (n=209). We ran generalized additive mixed models with penalized splines to estimate the association between walkability and sleep, adjusting for individual-level covariates, a weekday indicator, as well as GPS-based greenness, light-at-night, temperature, and neighborhood socioeconomic status.

Results: The average main sleep period duration was 7.9 hours and mean sleep efficiency was 92%. In adjusted models, we observed that an interquartile range increase in walkability exposure was associated with a decrease in sleep duration (-5.82 minutes, 95% CI: -1.80, -9.85), and was not associated with sleep efficiency (-0.06%, 95% CI: -0.35%, 0.24%).

Conclusions: In the NHS3 Mobile Health Substudy, we found that daily GPS-based neighborhood walkability exposure during wake time was associated with a decreased wearable-derived sleep duration, but no change in sleep efficiency.

Tuesday OS4

Impact on household air pollution following switch from gas to electric cook stoves in New York City public housing: the 'Out of Gas' pilot study.

Heather Miller[1], Annie Carforo[2], Misbath Daouda[3], Michelle Feliciano[4], Jennifer Ventrella[2], Ashlinn Quinn[1], Yu Ann Tan[5], Ricardo Piedrahita[1], Darby Jackson[3], Michael Johnson[1]
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Abstract

Background: Gas-burning stoves contribute to poor indoor air quality, emitting pollutants including fine particulate matter (PM2.5), nitrogen dioxide (NO2), carbon monoxide (CO), and formaldehyde (CH2O). Long-term exposure to these pollutants can increase the risk of respiratory and cardiovascular illness. In the United States, asthma disproportionately affects Black and Hispanic children and residents of high-poverty neighborhoods. This study aimed to capture the impact of a gas-to-electric induction stove transition in public housing in New York City.

Methods: Between October 2021 and July 2022, 20 gas stove households in a New York City apartment building were monitored for NO2, CO, and PM2.5 for three separate weeklong periods using the Home Health Box (Access Sensor Technologies, Fort Collins, CO). Stove-use monitors were deployed concurrently to determine the impact of cooking events on household air quality. Following the first monitoring period, gas stoves in 10 homes were replaced with electric induction stoves. Stoves in the remaining 10 homes were replaced following the conclusion of the study.

Results: Indoor NO2 concentrations were lower at follow-up in both the induction and gas groups, possibly due to seasonal factors. NO2 levels were above 54 ppb during 4% of total monitoring hours at follow-up in the gas group, compared with 0.2% in the induction group (see Figure). Cooking events specifically impacted NO2 concentrations, with levels 53.3% higher during gas cooking events than otherwise [95% CI: 50.0%, 56.8%] (minimal change observed during induction stove cooking events). 24-hr average CO concentrations averaged 1.4 ppm in gas households during the follow-up periods, compared to 0.8 ppm in induction homes. No significant changes were observed regarding PM2.5.

Conclusion: Stove technology (i.e., gas versus electric) is an important contributor to indoor air quality. Replacing a gas stove with electric is a feasible intervention that can positively impact a household's air quality.

Tuesday OS5

Impact of Personal and Neighborhood Low-Cost Sensors on Changing Air Pollution Awareness, Perceptions, and Behaviors in Gabon, Africa

Sigride Jenniska Asseko[1], Alain Souza[2], Medard Obiang Ebanega[3], Nicole Ngo[4], Perry Hystad[1]
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Abstract

Background: Air pollution is a global public health crisis affecting millions of people, especially in low- and middle- income countries (LMICs). The lack of air pollution research and regulations in LMICs has created reduced environmental health literacy, a major barrier to addressing air pollution.

Methods: We evaluated the use of low-cost air quality sensors to change awareness, perceptions and behaviors towards air pollution in Libreville, Gabon, Africa (a country that at the time of study had no government run air pollution monitors) between January 24th and March 11th, 2022. We recruited participants from the local Omar Bongo University and professionals from the four municipalities in Libreville and the ministry of environment. Individuals were assigned to two monitoring interventions: one group (N=60) was assigned to observe neighborhood measurements and the other group (N=42) wore personal air sensors. 13 PurpleAir monitors were set up across different areas of Libreville and participants were provided with a link to view air quality measurements. Personal monitoring was conducted with the FLOW2 sensor and participants used the corresponding smartphone app to view monitoring data. We implemented surveys to assess awareness, perceptions, and behaviors before and after the 1-week monitoring period.

Results: Compared to pre-intervention measures, awareness, perceptions, and behaviors towards air pollution generally changed in the hypothesized direction after both neighborhood and personal monitoring. 28% and 31% of individuals rated air quality where they live as worst and 28% and 38% of individuals had more concern about air pollutions impact on their health after neighborhood and mobile monitoring, respectively. We did not observe statistically significant differences in the amount of change between the neighborhood and personal monitoring groups.

Conclusion: Our results show that access to both neighborhood and personal monitoring data can substantially change air pollution health literacy in LMICs.

Uncaptioned visual

Figure: Themes associated with air pollution

Tuesday OS5

Examining greenspace exposure for a year using smartphone-based digital phenotyping – Results from two national prospective cohorts

Li Yi[1], Jaime Hart[1,2], Jukka-Pekka Onnela[1], Grete Wilt[1], Cindy Hu[1], Francine Laden[1,2], Jorge Chavarro[1], Peter James[1,3]

[1]Harvard T.H. Chan School of Public Health, Boston, USA. [2]Channing Division of Network Medicine, Department of Medicine Brigham and Women's Hospital and Harvard Medical School, Boston, USA. [3]Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston, USA

Abstract

Background: Evidence suggests that greenspace exposure may influence physical activity, mental health, and chronic disease risk. Greenspace exposure measures, on the other hand, often have limited spatial and temporal resolution and coverage. To address this, we used smartphone-based digital phenotyping to collect objective and self-reported greenspace exposure metrics in two prospective cohorts and to examine concordance between the two measures.

Methods: Beginning in July 2021, a subset of participants in the US-based nationwide Nurses' Health Study 3 (NHS3) and Growing Up Today Study (GUTS) (N = 2,127 as of October 31, 2022) completed up to four greenspace microsurveys using the Beiwe smartphone data collection application. The microsurveys assessed whether respondents had visited parks or spent time in nature within the previous week. During the week prior to each microsurvey, the app collected GPS location data every 15 minutes, which was then spatially joined to a nationwide park dataset (PAD-US-AR) to determine objective park exposure. Agreement between GPS-based and self-reported greenspace exposure metrics was examined using Cohen's Kappa.

Results: Participants completed 2,446 microsurveys about greenspace and nature in the past seven days. 65.7% of microsurvey responses reported visiting a park in the past week, and 44.0% reported spending time in nature in the past week. In the time window covered by the microsurveys, GPS-based measures revealed that 53.6% of the participants spent time in greenspace. The GPS-based and self-reported park exposure metrics, however, only demonstrated slight agreement ($\kappa=0.185$).

Conclusion: Smartphone-based digital phenotyping was utilized in this study to simultaneously collect objective and self-reported greenspace exposure metrics in two well-established prospective cohorts. The results suggested an overall lack of concordance between the two metrics. Future research should consider using multiple measures to capture greenspace exposure to avoid bias when analyzing the relationships between greenspace exposure and health outcomes.

Tuesday OS5

Fine particulate matter infiltration at Western Montana residences during wildfire season

Ethan Walker, Dave Jones, Taylor Stewart
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Abstract

Background/Aims:

Wildfire air pollution is a growing public health concern as wildfires increase in size, intensity, and duration in the United States. The public is often encouraged to stay indoors during wildfire smoke events to reduce exposure. However, there is limited information on how much wildfire smoke infiltrates indoors at residences and what household/behavioral characteristics contribute to higher infiltration. We assessed fine particulate matter ($PM_{2.5}$) infiltration into Western Montana residences during wildfire season.

Methods:

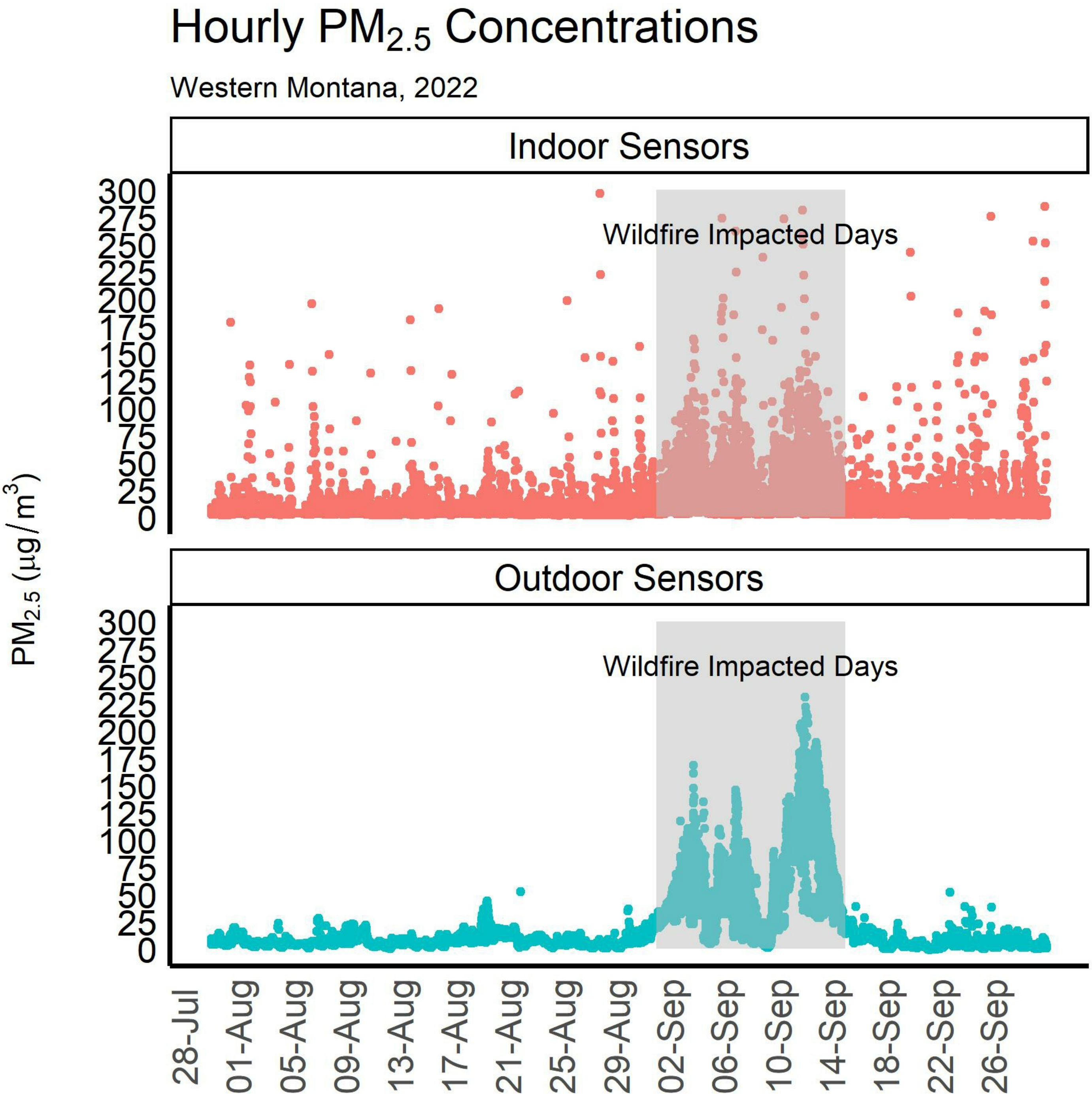
We measured continuous outdoor and indoor $PM_{2.5}$ concentrations from July-October 2022 at 20 residences in Western Montana during wildfire season using PurpleAir sensors (PAII-SD, PurpleAir, Inc, USA). We used paired outdoor/indoor $PM_{2.5}$ data from each household to calculate infiltration efficiency (F_{inf}; range 0-1; higher values indicate more outdoor $PM_{2.5}$ infiltration to the indoor environment) using previously validated methods. Analyses were conducted for all households combined, separately for each household, and by days impacted by wildfire smoke.

Results:

Median (25th percentile, 75th percentile) daily outdoor $PM_{2.5}$ at the households was 6.6 µg/m^3 (4.5, 11.2) during the entire study and 41.1 µg/m^3 (28.0, 68.9) during a 2-week period in September impacted by wildfire smoke. Median daily indoor $PM_{2.5}$ at the households was 5.4 µg/m^3 (3.8, 9.4) overall and 16.1 µg/m^3 (9.6, 32.4) during the wildfire period. Overall F_{inf} was 0.37 (95% Confidence Interval [95%CI]: 0.35, 0.38) with lower values during the wildfire period (0.33; 95%CI: 0.29, 0.38) versus non-wildfire period (0.50; 95%CI: 0.48, 0.52). F_{inf} at individual households ranged from 0.08 (95%CI: 0.03, 0.13) to 0.85 (95%CI: 0.77, 0.94).

Conclusions:

Indoor $PM_{2.5}$ was substantially higher during wildfire-impacted periods versus the rest of the study. F_{inf} was highly variable across households and suggests indoor exposures to wildfire smoke may be modifiable. Future analyses will assess the impact of household/behavioral factors on indoor $PM_{2.5}$ and F_{inf}.


Hourly PM2.5 Concentrations
Western Montana, 2022
Indoor Sensors
Outdoor Sensors
Wildfire Impacted Days
Wildfire Impacted Days
PM2.5 (μg/m3)
300
275
250
225
200
175
150
125
100
75
50
25
0
28-Jul
01-Aug
05-Aug
09-Aug
13-Aug
17-Aug
21-Aug
25-Aug
29-Aug
02-Sep
06-Sep
10-Sep
14-Sep
18-Sep
22-Sep
26-Sep

Tuesday OS5

Predicting Spatiotemporal Variations in Daily Mean Outdoor Ultrafine Particle Concentrations in Montreal and Toronto, Canada

Alessya Venuta[1], Marshall Lloyd[1], Arman Ganji[2], Junshi Xu[2], Leora Simon[1], Mingqian Zhang[2], Milad Saeedi[2], Shoma Yamanouchi[2], Joshua Apte[3], Kris Hong[1], Marianne Hatzopoulou[2], Scott Weichenthal[1]
[1]McGill University, Montreal, Canada. [2]University of Toronto, Toronto, Canada. [3]University of California Berkeley, Berkeley, USA

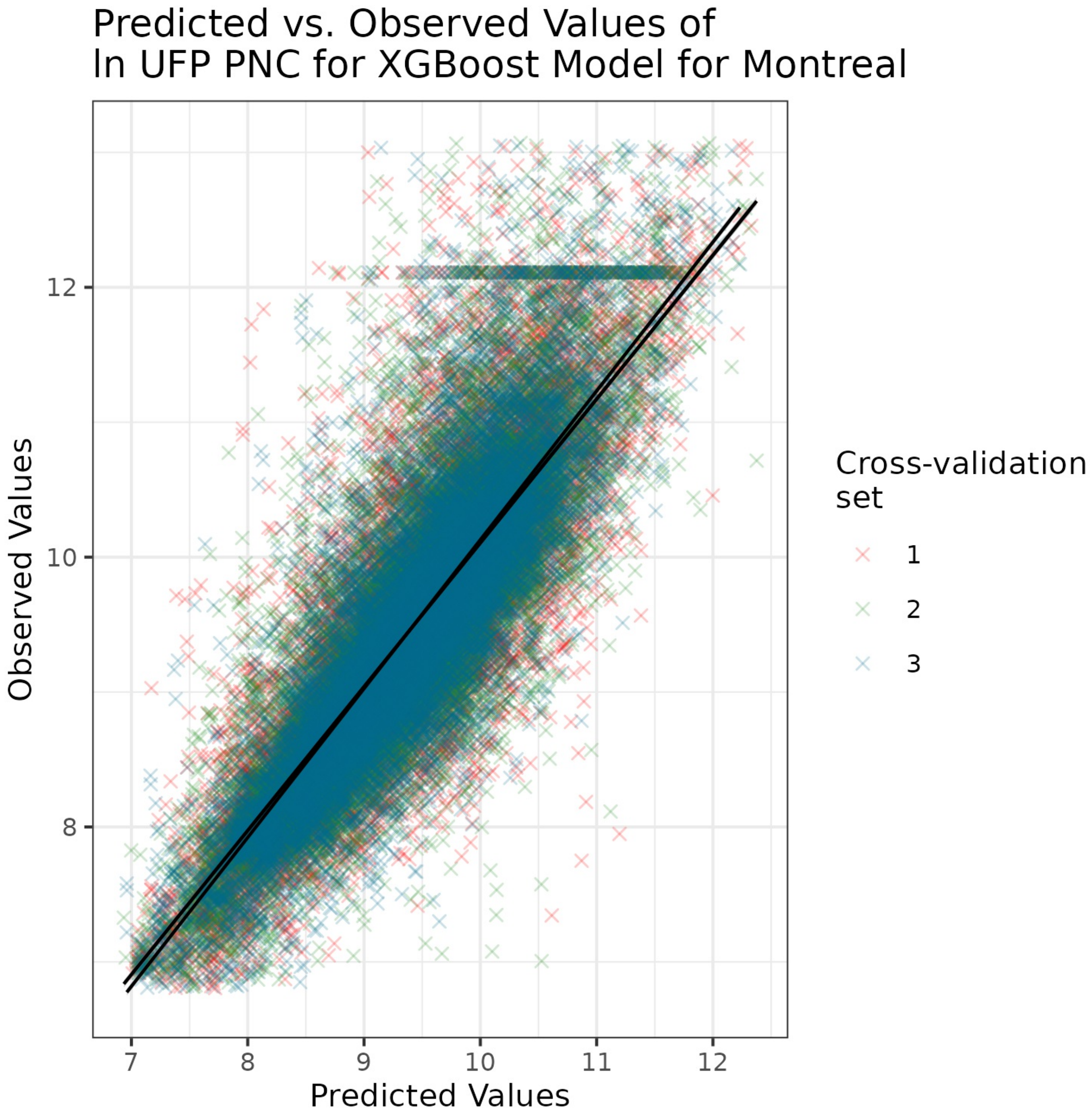
Abstract

BACKGROUND: Ultrafine particles (UFP, <100nm) are important components of ambient air pollution, and constitute a risk to human health through deposition and dissemination in the lungs, contributing to cardiorespiratory morbidity. UFPs are found in higher concentrations in proximity to roadways, but there is significant spatiotemporal variation in their distribution across urban environments. Current literature describes long-term models of UFP variation, but few models have been developed to predict high-resolution daily spatiotemporal variations in UFP number concentrations (PNC) and size across large urban areas.

METHODS: A one-year mobile-monitoring campaign was used to measure UFP PNC and size on predetermined routes in Montreal and Toronto, Canada (June 2020-August 2021). Data collected during monitoring were combined with land-use variables and weather data to train supervised machine learning algorithms to predict daily mean outdoor UFP concentrations and size. These methods included generalized additive models, random forest models, and gradient boosting models using XGBoost. Model performance was evaluated using a cross-validation procedure. Predictions will be validated on external data collected from fixed-site monitoring stations in each city.

RESULTS: 12,886 and 8,192 unique road segments from mobile monitoring were retained for model development in Montreal and Toronto, respectively. Cross-validated results for UFP PNC suggest that GAM models performed better in Montreal ($R2=0.339$) than Toronto ($R2= 0.229$). Additionally, random forest models outperformed GAM models in Montreal ($R2=0.416$) and Toronto ($R2=0.346$). XGBoost models outperformed all other models in Montreal ($R2= 0.713$) and Toronto ($R2=0.667$) and explained most spatiotemporal variations in UFP PNC across each city. Models for UFP size and further analyses are underway.

CONCLUSION: Of the machine learning methods examined, XGBoost performed best in predicting spatiotemporal variations in daily mean outdoor UFP PNC. The predictive models developed will be applied in future case-crossover studies examining acute health impacts of outdoor UFPs in Canada’s two largest cities.


Predicted vs. Observed Values of
ln UFP PNC for XGBoost Model for Montreal
Observed Values
12
10
8
7
8
9
10
11
12
Predicted Values
Cross-validation
set
1
2
3

Tuesday OS5

Exposure assessment for estimating thunderstorm asthma health effects: Is a single site relevant for an entire state?

M. Luke Smith[1], Richard F. MacLehose[1], Jesse D. Berman[2]
[1]Division of Epidemiology and Community Health, University of Minnesota School of Public Health, Minneapolis, USA. [2]Division of Environmental Health Sciences, University of Minnesota School of Public Health, Minneapolis, USA

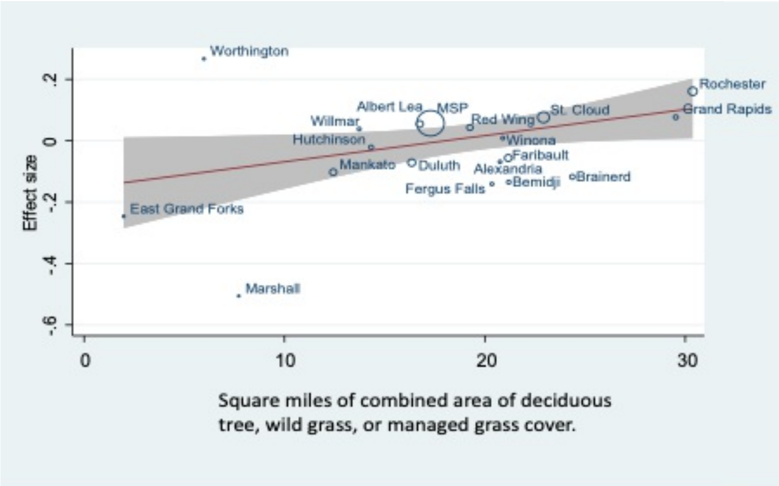
Abstract

Background: Thunderstorm asthma is a rare phenomenon in which dramatic increases in severe asthma follow thunderstorms in the presence of high levels of pollen. However, pollen measurements are extremely limited in the United States with fewer than 80 pollen measurement sites. We seek to determine the predictive value of pollen measured at a single site and variation across an entire state.

Methods: We combine weather and health data specific to each of 19 cities in Minnesota, USA, with available pollen data from a single site in Minneapolis St-Paul, Minnesota. Rates of asthma emergency department visits associated with thunderstorms occurring in the presence of high pollen were estimated for each of the cities. We then analyzed the overall measure of association in a meta-analysis, and investigated the effect heterogeneity to examine city-level explanatory covariates, including landcover and distance to the pollen monitor.

Results: Meta-analysis of 19 regression results across the largest population centers shows no evidence of an overall effect of thunderstorm asthma, but in a meta-regression using total square miles of plant types associated with thunderstorm asthma (deciduous trees, grasses) we find that for each 10 square mile area of deciduous trees or grassland within 20 miles of each study site, there is a 1.001 times higher effect size of relative risk (95% CI: 1.000, 1.002)[FIGURE]. Meta-regression exploring the association between distance to the pollen measurement site and the overall effect suggests that distance from the pollen collection site reduces estimated thunderstorm asthma risk (0.999, 95% CI 0.998, 1.000).

Conclusions: This study leverages the information from a single pollen site and suggests that there can be predictive value of pollen levels at longer distances than previously suggested, but that the predictive power decrease as you move farther from the pollen sampling location.


Worthington
Rochester
Albert Lea
MSP
Red Wing
St. Cloud
Grand Rapids
Willmar
Hutchinson
Winona
Faribault
Mankato
Duluth
Alexandria
Brainerd
Fergus Falls
Bemidji
East Grand Forks
Marshall
Effect size
.2
0
-.2
-.4
-.6
0
10
20
30
Square miles of combined area of deciduous
tree, wild grass, or managed grass cover.

Tuesday OS5

Predicting Monthly Community-level Radon Concentrations with Spatial Random Forest in the Northeast and Midwest United States

Longxiang Li, Brent Coull, Petros Koutrakis
Harvard T H Chan School of Public Health, Boston, USA

Abstract

United States Environmental Protection Agency recommended installing a mitigation system when indoor concentration of radon, a well-known carcinogenic radioactive gas, is at or above 148 Bq/m3. In response, tens of millions of short-term radon measurements have been conducted in residential buildings in the past three decades either for disclosure or to initially evaluate the need for mitigation. These measurements, however, are currently underutilized to assess population radon exposure in epidemiological studies. Based on two relatively small radon surveys, Lawrence Berkeley National Laboratory developed a state-of-the-art national radon model. However, this model only provides coarse and invariant radon estimations, which limits the ability of epidemiological studies to investigate the health effects of radon beyond cancer, particularly the effects of acute exposure. This study involved obtaining over 2.8 million short-term radon measurements from independent laboratories. Using these measurements, an innovative spatial random forest (SRF) model was developed based on geological, architectural, socio-economical, and meteorological predictors. The model was used to estimate monthly community-level radon concentrations for ZIP Code Tabulation Areas (ZCTAs) in the Northeastern and Midwestern regions of the United States from 2001 to 2020. Via cross-validation, we found that the community-level estimations were highly correlated with observations. The estimation errors declined quickly as the number of radon measurements in a community increased. When ≥15 measurements existed, the mean absolute error was 24.5 Bq/m3, or 26.3% of the observed concentrations (R^2=0.72). Our study demonstrates the potential of the large amount of short-term radon measurements that have been obtained to accurately estimate longitudinal community-level radon exposures at unprecedented levels of resolutions and accuracy.

Tuesday OS6

Gestational exposure to phthalates and phthalate replacements and measures of placental function

Emma Rosen[1,2], Danielle Stevens[2], Erin McNell[2], Mollie Wood[1], Alexander Keil[1,3], Stephanie Engel[1], Antonia Calafat[4], Julianne Botelho[4], Elena Sinkovskaya[5], Ann Przybylska[5], George Saade[6], Alfred Abuhamad[5], Kelly Ferguson[2]
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Abstract

Background/aims

Gestational phthalate exposure has been associated with adverse birth outcomes, and these relationships may be mediated by placental dysfunction. Previous studies examining phthalates and placental function have been limited by indirect outcome assessment and inadequate exposure assessment. Using novel ultrasound technology, we assessed associations between exposure to phthalates and phthalate replacements with in vivo placental development.

Methods

Analyses were conducted in a prospective cohort of 300 racially diverse pregnant women recruited from 2017-2020 at two U.S. hospitals. Women were enrolled in early pregnancy and followed through delivery, with up to 8 study visits. Participants contributed urine samples and underwent ultrasounds that captured placental elasticity, microcalcification presence, and microvasculature function (ratio of uterine artery pulsatility index and count of fetal placental arterioles). Urinary metabolites of 8 phthalates and 2 phthalate replacements were quantified in each sample, and molar sums of metabolites with shared parent compounds were calculated. Repeated metabolite concentrations and outcomes were averaged within trimesters. Adjusted linear and Poisson models with random effects examined associations between repeated measures of metabolite concentrations and outcomes pooled across pregnancy.

Results

Several phthalate and phthalate replacement metabolites were positively associated with placental elasticity and presence of microcalcification, and inversely associated with microvasculature function. For example, an interquartile range increase of summed di-2-ethylhexyl phthalate metabolites (∑DEHP) was associated with a 0.20 (95% CI: 0.13, 0.27) kilopascals increase in propagation speed (elasticity), -0.035 (95% CI: -0.044, -0.025) decrease in microvasculature ratio, and a risk ratio of 1.85 (95% CI: 1.51, 2.26) for presence of microcalcifications. The direction of observed associations with all three outcomes is considered adverse.

Conclusion

We found that multiple phthalate and phthalate alternative metabolites were associated with placental dysregulation. These findings may provide insight into disease pathology connecting gestational

phthalate exposures to adverse birth outcomes.

Tuesday OS6

Prenatal exposure to organophosphate esters (OPEs) and face preference at age 1 month.

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Abstract

Background/Aims: Organophosphate esters (OPEs) are chemicals used as flame-retardants and plasticizers. *In utero* exposure to OPEs has been associated with adverse childhood neurodevelopment (e.g., inattention, hyperactivity, externalizing behaviors), but results may be confounded by postnatal environmental exposures. We studied prenatal OPEs in relation to face preference, a measure of social and attentional development, in early infancy.

Methods: Using high performance liquid chromatography-mass spectrometry, we measured nine mid-pregnancy urinary OPE metabolites in UPSIDE cohort participants (n=166). At age 1 month, infants were presented with images of a face, a face with scrambled features, and a face shape with no features (in random order). We quantified *proportion looking time* as time looking at each stimulus divided by total trial time (mean 57.4±7.3 seconds); based on distributions, we created *proportion looking time* tertiles. We evaluated associations with OPE metabolites using proportional odds modeling adjusting for confounders. Three OPEs with >85% detection were considered continuously; six less prevalent OPEs were dichotomized (detected vs. undetected).

Results: Infants of mothers with detectable bis(2-methylphenyl) phosphate had increased odds of being in higher tertiles of *proportion looking time* for face and scrambled face conditions (face OR: 2.84, 95%CI:1.46–5.53; scrambled face OR: 2.77, 95%CI:1.41–5.44). Associations were stronger among female infants. Males born to mothers with detectable bis(2-chloroethyl) phosphate had 2.76 times the odds (95%CI:1.06–7.15) of a higher *proportion looking time* for the scrambled face (compared to unexposed sons). Females born to mothers with detectable dipropyl phosphate had lower odds (OR: 0.12, 95%CI: 0.03–0.44) of a higher *proportion looking time* for the scrambled face (compared to unexposed daughters).

Conclusion: Preliminary analyses suggest that OPEs may influence early child neurodevelopment in a sex-dependent manner; additional work is needed to replicate these findings and to better understand impacts of OPEs on early brain development.

Tuesday OS6

Quantifying the potential co-benefits of electronic tolling for air pollution, traffic congestion, and infant health in a population-based cohort study

Mary Willis[1], Lena Harris[2], Beate Ritz[3], Ethan Sawyer[2], Mira Chaskes[2], Elaine Hill[2], Perry Hystad[4]
[1]Boston University, Boston, USA. [2]University of Rochester, Rochester, USA. [3]University of California, Los Angeles, Los Angeles, USA. [4]Oregon State University, Corvallis, USA

Abstract

Background: Although traffic-related air pollution is largely regulated at the federal level, local congestion reduction projects may reduce traffic and subsequent air pollution to levels that create positive co-benefits for population health. Many urban areas have implemented electronic tolling systems to improve traffic conditions, but the health co-benefits are largely unknown.

Objective: Quantify changes in air pollution, traffic congestion, and local infant health from the implementation of tolling on nearby roadways.

Methods: Using a population-based birth cohort (Texas, 2007-2016), we calculated residential proximity to the nearest tolled road segment within 5 kilometers (n=1.3 million births). For each road segment before and after tolling was implemented, we examined measured ambient air pollutants (NO_2, $PM_{2.5}$) from EPA monitors and traffic volumes from the Texas Department of Transportation. In a difference-in-differences framework, we compare low birth weight and preterm birth among infants born to pregnant people residing <1 kilometer of a road segment before and after tolling was implemented (Figure 1.) We compared the change to a contemporaneous counterfactual population of pregnant people residing 2-5 kilometers away from the tolled road segment. We implemented linear regression models with sociodemographic, maternal health, and spatial-temporal covariates.

Results: We found that implementing tolling decreased traffic volume by 4.4% (95% CI: -13.5%, 5.1%), corresponding to a 15% increase in $PM_{2.5}$ (95% CI: 11%, 19%) and a 37% decrease in NO_2 (95% CI: -36%, -38%.) Contrary to our hypothesis, preliminary infant health models demonstrated little evidence of associations within 1 kilometer of a tolled road for low birth weight (OR: 1.02, 95% CI: 0.99, 1.06) or preterm birth (OR: 0.99, 95% CI: 0.96, 1.03.)

Discussion: Our preliminary results show that electronic tolling may not have measurable benefits for infant health. This study demonstrates a clear need for accountability research to determine which traffic-related policies yield local health benefits.

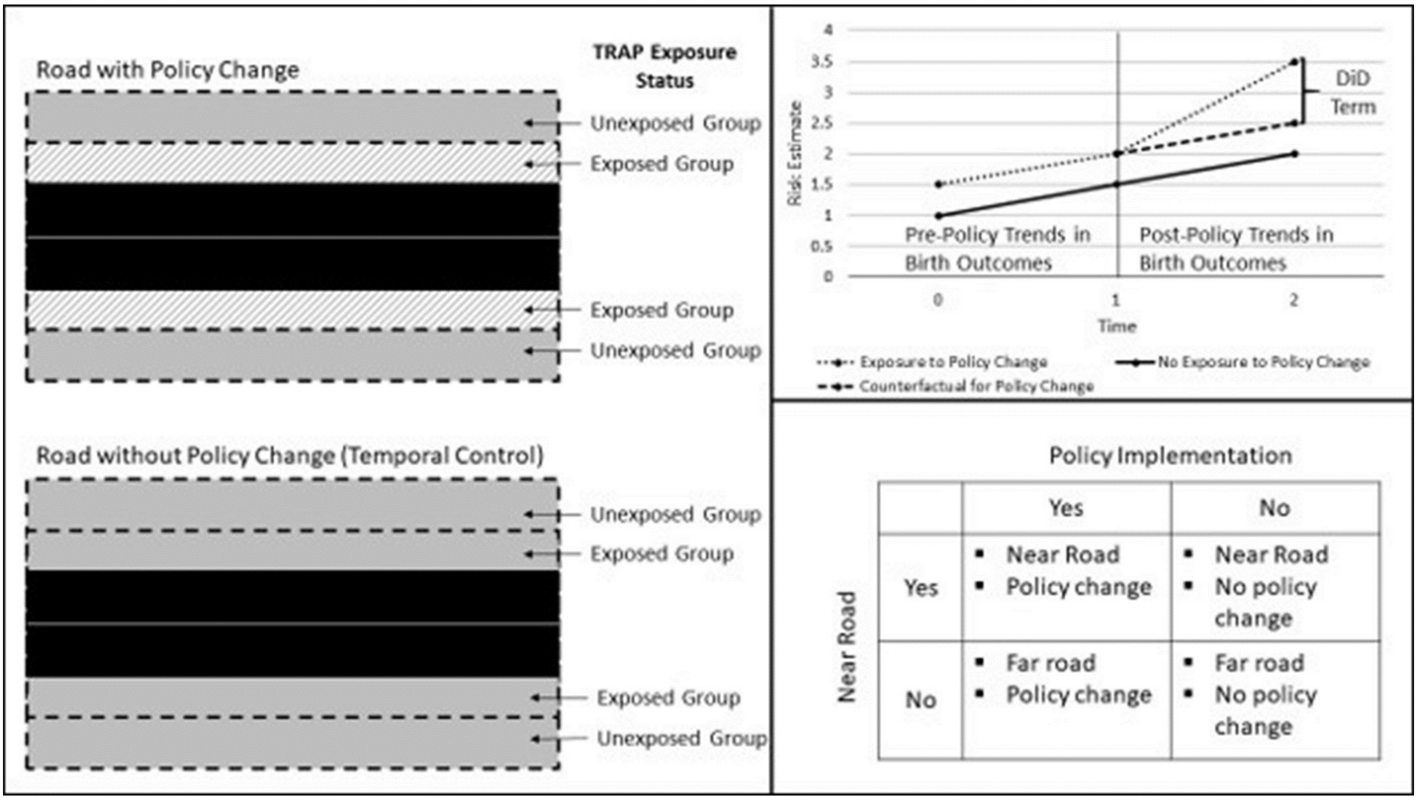

Figure 1: Schematic of the spatial and temporal components of the difference-in-differences study design for associations between a road policy change (e.g., tolling) and infant health

Tuesday OS6

A prospective study of blood lead concentrations and uterine fibroid incidence

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Abstract

Background and Aim: Uterine fibroids are common smooth muscle neoplasms that can confer substantial morbidity. Lead exhibits mutagenic and hormonal properties that may contribute to fibroid development. Prior human studies of lead and fibroids have yielded discrepant results. However, none were prospective, screened for fibroids by ultrasound, or accounted for progestin-only injectable contraceptive use and recent birth, factors associated with increased blood lead concentrations and decreased fibroid incidence.

Methods: We investigated the association between blood lead concentrations and fibroid incidence in the Study of Environment, Lifestyle & Fibroids, a prospective cohort study of 1,693 Black women ages 23-35 years in the Detroit, Michigan area. Participants underwent transvaginal ultrasound at baseline and every 20 months for 5 years to detect fibroids ≥0.5cm in diameter. Baseline whole blood lead concentrations were measured using inductively coupled plasma-mass spectrometry-triple quadrupole. Among 1,215 fibroid-free participants, we conducted Cox regression to estimate adjusted hazard ratios (aHRs) and 95%CIs for the association between quartiles of lead and fibroid incidence, adjusting for time-varying factors of parity, years since last birth, years since last depot medroxyprogesterone acetate (DMPA) use, body mass index, smoking, education, and blood cadmium concentrations.

Results: Median blood lead concentration was 0.47 µg/dl (interquartile range: 0.36-0.65). Select blood lead quartiles (Q2 and Q3) were associated with decreased fibroid incidence (vs. Q1) (Q2: aHR 0.87, 95%CI: 0.63-1.19; Q3: aHR 0.68, 95%CI: 0.48-0.97; Q4: aHR 0.94, 95%CI: 0.65-1.35). Sensitivity analyses excluding smokers, DMPA use in past 2 years, and birth in past 3 years, and restricting follow-up to the first 20-month visit yielded similar results.

Conclusion: Our data suggest a possible non-linear association between blood lead concentrations and fibroid incidence. Future analyses will examine blood lead and fibroid growth. This work is a vital first step in a larger research program to evaluate metal mixtures and fibroid incidence.

Tuesday OS6

A Cohort Study of Residential Proximity to Unconventional Oil and Gas Development and Birth Defects in Ohio

Casey Gaughan[1], Keli Sorrentino[1], Zeyan Liew[1], Nicholaus Johnson[1], Cassandra Clark[1], Mario Soriano Jr.[2], Julie Plano[1], Desiree Plata[3], James Saiers[4], Nicole Deziel[1]
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Abstract

Background: Chemicals used or emitted from unconventional oil and gas development (UOGD) include reproductive/developmental toxicants. Limited evidence suggests an association between residential proximity to UOGD and certain birth defects, with no studies conducted in the state of Ohio, which experienced a thirty-fold increase in natural gas production between 2010 and 2020.

Methods: We conducted a registry-based cohort study of 965,236 live births in Ohio from 2010-2017. We assigned UOGD exposure based on maternal residential proximity at birth to active UOGD wells and a water-specific proximity metric that incorporates groundwater flow patterns. We estimated odds ratios (ORs) and 95% confidence intervals (CIs) for all structural birth defects combined and specific birth defect types using binary exposure metrics (any versus no UOG wells within 10 km and any versus no upgradient UOG wells within 10 km), adjusting for multiple confounders.

Results: A total of 4,653 individuals had structural birth defects based on state birth records and a state surveillance system. The odds of any structural birth defect were 1.13 times higher in children born to mothers within 10 km of UOGD than those born to unexposed mothers (95%CI: 0.98-1.30). Odds were elevated for neural tube defects (OR: 1.57, 95%CI: 1.12-2.19), congenital heart defects (OR: 1.25, 95%CI: 0.94-1.67), oral clefts (OR: 1.20, 95%CI: 0.89-1.60), and limb reduction defects (OR: 1.99, 95%CI: 1.18-3.35). Odds for hypospadias (males only) were inversely related to UOGD exposure (OR: 0.62, 95%CI: 0.43-0.91). Odds of any structural defect were greater in magnitude but generally less precise for the water-specific metric (OR: 1.30; 95%CI: 0.85-1.90), rural areas (OR: 1.21, 95%CI: 0.77-1.91), areas with high social vulnerability (OR: 1.26, 95%CI: 0.99-1.60), and among females (OR: 1.28, 95%CI: 1.06, 1.53).

Conclusions: We observed elevated, but not always statistically significant, ORs across multiple birth defects in relation to UOGD exposure in Ohio.

Tuesday OS6

Associations between Prenatal Exposure to Hydroxy-Polycyclic Aromatic Hydrocarbons and the Placental Transcriptome

Alison Paquette[1,2], Samantha Lapehn[1], Sophie Freije[2], James MacDonald[2], Theo Bammler[2], Drew Day[1], Christine Loftus[2], Kannan Kurunthachalam[3], Nicole Bush[4], Kaja LeWinn[4], Daniel Enquobahrie[2], Carmen Marsit[5], Sheela Sathyanarayana[1,2]

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Abstract

Background/Aims: Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous organic pollutants. PAHs can cross the placenta, and prenatal PAH exposure has been linked to adverse infant and childhood health outcomes. Our objective was to examine associations between prenatal PAH exposure and placental gene expression to gain insight into mechanisms by which PAHs may disrupt placental function.

Methods: The ECHO PATHWAYS consortium generated data from 629 pregnant participants enrolled in the CANDLE study. Monohydroxy-PAH (OH-PAH) metabolites were measured in mid-pregnancy urine using high performance liquid chromatography tandem mass spectrometry. Transcriptomic data were obtained via RNA sequencing. Linear models were fitted to estimate covariate-adjusted associations between maternal urinary OH-PAHs and placental gene expression. We performed sex-stratified analyses to evaluate whether associations varied by fetal sex. Experimental validation was performed by treating HTR-8/SVneo cells with phenanthrene and quantifying *TRIP13* expression via qPCR.

Results: Urinary concentrations of 6 OH-PAHs were associated with placental expression of 8 genes. Three biological pathways were associated with 4 OH-PAHs. Placental expression of SGF29 and TRIP13 and the vitamin digestion and absorption pathway were positively associated with multiple metabolites. HTR-8/SVneo cells treated with phenanthrene exhibited 23% increased *TRIP13* expression compared to controls ($p=0.04$). More associations between OH-PAHs and genes were identified in females (45) than males (28).

Conclusion: Our study highlights novel genes whose placental expression may be disrupted by OH-PAHs. Increased expression of the DNA damage repair gene *TRIP13* may represent a response to double-stranded DNA breaks. Increased expression of genes involved in vitamin digestion and metabolism may reflect dietary exposures or represent a compensatory mechanism to combat damage related to OH-PAH toxicity. Fetal sex may modify the relationship between prenatal OH-PAHs and placental gene expression. Further work is needed to study the role of these genes in placental function and their role in perinatal and lifelong health.

Uncaptioned visual

Tuesday OS7

Associations between short-term exposure to $PM_{2.5}$, NO_2 and O_3 pollution and kidney-related conditions and the role of temperature-adjustment specification: A case-crossover study in New York State

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Abstract

Background/Aims

There is limited evidence on short-term associations between air pollution exposure and kidney-related conditions, and the role of temperature specification in model adjustment is unclear. This study aimed to examine the relationships between short-term $PM_{2.5}$, NO_2, and O_3 exposure and kidney-related conditions and to evaluate the influence of temperature adjustment using 1) various metrics incorporating other meteorological variables (e.g., heat index, wet-bulb globe temperature [WBGT]) and 2) different intraday temperature measures (e.g., daily mean, nighttime mean).

Methods

We obtained data on unplanned hospital visits from adults for seven kidney-related conditions in New York State (2007-2016). We adopted a symmetric bi-directional case-crossover design with conditional logistic regression, using moving averages of $PM_{2.5}$, NO_2 and O_3 concentrations (spatiotemporally highly-resolved) at lag 0-5 days. We compared seven temperature metrics and five intraday temperature measures.

Results

In three-pollutant models adjusting for daytime mean outdoor WBGT (which statistically performed well for all outcomes), per 5 μg/m^3 increase in $PM_{2.5}$ was associated with an increased risk of 1.3% (95% confidence interval [CI]: 0.1%, 2.5%) for acute kidney failure (AKF), 10.7% (95% CI: 1.8%, 20.3%) for glomerular diseases (GD), and 2.7% (95% CI: 1.5%, 3.8%) for volume depletion. AKF risk increased by 1.4% (95% CI: 0.8%, 2.1%) per 5 ppb increase in NO_2. We found no associations between O_3 and any outcomes. Our estimates were robust in sensitivity analyses, except for analysis using alternative intraday temperature measures, which did not statistically perform well.

Conclusion

$PM_{2.5}$ exposure within one week is a risk factor for AKF, GD and volume depletion, and NO_2 exposure is a risk factor for AKF. There was no risk of kidney-related outcomes associated with O_3 exposure. The differential estimates in models adjusting for temperature using different intraday measures underlines the importance of carefully adjusting for temperature when estimating air pollution health impacts.

Tuesday OS7

Long-term Exposure to Outdoor Ultrafine Particles and Nonaccidental Mortality in a Large Population-Based Cohort: Persistent Associations Across Different Approaches to Exposure Assessment

Marshall Lloyd[1], Olaniyan Toyid[2], Arman Ganji[3], Junshi Xu[3], Alessya Ventura[1], Leora Simon[1], Mingqianz Zhang[3], Milad Saeedi[3], Shoma Yamanouchi[3], An Wang[3], Alexandra Schmidt[1], Kris Hong[1], Hong Chen[4], Paul Villeneuve[5], Joshua Apte[6], Eric Lavigne[7], Michael Tjepkema[2], Marianne Hatzopoulou[3], Scott Weichenthal[1]

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Abstract

BACKGROUND: Outdoor ultrafine particles (UFP; <100nm) have been associated with adverse health outcomes including cardiovascular disease and brain tumour incidence. Assessing long-term UFP exposures is a challenge and health effect estimates may be sensitive to exposure assessment approach. We applied estimates from several novel UFP exposure models to a population-based cohort of 1.9 million people and investigated associations with nonaccidental mortality.

METHODS: Canadian Census Health and Environment Cohort members living in Montreal or Toronto were followed between 2001 and 2016. Cox proportional hazard ratios (HR) were estimated for nonaccidental mortality (ICD-10: A through R) and long-term exposure to outdoor UFP concentrations at residential address. UFP exposures were estimated using deep learning models, generalized additive models (GAM), and models combining deep learning and GAM approaches. Estimates were weighted to account for population mobility and projected into the past (i.e., backcasted). HRs were estimated using UFP estimates from each exposure modelling approach with and without mobility weighting and backcasting in order to investigate how choice of exposure assessment approach may impact estimated HRs. Models controlled for relevant sociodemographic factors and outdoor concentrations of fine particulate matter (PM2.5), black carbon, and oxidant gases (NO2 and O3).

RESULTS: For each exposure assessment approach, an interquartile increase in UFP concentrations (~5000 pt/cm3) was associated with nonaccidental mortality. The UFP combined model resulted in an HR of 1.016 (95% CI 1.011-1.021). Backcasting resulted in an HR of 1.034 (95% CI 1.029-1.041) and for mobility-weighting it was 1.024 (95% CI 1.019-1.029). Backcasting and mobility-weighting together led to an HR of 1.010 (95% CI 1.005-1.015). Results were similar when using deep learning models and GAMs on their own.

CONCLUSION: Long-term exposure to outdoor UFPs was associated with nonaccidental mortality regardless of exposure assessment approach with the strongest association observed for back-casted models combining deep learning and GAM approaches.

Tuesday OS7

Can NO_2 trigger myocardial infarction within a few hours of exposure? Identifying hourly hazard periods

Jenni Shearston[1], Sebastian Rowland[2,1], Tanya Butt[1], Amelia Boehme[1], Steven Chillrud[3], Joan Casey[1,4], Donald Edmondson[5], Markus Hilpert[1], Marianthi-Anna Kioumourtzoglou[1]

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Abstract

Background/Aims: Traffic-related air pollution is a known risk factor for triggering myocardial infarction (MI). However, the hazard period of ultra-short-term exposure to nitrogen dioxide (NO_2) for incident MI has not been fully evaluated. We characterized the hourly hazard period for MI after short-term NO_2 exposure in the US state of New York (NYS), for 24 hourly lags prior to an MI.

Methods: MI hospitalization data were obtained from the NYS Department of Health Statewide Planning and Research Cooperative System, while hourly NO_2 concentrations were obtained from the US Environmental Protection Agency's Air Quality System database, for nine cities in NYS. We used city-wide exposures and a case-crossover study design with distributed lag non-linear models to assess the relationship between hourly NO_2 concentrations and MI for the 24-hour period prior to the event, adjusting for temperature and relative humidity.

Results: In the six hours preceding MI, we found increased risk with increasing NO_2 concentrations; at earlier lags (7-24 hours before MI) we found null associations. At lag 2 hours, a 10 ppb increase in NO_2 increased risk of MI by 0.2% (Rate Ratio [RR]: 1.002, 95% Confidence Interval [CI]: 1.001, 1.003). We estimated a cumulative RR of 1.012 (95% CI: 1.007, 1.018) for lags 0-6, and of 1.015 (95% CI: 1.008, 1.021) for 0-24 lags per 10 ppb NO_2. Lag hours 2-3 had consistently elevated risk in sensitivity analyses.

Conclusion: Consistent positive relationships between NO_2 and MI are demonstrated in the literature, and experimental studies provide compelling mechanisms. We found robust associations between sub-daily NO_2 exposure and MI risk at levels far lower than current hourly NO_2 national standards (100 ppb). Our findings, combined with ubiquitous population-level exposure to NO_2, suggest that the current ambient standards are likely insufficient to protect population health from risk of ultra-short-term NO_2 exposure.

Uncaptioned visual

Tuesday OS7

Childhood exposure to traffic-related air pollution and cardiometabolic health in young adulthood

Fanggi Guo, Rima Habre, Xinci Chen, Carrie Breton, Theresa Bastain, Shohreh Farzan
University of Southern California, Los Angeles, USA

Abstract

Background: Traffic-related air pollution (TRAP) exposure has been associated with cardiometabolic health (e.g. cholesterol level, glucose tolerance, and adiposity). Although TRAP impacts people of all ages, children's developing bodies might be more vulnerable to the adverse impacts of air pollution. We aimed to investigate the association between childhood TRAP exposure and components of cardiometabolic health in adulthood, which has not been thoroughly investigated.

Methods: Participants (N=230) from the Southern California Children's Health Study (2003-2013) completed a follow-up assessment in early adulthood (2018-present). Average childhood TRAP exposures (from birth to age 11) were estimated for total nitrogen oxides (NO_x), freeway NO_x, and non-freeway NO_x (modeled using the CALINE4 line source dispersion model). Traffic density was calculated within a 300-m residential buffer. Cardiometabolic health was assessed in adulthood (age 21-26), using measures of blood lipids (total cholesterol, HDL, LDL, triglycerides), glucose tolerance (fasting glucose, insulin level, HbA1c), and adiposity (BMI, android/gynoid ratio, percent body fat). Mixed effect models, adjusted for age, sex, race/ethnicity, smoking status, and parental highest degree, were used to examine the association between childhood TRAP exposure and cardiometabolic health measures in adulthood.

Results: Every one standard deviation increase in childhood exposure to total NO_x was associated with 0.062% increase in HbA1c (95%CI: -0.002–0.125; p=0.058), 2.419uIUmL increase in insulin (0.651–4.186; p=0.007), 0.829kg/m^2 increase in BMI (0.000–1.659; p=0.050), and 1.181% increase in percent body fat (0.199–2.162; p=0.018). We also observed similar statistically significant effects between both freeway NO_x and residential traffic density and each of these outcomes. No associations were observed between TRAP and lipid measures.

Conclusion: Exposure to TRAP in early-to-middle childhood may have adverse long-term impacts on cardiometabolic health. Future research investigating sensitive windows of childhood TRAP exposure on cardiometabolic health in later life is warranted.

Tuesday OS7

Associations of outdoor fine particulate matter ($PM_{2.5}$) exposure and symptoms of depression in the Prospective Urban Rural Epidemiology (PURE) study

Svetlana Zdero[1], Michael Brauer[1,2], Perry Hystad[3,2], Selina Rajan[4,2], The PURE team[2]
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Abstract

Background/Aim:

Emerging evidence suggests long-term exposure to outdoor fine particulate matter ($PM_{2.5}$) may be a risk factor for major depressive disorder (MDD). Within the Prospective Urban Rural Epidemiology (PURE) cohort, long-term $PM_{2.5}$ exposure has been linked to cardiovascular disease, and increased risk of cardiovascular disease has been linked to experiencing depressive symptoms. We built on this work by evaluating associations between $PM_{2.5}$ concentrations and depressive symptoms at cohort baseline, across 21 high-, middle-, and low-income countries.

Methods:

Within the PURE study, adults aged 35-70 completed the Short-Form Composite International Diagnostic Interview, for which validation studies indicate that reporting ≥4 of 7 depressive symptoms is predictive of MDD. Based on their community of residence, participants were assigned 3-year rolling mean $PM_{2.5}$ estimates for the year preceding cohort entry. Multivariate logistic regression models were used to estimate country-specific associations between $PM_{2.5}$ concentrations and ≥4 depressive symptoms. Country-specific odds ratios were then pooled using a random effects meta-regression model.

Results:

Between January 2003 and July 2018, 202,131 adults were enrolled into the PURE study, 164,213 of which had complete data on $PM_{2.5}$ and depressive symptoms at baseline. 12.2% of participants reported ≥4 symptoms of feeling sad, blue, or depressed for two weeks or longer in the past year. The mean 3-year $PM_{2.5}$ concentration at baseline was 38.6μg/m^3, ranging from 5–94. In models adjusted for individual, household, and community factors, country-specific odds ratios ranged from 0.63 in Saudi Arabia (95% CI: 0.47–0.84) to 4.51 in Brazil (95% CI: 3.09—6.57). The pooled odds ratio was 1.74 per 10μg/m^3 increase in $PM_{2.5}$ (95% CI: 1.16–2.62, I^2=98.9%).

Conclusions:

The results suggest an overall positive association between $PM_{2.5}$ exposure and depressive symptoms, with high heterogeneity between countries. The findings of this project can characterize the magnitude of this association on a multinational scale.

Tuesday OS7

Cardiovascular-related Emergency Department Visits During a Hydrogen Sulfide Emergency in Southern Los Angeles County, CA

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University of Southern California, Los Angeles, USA

Abstract

Background: In October 2021, thousands of residents in Carson, California began complaining of noxious odor and headaches. Hydrogen sulfide (H2S), a toxic odorous gas, was measured at concentrations up to 7000 parts per billion—230 times California's acute air quality standard. H2S concentrations remained above the standard for 4 weeks and above baseline levels for 4 months. Residents complained of various symptoms, from nausea and fatigue to chest pain, and want to understand the event's effect on health. Because existing research on the impact of low-level H2S exposure on cardiovascular outcomes has yielded conflicting results, we aimed to assess the acute cardiovascular effects of this H2S emergency.

Methods: We calculated daily rates of emergency department (ED) visits for diseases of the circulatory system and for heart disease in Carson area ZIP codes and in Los Angeles County ZIP codes >20 km from Carson (control). Using controlled interrupted time series, we compared ED visit rates during the 4 weeks of the H2S incident in Carson to the predicted rates had this event not occurred, based on 2018-2021 ED trends, and controlling for ED visit rate changes in control areas of Los Angeles County. We examined effect measure modification by sex and age.

Results: We observed an 8% increase (rate ratio (RR): 1.08, 95% CI: 1.03, 1.13) in ED visit rate for diseases of the circulatory system in the Carson area during the 4 weeks of the event. These effects were stronger among men (RR: 1.14, 95% CI: 1.07, 1.22), among patients <40 years of age (RR: 1.19, 95% CI: 1.05, 1.33), and for heart disease-related ED visits (RR: 1.11, 95% CI: 1.01, 1.22). Effects persisted for 10 weeks.

Conclusion: Exposure to H2S and other malodors are often underprioritized in environmental justice communities, and H2S releases may harm cardiovascular health.

Tuesday OS8

Patterns of infant fecal metabolite concentrations and social behavioral development in toddlers

Hannah E. Laue[1], Julia A. Bauer[1], Susan Sumner[2], Susan McRitchie[2], Wimal Pathmasiri[2], Thomas J. Palys[1], Anne G. Hoen[1], Juliette C. Madan[1,3], Margaret R. Karagas[1]

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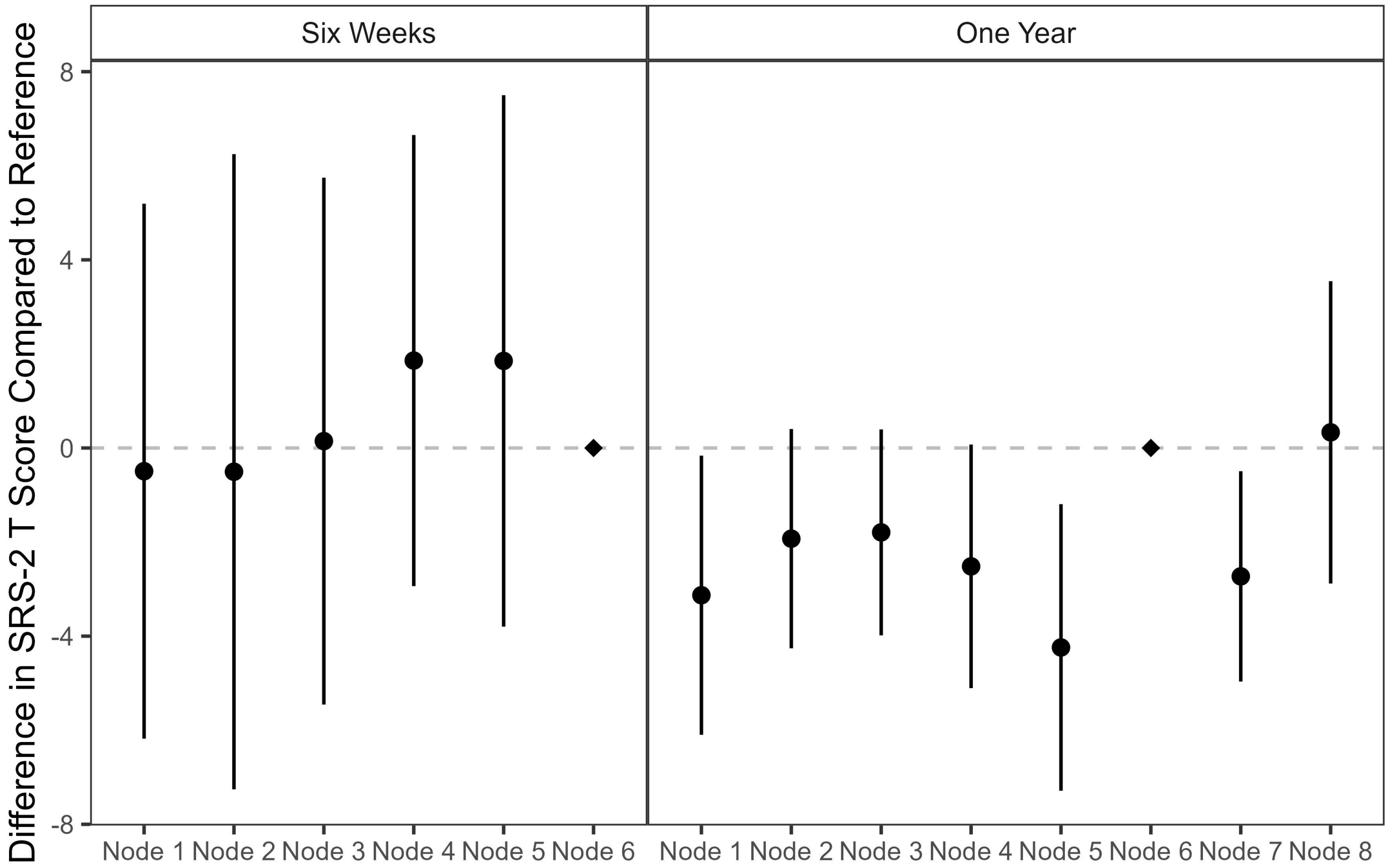
Abstract

Background/Aims: Gut-derived metabolites in infants may have mechanistic links to subsequent neurobehavior. We investigated whether infant fecal metabolites were related to toddler social behavior.

Methods: Stool samples collected from six-week-olds (n=86) and one-year-olds (n=209) in the New Hampshire Birth Cohort Study (NHBCS) were analyzed using nuclear magnetic resonance spectroscopy. Chenomx software was used to fit signals and estimate concentrations of 34 host-bacterial metabolites. Autism-related behavior in three-year-olds was assessed by their caregivers using the Social Responsiveness Scale (SRS-2), for which higher scores indicate more autism-related behavior. To assess the association between metabolites and SRS-2 scores, we compared a traditional one-by-one approach, quantitative enrichment analysis (QEA), and self-organizing maps (SOMs), a machine learning approach to derive metabolic profiles. All analyses were adjusted for covariates.

Results: Using traditional methods, no individual fecal metabolite or metabolic pathway was associated with SRS-2 scores. Using the SOM method, fecal metabolites of six-week-olds organized into six groups (8-20 participants each), which were not related to SRS-2 scores (**Figure**). Fecal metabolites of one-year-olds organized into eight groups (13-42 participants each). Of the eight groups at one year, four (characterized by 1) high concentrations, 2) low concentrations, 3) moderately high concentrations with very high lactate concentrations, and 4) average concentrations) had lower SRS-2 scores compared to the largest group, which was characterized by moderately high metabolite concentrations except for low lactate (**Figure**). Uncaptioned visual



Conclusion: By employing novel statistical methods, we uncovered metabolic profiles in infant stool that associated with subsequent social behavior, highlighting one potential mechanism by which gut bacteria may influence host neurobehavior. The SOM method may be useful in other environmental epidemiologic studies with high-dimensional exposures or outcomes.

Tuesday OS8

Prenatal/Early-Life Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) and Adverse Neurodevelopment Outcomes in Children: A Systematic Review and Meta-Analysis

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Abstract

Background: Research indicates prenatal/early-life exposure to PAHs may be associated with adverse neurodevelopment outcomes, but there are conflicting research results. A weight of evidence approach is needed.

Aim: Summarize eligible evidence of prenatal/early-life PAH exposure on neurodevelopment outcomes in children.

Methods: Using a priori search strategy, we conducted a systematic review (SR) to identify eligible peer-reviewed studies in English, in PubMed, Wed of Science, and Google Scholar. Eligible studies modeled or measured PAH exposure during pregnancy or at least six months prior to neurodevelopment assessment, with no limits on study time-period or geography. Two reviewers, working independently, followed PRISMA protocol. Risk of bias assessment followed Navigation Guide protocol. Of 613 studies identified, 26 were included in final meta-analysis. Outcomes were grouped into either dichotomous (summary effect measure: odds ratio) or continuous outcomes (Cohen's d). We report the summary effect size of each outcome, 95%CI, and I2.

Results: We found a statistically significant positive association in dichotomous outcomes between prenatal/early-life PAH exposure and anxiety/depression (OR: 1.36; 95%CI:1.10,1.68; p=0.005; n_{pooled}=4,989; I^2=73.6%), and in neurodevelopment delay (1.07; 95%CI: 1.01, 1.14; p =0.028; n_{pooled} = 1,113; I^2 = 30.2%). We found a marginal positive association with attention problems (OR: 1.81; 95%CI:0.96,3.43; p=0.068; n_{pooled}=2,997; I^2=86.4%). In continuous outcomes, we found a statistically significant negative association in motor skills (Cohen's d: -0.371; 95%CI:-0.52,-0.22; p<0.001; n_{pooled}=1,372; I^2=96.7%), and in adaptive behavior (-0.142, 95%CI:-0.25,-0.00; p=0.042; n_{pooled} = 1,128; I^2=84.3%). We did not find an association in intelligence, language skills, social behavior, ADHD, or other behavior problems.

Conclusion: There is limited human evidence that prenatal/early-life PAH exposure adversely affects neurodevelopment. Between-study variance was low to high. However, limited human evidence of adverse neurodevelopment effects associated with prenatal/early-life exposure to common environmental pollutants is cause for concern.

Tuesday OS8

Prenatal Traffic-related Air Pollution and Maternal Postpartum Depressive and Anxiety Symptoms in the MADRES Pregnancy Cohort

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Abstract

BACKGROUND/AIMS

Ambient air pollution has been linked to increased postpartum depression. However, few studies have investigated the effects of local traffic-related air pollution on postpartum mental health. This study aimed to evaluate the association between prenatal exposure to traffic-related NO_x and postpartum depressive and anxiety symptoms.

METHODS

This study included 438 predominantly low-income Hispanic/Latina women participating in the MADRES cohort (2015-2022). Daily traffic-related NO_x concentrations (freeways/highways, major roads, minor roads, total) were estimated using California LINE-source dispersion model (CALINE4) at participants' residential locations. Prenatal traffic-related NO_x exposures were averaged across pregnancy, due to high temporal correlation. Postpartum depressive and anxiety symptoms were evaluated by a validated questionnaire (Postpartum Distress Measure, PDM), at 1, 3, 6 and 12 months postpartum. Multivariate linear regressions were performed to estimate the associations between prenatal traffic-related NO_x and postpartum distress at each timepoint. Covariates included maternal age, race, education, pre-pregnancy BMI, parity, seasons of birth, and calendar years of birth. Mixed effect models with time as a covariate were also performed to evaluate the longitudinal association across the first postpartum year.

RESULTS

We found each IQR increase in prenatal traffic-related NO_x from major roads (0.22 ppb) was associated with a 4.0% (95% CI: 0.7%–7.4%) increase in 3-month PDM scores, and a 5.7% (95% CI: 0.9%–10.8%) increase in 12-month PDM scores, respectively. In longitudinal models, prenatal traffic-related NO_x from major roads (per IQR: 0.22 ppb) was associated with a 3.2% increase in average PDM score across the first postpartum year (95% CI: 0.6%–5.9%). We also found non-significant positive associations between the other types of traffic-related NO_x and average PDM scores across the first postpartum year.

CONCLUSION

Prenatal traffic-related NO_x was positively associated with increased postpartum depressive and anxiety symptoms, suggesting important relationships between prenatal air pollution and postpartum mental health.

Tuesday OS8

Longitudinal exposure to natural hazards and anxiety and depression symptoms among young adults in Ethiopia, India, Peru, and Vietnam

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Abstract

Background/Aim

We lack information on how longitudinal exposure to natural hazards affects mental health, particularly in low- and middle-income countries (LMICs). This study sought to identify the effect of early life, recent, and repeat natural hazard exposure on anxiety and depression symptoms among young adults.

Methods

We analyzed longitudinal data from the Young Lives study (2002-2020) for 9441 respondents from Ethiopia, India, Peru, and Vietnam. We estimated differences in anxiety and depression scores between young adults who had one of three natural hazard exposure patterns (early life, recent, or repeat) and their unexposed peers, adjusting for selected individual- and community-level covariates. We used targeted maximum likelihood estimation (TMLE) with a machine learning ensemble of algorithms for analysis. Sensitivity analyses identified possible biases by age cohort, missingness in recent exposures, and missingness in Peru's outcomes.

Results

Exposed young adults generally had more anxiety and depression symptoms than their unexposed peers in three of the four countries (Ethiopia, India, and Vietnam). These differences existed regardless of the time point of exposure and did not follow clear dose-response patterns. For anxiety, the average mean difference in scores among exposed young adults ranged from 0.03 points higher [95% CI: 0.01, 0.05] after recent exposure in Vietnam to 1.09 points higher [95% CI: 0.85, 1.34] after recent exposure in Ethiopia. For depression, scores ranged from 0.31 points higher [95% CI: 0.22, 0.40] after recent exposure in India to 1.40 points higher [95% CI: 0.99, 1.82] after early life exposure in Ethiopia. The findings were largely consistent across sensitivity analyses.

Conclusion

Natural hazards increase symptoms of anxiety and depression among young adults, even after single exposures and long time periods since exposure. Climate change will continue to spur increases in natural hazards in the future, disproportionately affecting LMICs where the majority of young people live.

Tuesday OS8

DNA methylation as a potential mediator of the association between long-term exposure to traffic-related fine particulate matter and neuropathologic markers of dementia at autopsy

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Abstract

Background/Aims: Exposure to traffic-related fine particulate matter (TRAP-PM2.5) have been associated with dementias and related neuropathologic changes in late life, but the underlying biological mechanisms are not fully understood. We investigated whether differentially-methylated DNA in the brain mediates the relationship between long-term exposure to TRAP-PM2.5 and neuropathologic markers of dementias in a cohort of brain donors.

Methods: Among 160 deceased donors of the Emory Alzheimer's Disease (AD) Research Center, we performed genome-wide DNA methylation (DNAm) profiling of the prefrontal cortex using Infinium MethylationEPIC BeadChips (789,286 CpG sites after quality control). We evaluated neuropathology using Braak stage, CERAD neuritic plaque score, and combined AD neuropathologic change (ABC score), which are used for neuropathologic diagnosis of AD. Using land-use random forest model, we estimated individual residential exposures to TRAP-PM2.5 during one, three, and five years prior to death. We first assessed associations of CpG sites with each of the neuropathologic markers. Using high-dimensional mediation analysis, we investigated whether the differentially methylated CpG sites associated with neuropathologic markers were also mediators of the association between TRAP-PM2.5 exposure and neuropathologic markers.

Results: After correcting for multiple comparisons (Bonferroni) and potential confounding, we identified 6 CpGs associated with neuropathologic markers (4 for Braak stage, 3 for ABC score, and zero for CERAD score). Among those 6 CpGs, 2 (including cg05417607) have been previously reported in association with dementia-related outcomes. Furthermore, we identified DNAm in cg05417607 as mediator of the association between TRAP-PM2.5 and Braak stage and ABC score.

Conclusions: One CpG was identified as a mediator of the association of TRAP-PM2.5 with Braak stage and ABC score, suggesting a potential effect of TRAP-PM2.5 exposure modulating the epigenetic mark and in turn influencing disease development. Further research is needed to elucidate the biological pathways underlying TRAP-PM2.5-related changes in DNA methylation.

Tuesday OS8

Prenatal manganese exposure and operant test battery performance in Mexican children: Effect modification by child sex

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Abstract

Background: Manganese (Mn) exposure is essential to healthy neurodevelopment, but both Mn deficiency and over-exposure have been linked to prefrontal cortex (PFC) impairments, which regulate executive functions. These processes (attention, inhibitory control, working memory, cognitive flexibility) are often sexually dimorphic and complex, driven by multiple interconnected neurologic and cognitive domains.

Objective: We investigated the role of child sex as an effect modifier of the association between prenatal Mn exposure and performance in an operant testing battery (OTB) that assessed multiple cognitive and behavioral functional domains.

Methods: Children ($N = 575$) aged 6 – 8 years completed five OTB tasks. Blood and urinary Mn measurements were collected from mothers in the 2nd and 3rd trimesters. Multiple regression models estimated the association between Mn biomarkers at each trimester with OTB performance while adjusting for socio-demographic covariates. Interaction terms were used to estimate modification effect by child sex.

Results: Higher blood Mn exposure was associated with better response rates on the progressive ratio task, overall accuracy on the delayed matching-to-sample task, and complete chains accuracy on the incremental repeated acquisition task. Additionally, we observed a modification effect by child sex in the progressive ratio and delayed matching-to-sample tasks. Prenatal Mn exposure was associated with improved task performance for girls and reduced performance in boys.

Conclusion: Prenatal blood Mn concentrations generally improved performance on three of five operant tasks. Higher prenatal blood Mn concentrations dysregulate executive functions in children in a sexually dimorphic manner. Higher prenatal Mn exposure is associated with better performance on spatial memory and motivation in girls suggesting that Mn’s nutritional role benefits girls. Therefore, understanding the sex-specific effects of prenatal Mn exposure may better inform dietary and environmental interventions.

Tuesday OS9

Projecting ozone-related excess morbidity of cardiovascular diseases under climate change scenarios in China

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Abstract

Background/Aims

Climate change has been found to increase future ambient ozone (O_3) related mortality, but there is little evidence on O_3-related morbidity. This study aims to project the excess morbidity of cardiovascular diseases attributable to short-term O_3 exposure under different climatic scenarios considering China’s carbon-neutral policy.

Methods

We first applied a multi-center cardiovascular incidence surveillance dataset and a time-stratified case-crossover design to estimate the exposure-response relationships between short-term exposure to O_3 and cardiovascular diseases incidences, including stroke, coronary heart disease (CHD), and hypertension. Then we bias corrected the daily O_3 projections from the GISS-E2-R model using historical observations. Finally, we projected future national O_3-related excess morbidity under RCP2.6-SSP1 (a low emission scenario), RCP4.5-SSP4 (a medium emission scenario), and RCP8.5-SSP5 (a high emission scenario) during every three years of 2023-2025, 2033-2035, 2043-2045, 2053-2055 and 2063-2065.

Results

With each 10 μg/m^3 increase in daily 8h-max O_3, the incidence risk of stroke, CHD, and hypertension could increase by 0.97% (95% CI: 0.39%, 1.56%), 0.49% (95% CI: 0.03%, 0.95%), and 0.69% (0.00%, 1.48%), respectively. The average O3 concentration during baseline years (2013-2015) is 85.0 μg/m^3, that in 2060s under RCP8.5 will be 49.4 μg/m^3, which is higher than the level of 27.9, and 27.3μg/m^3 under RCP2.6 and RCP4.5, respectively. The annual-averaged excess cardiovascular disease burden is 0.180 (95% CI: 0.018, 0.206) million during the baseline years. Under RCP8.5-SSP5, the excess morbidity will increase to 0.355 (95%CI: 0.058, 0.677) million in 2020s, which is over 200% compared to the baseline. O_3-related excess cardiovascular diseases will decrease under RCP2.6-SSP1 and RCP4.5-SSP4, except a slight increase in 2020s under RCP4.5-SSP4.

Conclusion

Compared with the high emission scenario RCP8.5-SSP5, the low and medium emission scenarios (RCP2.6-SSP1 and RCP4.5-SSP4) would yield reductions in ozone pollution and its related cardiovascular morbidity burden.

Tuesday OS9

Infant Phenol Exposure and Growth: The Infant Feeding and Early Development Study

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Abstract

BackgroundAims: Phenols are prevalent environmental chemicals with endocrine-disrupting effects that may perturb human development. Infancy is a period of increased susceptibility to environmental exposures, and infant growth patterns characterized by heightened BMI (level) or rapid BMI development (trajectory) contribute to obesity. No prior studies have investigated infant urinary phenols and growth. We therefore investigated associations between phenols and BMI in the Infant Feeding and Early Development Study (IFED).

Methods: IFED is a prospective cohort of healthy, term singleton infants conducted 2010-2014. Among 199 infants, exposure to bisphenol A, benzophenone-3, dicholorophenols (DCP), parabens, and triclosan was assessed in urine collected at 6-8 and 12 weeks. Phenols were creatinine-corrected and averaged across repeated measures. BMI was collected at 12 study visits between birth and 36 weeks. Adjusted linear mixed effects spline models estimated differences (β [95% confidence intervals (CI)]) in BMI z-score for a one-interquartile range (IQR) increase in individual phenols. Growth mixture models determined trajectories of BMI z-score, and adjusted multinomial logistic regression models estimated relative risks (RR [95% CI]) for associations between individual phenols and trajectories.

Results: Infants were predominantly black (62%) and highly exposed to phenols (91% detection), with 3 times higher paraben concentrations relative to US children. A one-IQR increase in 2,5-DCP was positively associated with BMI z-score across infancy (12 weeks: 0.21 [0.01, 0.41], 24 weeks: 0.23 [0.04, 0.42], 36 weeks: 0.20 [-0.02, 0.42]). Similar associations were observed for parabens. Growth mixture models identified four BMI z-score trajectories (Figure 1). Relative to normal growth, a one-IQR increase in Benzophenone-3, 2,4-DCP, and 2,5-DCP was positively associated with risk of rapid growth (2.39 [1.22, 4.69], 1.79 [1.00, 3.20], and 2.35 [1.25, 4.42], respectively).

Conclusions: In a diverse cohort of US infants, urinary phenols were associated with increased BMI z-score and rapid BMI z-score development, suggesting obesogenic effects.

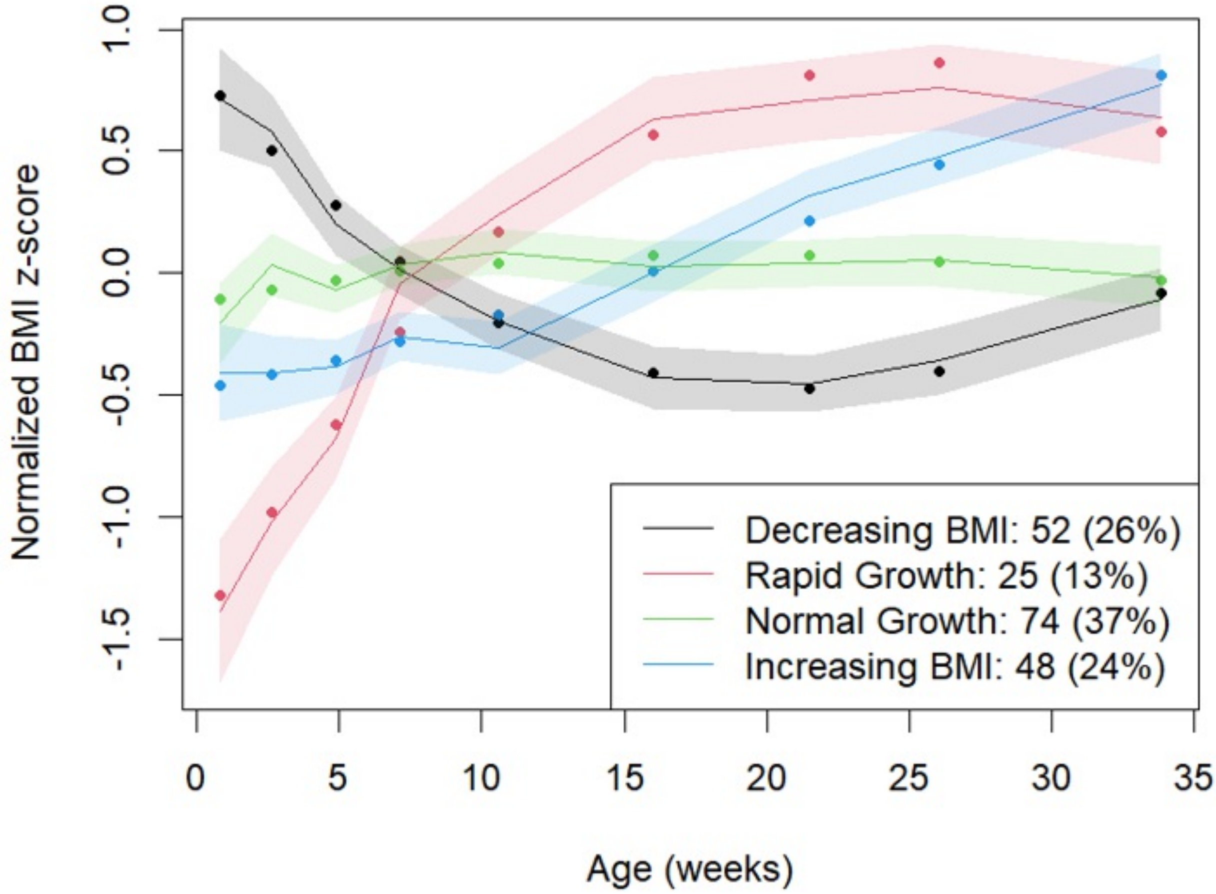

Figure 1. BMI z-score trajectories from growth mixture models fit to BMI z-scores normalized to individual mean BMI. Predicted values indicated with circles. Observed values and 95% confidence intervals indicated with lines and shaded portion.

Tuesday OS9

Estimating epigenetic age acceleration's causal effect on cardiovascular and inflammatory responses to ozone exposure: a block randomization approach

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Abstract

Background/Aims: Increased chronological age increases health risks from environmental exposures, but this question has rarely been investigated using epigenetic measurements of *biological* age. DNA methylation can be used to estimate biological aging. Epigenetic age acceleration (EAA), which is the difference between biological and chronological age, is associated with morbidity and mortality. However, it remains unknown whether EAA modifies physiological responses to environmental exposure. Here, we use a block randomization approach to examine EAA as a modifier of ozone's effect on physiological response.

Methods: LAMARCK study participants (N=17) were exposed to 0.3-ppm ozone or to clean air for two hours in a randomized single-blind crossover study design. Cardiorespiratory and inflammatory factors were measured in participants immediately before and 24 hours after exposure. DNA methylation was assessed in cells extracted from bronchoalveolar lavage fluid, and Horvath's method was used to estimate EAA. Outliers were determined based on Cook's Distance and the standardized residual and removed. Participants were dichotomized into a low EAA block and a high EAA block, using median EAA as cutoff. The difference in the median risk difference between blocks served as the causal Estimate of Effect Modification (EEM) by EAA, which we report along with two-sided Fisher-exact p-values.

Results: We detected evidence of effect modification for both QT interval (EEM = 0.02, $p=0.007$) and C-reactive protein (EEM = -1.21, $p=0.016$) with the direction of association indicating further lengthening of QT interval and attenuation of C-reactive protein response under ozone exposure, in individuals with elevated EAA.

Conclusions: Our study suggests that accelerated epigenetic aging may modify cardiovascular and inflammatory responses to ozone. However, the small sample size and multiple testing warrant caution in our results; therefore, we advocate for future, larger and more diverse studies. This abstract does not necessarily represent the views of the EPA.

Tuesday OS9

Housing characteristics, in-home environmental exposures, and lung function in a safety net population of children with asthma.

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Abstract

Objective: The health effects of in-home environmental exposures (IHEEs) including asthma triggers are challenging to examine in large populations. In this study, we investigated the influence of housing and IHEEs on lung function among children with asthma visiting a safety net hospital.

Methods: We merged data on clinical pulmonary function tests from electronic health records (EHRs) for 1,070 children from Boston Medical Center to publicly available geospatial data on housing and census tract characteristics, as well as previously predicted probabilities of IHEEs – indoor cockroach and rodent presence. We fit two Bayesian hierarchical of models of percent predicted forced expiratory volume in one second (FEV1%) with and without IHEEs as latent variables to identify confounders.

Results: Children were 10.2 years old on average, 58% male, and 75% identified as Black. In fully adjusted models, we found 6.4% lower FEV1% (95% confidence interval, CI: -9.3%, -3.5%) from a one-unit increase in the log odds of the probability of cockroach presence, and no significant association with rodents (point estimate: -0.1, 95% CI: -3.5%, 3.4%). Living in public housing, older housing <1950, and newer housing >1980 were associated with 5.1% (95% CI: 1.6%, 8.6%), 5.8% (3.7%, 7.9%), and 2.7% (95% CI 0.0%, 0.6%) higher FEV1%, respectively. Living in a Black residentially segregated census tract was associated with 3.9% lower FEV1% (95% CI: -6.4%, -1.4%).

Discussion: In this safety net population of children with asthma, predicted cockroach allergen presence from EHRs and geospatial housing and neighborhood characteristics such as housing age and racial residential segregation were associated with differential lung function. Our unique approach provided evidence that IHEEs confounded the relationship between housing, neighborhood characteristics, and lung function. Observational environmental epidemiology studies that can articulate the health effects of underlying and modifiable indoor environmental exposures could support precision medicine and interventions.

Tuesday OS9

AESurv: autoencoder survival analysis assists accurate early prediction of coronary heart disease

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Abstract

Background: Accurate early prediction of coronary heart disease (CHD) can assist with early intervention strategies preceding the disease development. Previous studies using clinical features, traditional risk factors, limited DNA methylation features, binary CHD outcomes, and basic survival analysis models may be incomplete in CHD prediction with various prediction performances. Hence it is crucial to develop state-of-the-art deep learning survival analysis models for CHD prediction.

Methods: Autoencoder is a deep learning model that can be used for learning low-dimensional representations (embeddings) from high-dimensional data. We combined our autoencoder model with Cox proportional hazards (CPH) model to predict time-to-event CHD from high dimensional DNA methylation features (CpG sites from Illumina 850K) together with available clinical features (e.g., age, low/high-density lipoprotein cholesterol, sex, smoking status, etc.). We name our deep learning autoencoder survival analysis model – AESurv. We applied our model in the Strong Heart Study (SHS) (N=2321, age 56±8) and compared the results with several other survival analysis models, including CPH, DeepSurv, and random survival forest (RSF).

Results and discussion: Our AESurv successfully predicted time to CHD event (n=749) in the SHS Population based on selected CpG features (635) and clinical features (25), with the highest Concordance index (C-index) of 0.864 ± 0.009 and time-to-event mean AUROC of 0.905 ± 0.009. We reported average prediction accuracy and standard deviation (±) based on 25 runs (five-fold cross validation and five repeats). Tree-based RSF model had the poorest model performance with the C-index being as low as 0.683 ± 0.023 and mean AUROC of 0.719 ± 0.024. CPH and DeepSurv models had slightly lower performance than AESurv.

Conclusion: Our AESurv model effectively learned participant representations in low-dimensional latent space and performed better than all other survival analysis models. The proposed model has the potential to assist health care professionals to suggest early CHD intervention strategies.

Tuesday OS9

Multiple Imputation of Missing Covariates in RNA Sequencing Studies

Brennan Baker[1,2], James MacDonald[1], Alison Paquette[2], Adam Szpiro[1], Theo Bammler[1], Nicole Bush[3], Kaja LeWinn[3], Catherine Karr[1], Sheela Sathyanarayana[1,2]

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Abstract

Background

Epidemiologic studies utilizing ‘omics’ technologies are critical for advancing our understanding of the mechanisms linking environmental exposures to human health. Unfortunately, missing covariate data is common in human studies and difficult to address with high dimensional outcomes including DNA methylation and RNA-sequencing. Often, complete-case analysis (CCA) is employed, but since this method drops participants, it can reduce statistical power and result in bias. Multiple imputation (MI) is another common technique that imputes missing observations with predicted values. However, MI is only valid when the outcome is included in the imputation prediction model. Owing to the high dimensionality of the outcome data (i.e., gene expression) in RNA-sequencing studies, including outcome genes in MI is challenging. Single imputation (SI) is another alternative that does not require including the outcome in the imputation model.

Methods

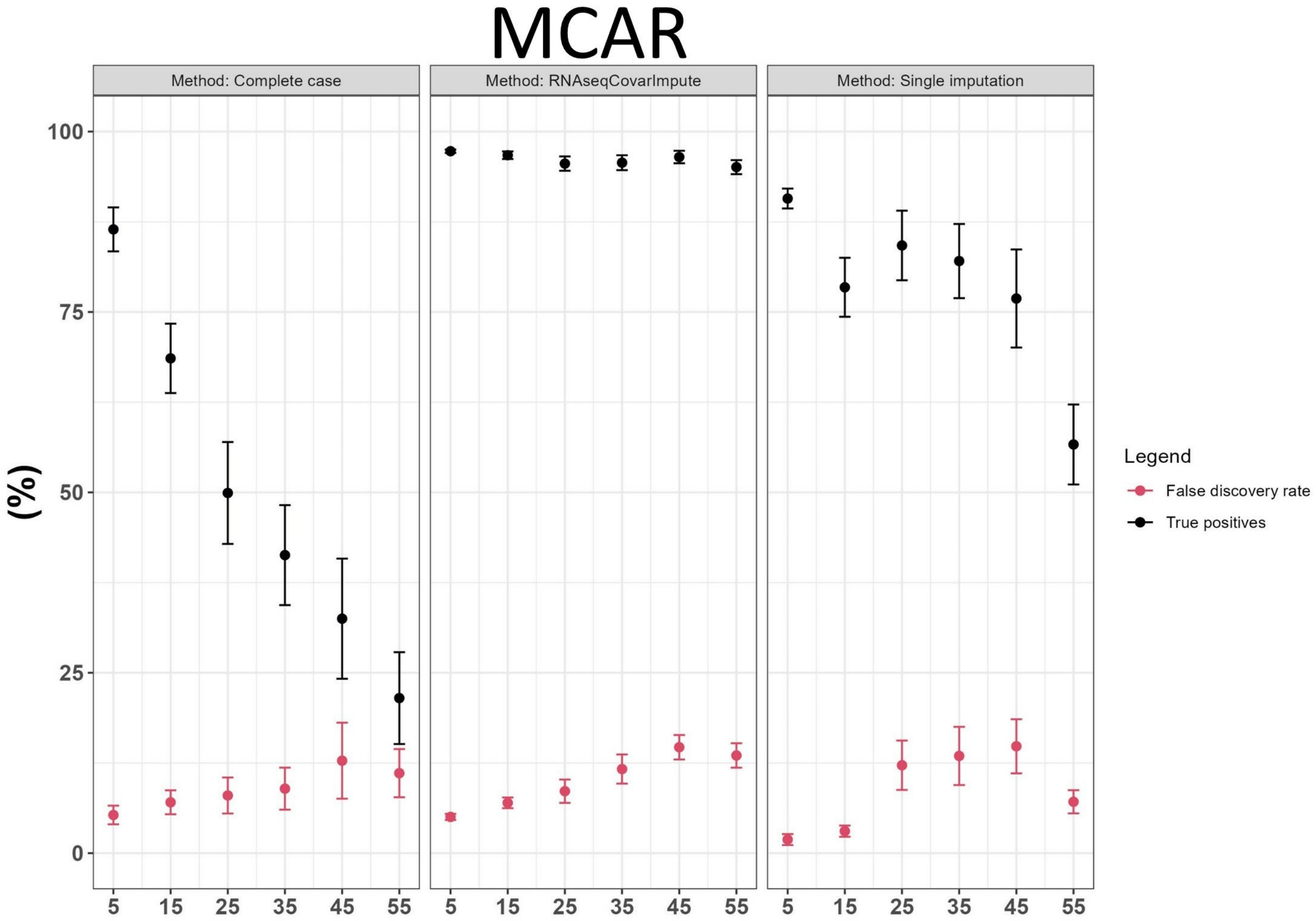
We developed a method (RNAseqCovarImpute) for MI of missing covariates in RNA-sequencing studies that integrates with the Limma-Voom pipeline for differential expression. This method accommodates high dimensional expression data by binning genes into smaller groups, creating separate MI datasets and differential expression models within each bin, and pooling results with Rubin's rules. Using real (N=14,027 genes) and synthetic RNA-sequencing data, we conducted a simulation study to artificially induce covariate missingness and compare RNAseqCovarImpute with SI and CCA with respect to uncovering true positives and limiting false-discovery-rates (FDR).

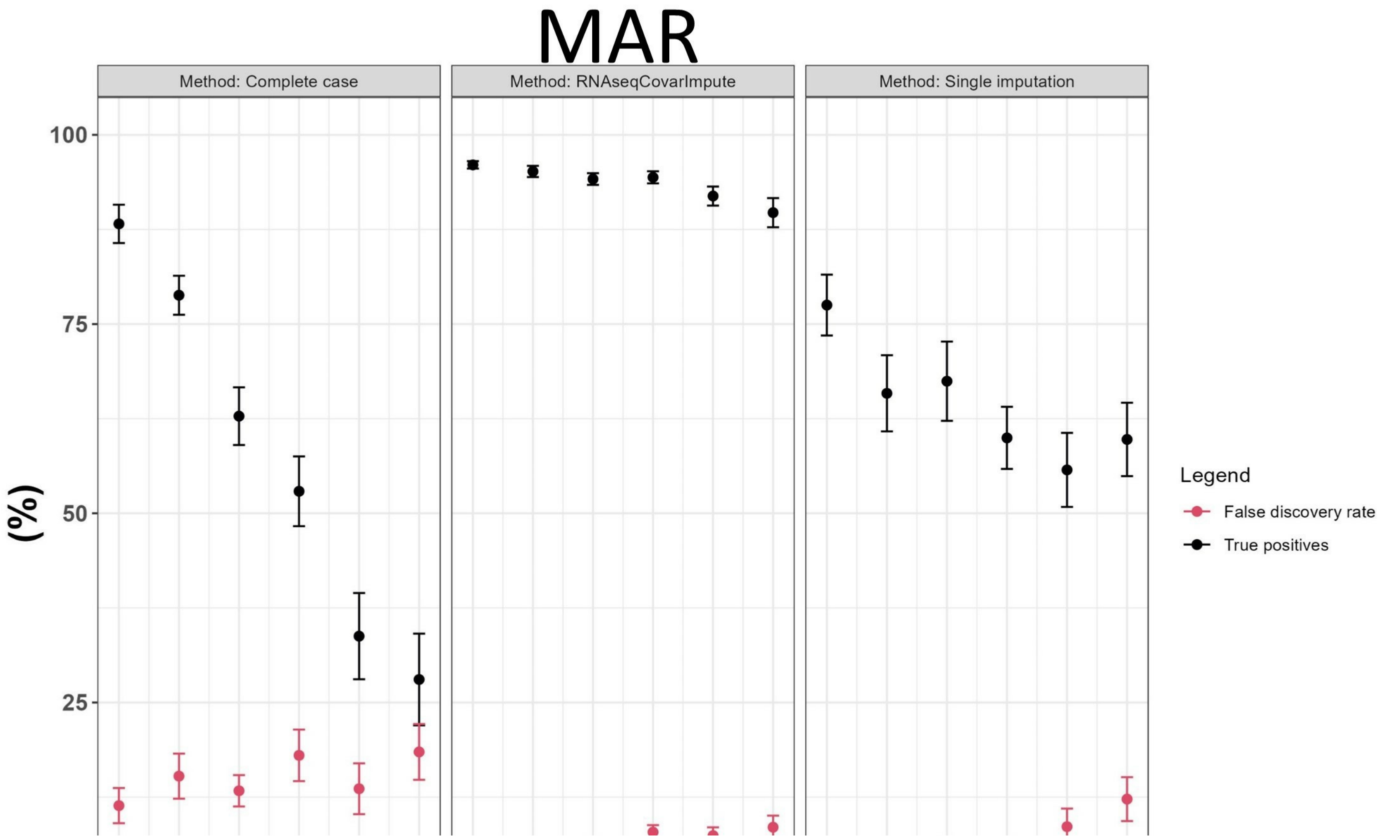
Results

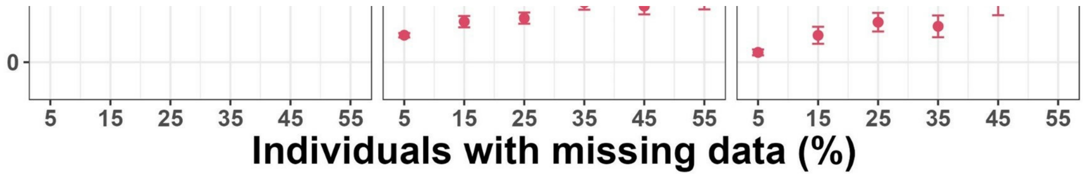
When data were missing completely at random (MCAR) or missing at random (MAR), RNAseqCovarImpute performed better than SI, and SI performed better than CCA at uncovering true positives (Figure). With respect to FDR, all three methods performed similarly when data were MCAR, while CCA had higher FDR than both imputation methods when data were MAR (Figure).

Conclusion

In future observational studies, RNAseqCovarImpute can be used to improve power for uncovering differentially expressed genes linking environmental exposures to human health.






0
5
15
25
35
45
55
Individuals with missing data (%)

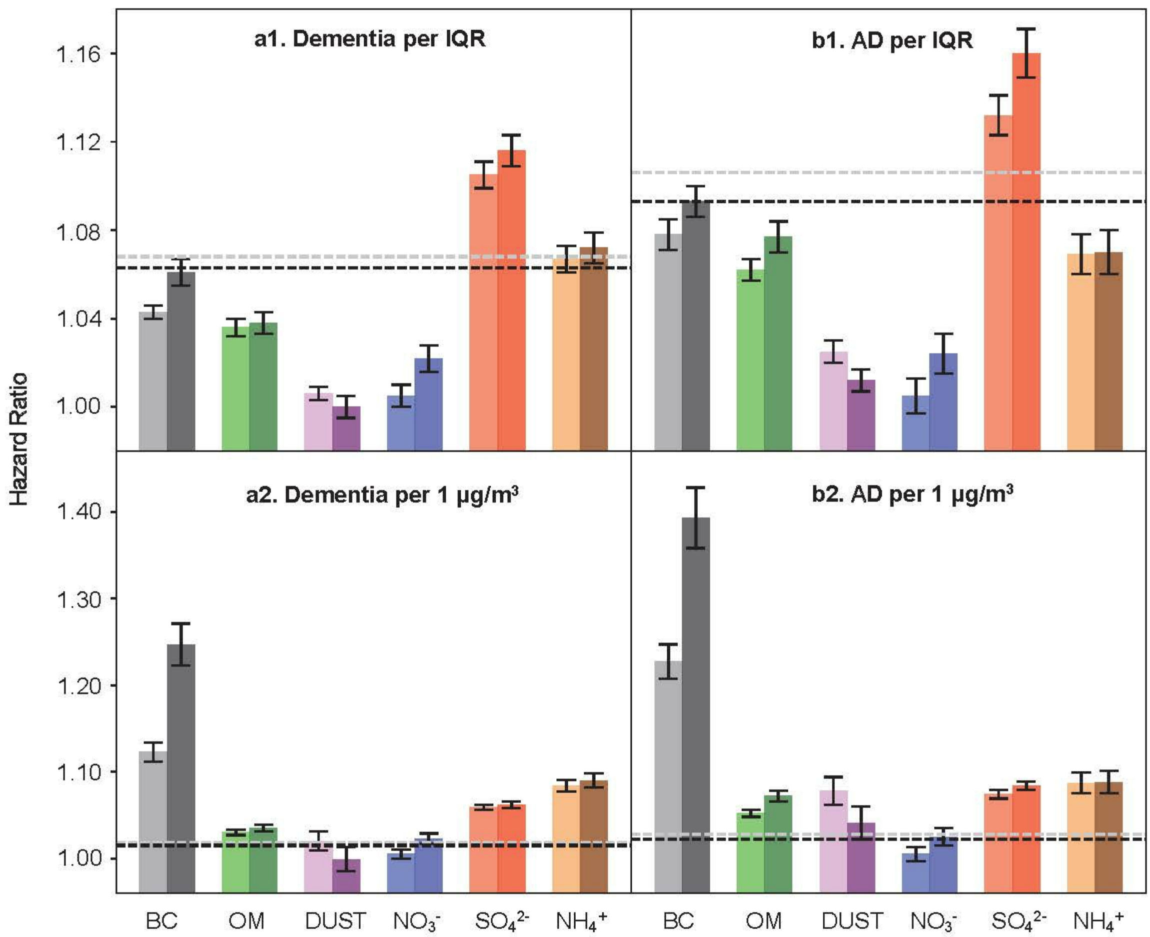
Tuesday PD1

Incident Dementia and Long-Term Exposure to Constituents of Fine Particle Air Pollution: A National Cohort Study in the United States

Liuhua Shi[1], Qiao Zhu[1], Yifan Wang[1], Hua Hao[1], Haisu Zhang[1], Joel Schwartz[2], Heresh Amini[3], Kyle Steenland[1], Howard Chang[1], Rodney Weber[4], Pengfei Liu[4]
[1]Emory University, Atlanta, USA. [2]Harvard University, Boston, USA. [3]University of Copenhagen, Copenhagen, Denmark. [4]Georgia Tech, Atlanta, USA

Abstract

Growing evidence suggests that fine particulate matter (PM2.5) likely increases the risks of dementia, yet little is known about the relative contributions of different constituents. Here we conducted a nationwide population-based cohort study (2000-2017), by integrating the Medicare Chronic Conditions Warehouse database and two independently sourced datasets of high-resolution PM2.5 major chemical composition to investigate the impact of long-term exposure to PM2.5 constituents on incident all-cause dementia and Alzheimer's disease (AD). Hazard ratios for dementia and AD were estimated using Cox proportional hazards models, and penalized splines were used to evaluate potential nonlinear concentration-response relationships. Results using two exposure datasets consistently indicated higher rates of incident dementia and AD for an increased exposure to PM2.5 and its major constituents. An interquartile range increase in PM2.5 mass was associated with a 6-7% increase in dementia incidence and a 9% increase in AD incidence. For different PM2.5 constituents, associations remained significant for black carbon (BC), organic matter (OM), sulfate (SO42−), and ammonium (NH4+) for both endpoints (even after adjustments of other constituents), among which BC and SO42− showed the strongest associations. All constituents had largely linear concentration-response relationships in the low exposure range, but most tailed off at higher exposure concentrations. Our findings suggest that long-term exposure to PM2.5 is significantly associated with higher rates of incident dementia and AD, and that SO42−, BC, and OM might drive the observed associations. Reduction of PM2.5 sources, especially those related to traffic and sulfur-containing fossil fuel combustion, may lower dementia rates in the U.S.



a1. Dementia per IQR
b1. AD per IQR
a2. Dementia per 1 μg/m³
b2. AD per 1 μg/m³
Hazard Ratio
1.16
1.12
1.08
1.04
1.00
1.40
1.30
1.20
1.10
1.00
BC
OM
DUST
NO3-
SO42-
NH4+

Figure 2

Tuesday PD1

A systematic review assessing the impact of improved cookstove technology interventions on household air pollution on human health in sub-Saharan Africa

David Dillon[1], Samara Reigh[2], Kristen Rappazzo[3], Tom Luben[3], Anne Weaver[3]
[1]Oak Ridge Institute of Science and Education, Durham, USA. [2]University of Illinois at Chicago, Chicago, USA. [3]US Environmental Protection Agency, Durham, USA

Abstract

Background and aims: A major contributor to household air pollution (HAP) in sub-Saharan Africa is reliance on unclean fuel sources. Improved cookstove technology (ICT) interventions have been promoted as a potential solution, but their impacts on health are unclear. Our aim is to conduct a systematic review to explore impacts of ICT interventions on health outcomes in sub-Saharan Africa.

Methods: We conducted a systematic review, following PRISMA guidelines, focused on ICT interventions carried out in sub-Saharan Africa from 2000-present. We performed this search in MEDLINE, PubMed, Web of Science, Web of Science CABI, and EMBASE via ProQuest using comprehensive search terms. Two reviewers assessed each study using predefined inclusion/exclusion criteria and extracted data. We evaluated each study on participant selection, exposure assessment, control comparability, outcomes, analyses, and biases.

Results: From 4,461 articles, a total of k = 23 articles described results of an ICT intervention on health outcomes. These took place in seven countries. Pooled mean exposure estimates for PM2.5 in control and interventions groups were 102.88 µg/m3 (95%CI: 52.63, 153.14; I2 96.9%) and 101.76 µg/m3 (95%CI: 57.47, 146.06; I2 98.2%) respectively. Estimates for pooled mean CO were 2.40 ppm (95%CI: 0, 8.33; I2 99.0%) and 1.66 ppm (0, 4.91; I2 98.5%)abs for control and intervention groups. Most study outcomes focused on respiratory and pregnancy-related endpoints. Fewer studies focused on cardiovascular endpoints, functional limitations, burns, eye issues, or other endpoints. Of all health outcomes reported, 49/252 (19.44%) endpoints were reported as significantly different between control and intervention groups. Significant associations between interventions and improved health outcomes were most common for respiratory endpoints, specifically lung function or incident infectious diseases.

Conclusion: There is mixed evidence that ICT interventions influenced health outcomes. ICT interventions may decrease HAP, other sources/routes of air pollutant exposure are not addressed by improved cookstoves .

Tuesday PD1

Association of Ischemic Placental Disease in a Southern California Birth Cohort and PM~2.5~ Chemical Species and Oxidative Stress Markers

Jonathan Liu[1], Qi Meng[1], Jiaqi Shen[1], Irish del Rosario[1], Pascale Lakey[2], Manabu Shiraiwa[2], Jason Su[3], Scott Weichenthal[4], Yifang Zhu[1], Farzan Oroumiyeh[1], Suzanne Paulson[1], Carla Janzen[1], Sherin Devaskar[1], Michael Jerrett[1], Beate Ritz[1]
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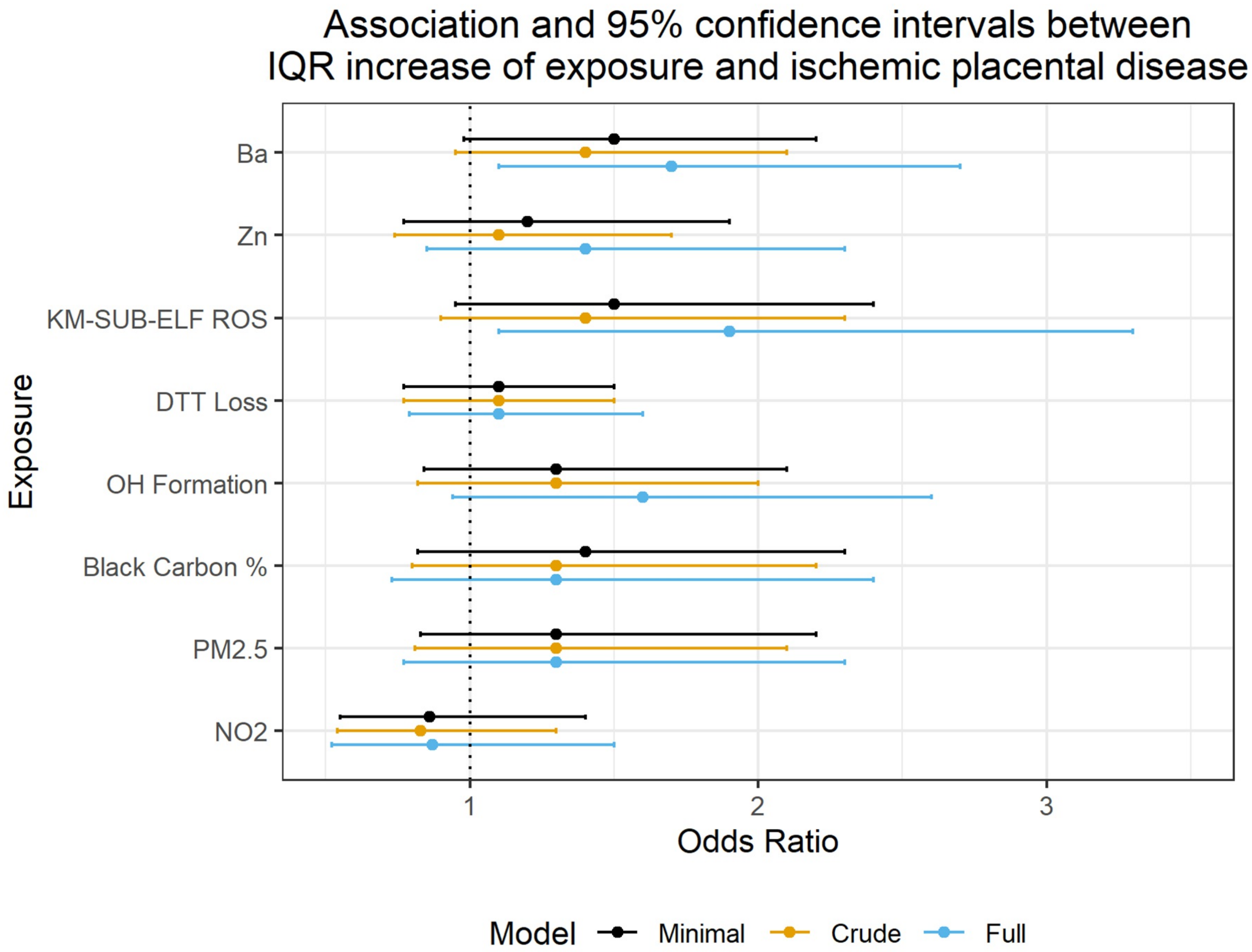
Abstract



Background: Road traffic is a significant source of particulate matter (PM) pollution, whose exposure is a significant risk factor in pregnancy-related health outcomes. The exact mechanisms behind the relationship between traffic-related air pollution (TRAP) exposure and adverse pregnancy outcomes remain unclear, partly due to a lack of detailed exposure assessment of PM constituents and to reliance on administrative birth outcome data. In this study, we assess the relationship between PM2.5 chemical species and ischemic placental disease (IPD) in a birth cohort.

Methods: We use a novel co-kriging model combining filter samples alongside a low-cost sensor network to estimate first trimester exposure to chemical constituents of PM2.5 alongside oxidative stress markers. We use the high temporal resolution provided by the low-cost sensor network to scale estimates of PM chemical constituent exposure. Using logistic regression, we estimate odds ratios and confidence intervals to assess the relationship between exposure estimates and IPD. We adjust for a number of covariates, including maternal age, race, smoking, education, family income, and BMI.

Results: We found a positive relationship between IPD and brake and tire wear-related metals. Scaled to the interquartile range, odds ratios (95% CI) were as follows: barium OR: 1.7 (1.1, 2.7), zinc OR: 1.4 (.85, 2.3), and oxidative stress, both modeled as well as measured through DTT loss and OH formation assays (ORs ranging from 1.1-1.9). Associations for more commonly used markers of TRAP were less consistent (ORs ranging from 0.87-1.3).

Conclusion: We observe higher effect sizes with Ba and oxidative potential markers compared to traditional PM measurements. Our findings suggest that exposures associated with brake and tire wear, currently unregulated, may play an important role in the relationship between TRAP and adverse pregnancy outcomes, suggesting that reducing tailpipe emissions may not be sufficient to protect pregnant women from air pollution.

Tuesday PD1

Exposures to particulate matter and carbon monoxide for beneficiaries of Bangladesh’s national cookstove program.

Ahana Ghosh[1], Michael Johnson[1], Masum Billah[2], S. M. Rokonuzzaman[2], Sajia Islam[2], Ricardo Piedrahita[1], AFM Shahed[3]
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Abstract

Background: Exposure to household air pollution (HAP) from the burning of solid fuels for cooking and heating has been linked to increased risk for several health outcomes. This study was conducted to assess how exposure to HAP may be affected by Bangladesh’s national biomass stove program, implemented by the Infrastructure Development Company Limited (IDCOL).

Methods: 300 households were monitored across 25 clusters in five districts in the IDCOL program implementation areas, using a nested post-intervention cross-sectional design, to assess how the exposures of PM2.5 and carbon monoxide differed between users of the IDCOL-promoted cookstoves and comparable users of traditional stoves. Three IDCOL promoted stoves were studied, with equal numbers of each being included in the study. 24-hour personal exposure samples were made using electrochemical CO loggers (EL-USB-300, Lascar, UK), and gravimetric PM2.5 samplers (UPAS, Access Sensors Technology, USA).

Results: PM2.5 exposures were significantly lower ($p<0.05$) for users in each improved stove group compared to the control arm, ranging from -39% to -24%. PM2.5 exposures were generally high - with the mean estimates in the control (236 µg/m3) and improved stove arm (164 µg/m3) multiple times greater than the WHO Interim-1 Target of 35 µg/m3, which was in part likely due to high regional ambient PM2.5 concentrations. CO exposures were relatively lower, with 97% of samples for users of the IDCOL-promoted stoves falling under the WHO guideline of 3.5ppm. Modeling potential health benefits suggests that the current IDCOL program could be responsible for approximately 3,000 averted deaths and 82,000 averted disability-adjusted life-years, integrated over the stove operational lifetime of 3 years.

Conclusion: Overall, this study suggests that users of IDCOL-promoted stoves have lower personal exposures to PM2.5 and CO. Further lowering PM2.5 exposures to WHO guidance levels will require additional policies and measures to mitigate regional air pollution.

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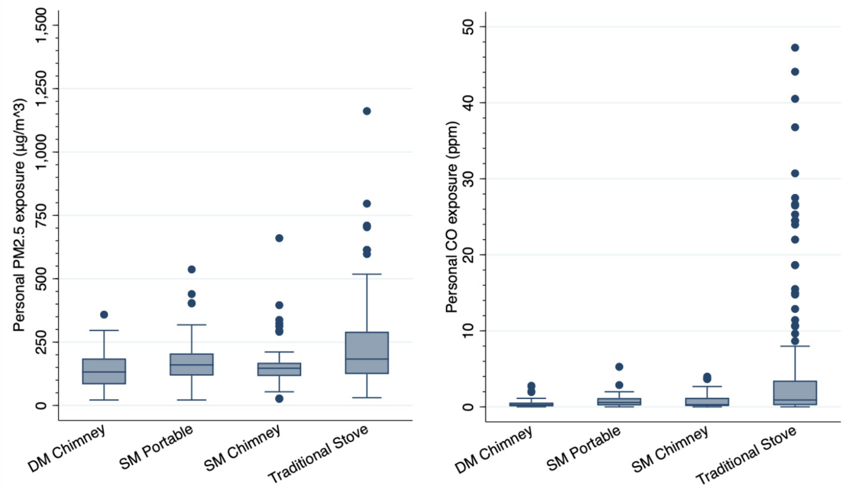

Notes: DM chimney = Double-mouth chimney stove; SM Portable = Single Mouth Portable Stove; SM chimney = Single Mouth chimney Stove. Box plot definition – shaded boxes denote the interquartile range (IQR [middle 50% of the data]), with medians shown in the center line, and whisker ends encompass the most extreme values within the 75th percentile+1.5*(IQR) and the 25th percentile-1.5*(IQR) Points beyond the whiskers are shown as individual dots.

Figure 7. Box plots of $PM_{2.5}$ (left) and CO personal exposures by stove type.

[redacted]

Tuesday PD1

A long-term source apportionment of $PM_{2.5}$ across the United States during 2000-2019

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Abstract

In this study, we collected daily $PM_{2.5}$ components data (elemental carbon (EC), organic carbon (OC), ammonium (NH_4^+), nitrate (NO_3^-), sulfate (SO_4^{2-}), Br, Ca, Cu, Fe, K, Ni, Pb, Si, V and Zn) at over 200 monitor sites from EPA chemical speciation network and other sources during 2000 to 2019, to perform source apportionment analysis using a consistent bilinear model of the multilinear engine (ME-2) model with predetermined constraints, which could produce more environmentally meaningful results comparing to using traditional positive matrix factorization (PMF) model. To reduce errors caused by spatial differences, K-mean clustering method was applied to divide monitor stations into five groups, which correspond to five geographic regions, i.e., Northeastern, Northern, Southeastern, Central and Western region. The 20 years average total concentrations of 15 $PM_{2.5}$ components were the highest in the Northeastern and the Western regions (14.2ug/m^3), while the lowest in the central region (9.7ug/m^3). ME-2 model resolved 7 $PM_{2.5}$ source factors (tracers) including secondary sulfate and nitrate rich factors (SO_4^{2-} and NO_3^-); dust (Si and Ca); Vehicle emission (OC and EC, as well as certain fractions of Cu and Zn); biomass burning (K); coal combustion (Br); industry/heavy fuel oil emission (Pb, Ni and V). Additionally, secondary organic aerosol (SOA) was identified by extracting the mass percentage of OC from secondary sulfate and nitrate factors, leaving the remaining mass as the “pure” secondary sulfate/nitrate. The contribution of each source varied from site to site. Among five regions, secondary factors (secondary sulfate and nitrate and SOA) contributed 44%-65% to $PM_{2.5}$. Vehicle emission was the largest primary source for all regions (20%-26%), while biomass burning was highest in Western region and varied by regions significantly (7%-22%). Coal combustion, industry/heavy fuel oil emission and dust contributed 3%-4%, 2%-5% and 1%-5% of $PM_{2.5}$, respectively.

Tuesday PD1

Long-Term Exposure to Air Pollution and Risk of Stroke by Ecoregions: The REGARDS Study

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Abstract

Background: Several cohort studies have found associations between long-term exposure to air pollution and stroke risk. However, it is unclear whether the surrounding ecology may modify these associations. This study evaluates associations of air pollution with stroke risk by ecoregions, which are areas of similar type, quality, and quantity of environmental resources in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study.

Methods: Between 2003 and 2007, REGARDS enrolled 26,792 adult participants (45+years) living across the contiguous United States. Long-term exposure to $PM_{2.5}$, PM_{10}, O_3, NO_2, SO_2, and CO was estimated at baseline 1-year and 3-year averages using data from the Center for Air, Climate, & Energy Solution, and assigned to participants at the block group level. Incident stroke was ascertained through September 30, 2020. Relations of air pollutants with the risk of incident stroke were estimated using Cox proportional hazards models, adjusting for relevant demographics, behavioral risk factors, and neighborhood urbanicity. Models were stratified by EPA designated ecoregions.

Results: A 5.4 μg/m^3 (interquartile range) increase in 1-year PM_{10} was associated with a hazard ratio (95%CI) for incident stroke of 1.07 (1.003, 1.15) in the overall study population. We did not find evidence of positive associations for $PM_{2.5}$, O_3, NO_2, SO_2, and CO in the fully adjusted models. In our ecoregion-specific analysis- associations of $PM_{2.5}$ with stroke were stronger in the Great Plains ecoregion (HR=1.44) than other ecoregions, while associations for PM_{10} were strongest in the Eastern Temperate Forests region (HR=1.15).

Conclusion: The associations between long-term exposure to air pollution and risk of stroke varied by ecoregion. Our results suggests that the type, quality, and quantity of the surrounding ecology, or regional pollution composition, can modify the effects of air pollution on risk of stroke.

Tuesday PD1

Disparity in exposure to ambient $PM_{2.5}$ in California from 2006 to 2018 and the role of wildfire

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Abstract

Background

Disparity exists in exposure to ambient fine particulate matter ($PM_{2.5}$) by social determinants of health, including race/ethnicity and socioeconomic status (SES). Wildfires became major contributors to ambient $PM_{2.5}$ in California in recent years but were not considered in previous disparity studies. We aim to explore the temporal trend in disparity of exposure to ambient $PM_{2.5}$ and the role of wildfires in this trend.

Methods

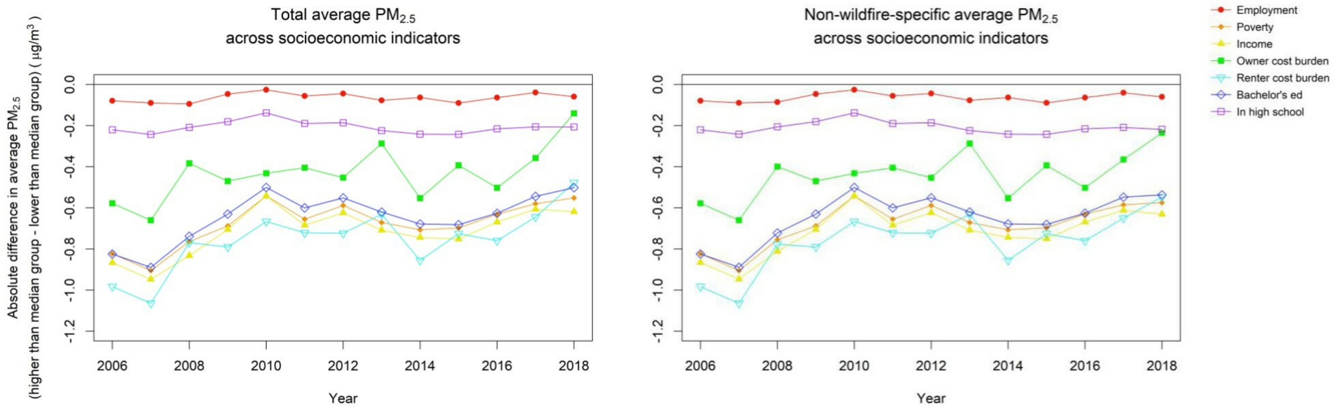
Using previously estimated exposure surfaces for daily wildfire-specific and total $PM_{2.5}$ concentrations, we calculated annual average total and non-wildfire $PM_{2.5}$ concentrations for each zip code tabulation area (ZCTA) in California from 2006 to 2018. We obtained census tract-level population of race/ethnicity (White, Black, Asian, Latino, Native American, Pacific Islander) and SES indicators (education, employment, poverty, housing burden, income) from the Healthy Places Index report and calculated corresponding ZCTA specific values. We dichotomized SES indicators by median value and summed the population of each race/ethnicity. We calculated the annual population-weighted average non-wildfire and total $PM_{2.5}$ concentrations for each subgroup and ZCTA, and relative differences between subgroups.

Results

Estimated population-weighted average total $PM_{2.5}$ concentration decreased from 13.3µg/m^3 in 2006 to 12.2µg/m^3 in 2018 with some fluctuations over time for the entire population in California. Similar decreasing patterns were observed for all subgroups and higher exposures were observed for groups with worse SES (lower employment, greater poverty, lower income, lower % with bachelor's degree, lower % with high school diploma, higher mortgage or rent burden) and higher % of Latino or Black. The differences between subgroups in total $PM_{2.5}$ concentrations decreased over time, while the corresponding changes for differences between subgroups in non-wildfire $PM_{2.5}$ concentrations were smaller.

Conclusion

A disparity in exposure to ambient $PM_{2.5}$ by SES and race/ethnicity exists but has decreased over time in California. This decrease in disparity shrinks after removing wildfire-specific $PM_{2.5}$.


Total average $PM_{2.5}$
across socioeconomic indicators
Non-wildfire-specific average $PM_{2.5}$
across socioeconomic indicators
Absolute difference in average $PM_{2.5}$
(higher than median group - lower than median group) ($\mu g/m^3$)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
2006
2008
2010
2012
2014
2016
2018
Year
Employment
Poverty
Income
Owner cost burden
Renter cost burden
Bachelor's ed
In high school

Tuesday PD1

California's early transition to electric vehicles: observed health and air quality co-benefits

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University of Southern California, Los Angeles, USA

Abstract

BACKGROUND: The transition to electric vehicles is projected to have considerable public health co-benefits, but most evidence regarding air quality and health impacts of this transition comes from projections rather than real-world data. We evaluated whether population-level respiratory health and air quality co-benefits were already detectable at relatively low levels of zero-emissions vehicles (ZEV: battery electric, plug-in hybrid, hydrogen fuel cell vehicle) adoption in California, and evaluated the ZEV adoption gap in underserved communities.

METHODS: We conducted a zip code-level ecologic study using linear mixed effects models relating changes in annual number of ZEVs (nZEV) per 1000 population from 2013 to 2019 to: (i) annual average nitrogen dioxide (NO_2) concentrations using 629 records from 107 air monitoring stations in 95 zip codes and (ii) annual age-adjusted asthma-related emergency department (ED) visit rates using 8163 observations in 1238 zip codes, adjusting models for year and educational attainment.

RESULTS: The average nZEV increased from 1.4 (standard deviation [SD]: 2.1) to 14.7 (SD: 14.7) per 1,000 population between 2013 and 2019. ZEV adoption was considerably slower in zip codes with lower educational attainment ($p<0.0001$). A within-zip code increase of 20 ZEVs per 1,000 was associated with a -0.41 ppb change in annual average NO_2 (95%CI:-1.12, 0.29). A within-zip code increase of 20 ZEVs per 1,000 population was associated with a 3.2% decrease in annual age-adjusted rate of asthma-related ED visits (95%CI:-5.4, -0.9). Findings were supported by a variety of sensitivity analyses.

CONCLUSION: Observational data on the early phase ZEV transition in California provided a natural experiment, enabling us to document one of the first real-world associations between increasing nZEV and changes in air quality and health. Results suggest co-benefits of the early-phase ZEV transition but with an adoption gap among people with lower socioeconomic status which threatens the equitable distribution of possible co-benefits.

Tuesday PD2

Cadmium Exposure and Risk of Breast Cancer: A Meta-analysis

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Abstract

Background: Cadmium is a heavy metal highly prevalent in industrialized areas worldwide. The possible role of cadmium as a risk factor for breast cancer is still uncertain. Objective: To evaluate the association between cadmium and female breast cancer using evidence from recent epidemiologic studies. Methods: We conducted a meta-analysis of epidemiological studies identified in PubMed, Web of Sciences, and Scopus. We included original articles until October 2022 that had measurements of cadmium body burden with biomarkers (urinary and blood), diet, and air. Then, we stratify the analysis based on menopausal status and sources. We used a random effects model to estimate the pooled effect of cadmium on incident breast cancer. Results: A total of 17 studies were eligible for our meta-analysis. Most of them (7) were conducted in the United States and used body burden biomarkers of cadmium exposure.   Breast cancer risk was not significantly higher in women exposed to high levels of cadmium −pooled odds ratio: 1.13 (95% confidence interval: 1.00, 1.28). The increase in risk was not statistically significant in pre (OR:1.04; confidence interval: 0.79, 1.36) or post-menopausal women (OR: 1.07 95% confidence interval: 0.97, 1.19). There was no significant heterogeneity across the studies (PHet=0.190). The subgroup analysis did not show significant breast cancer risk in overall and postmenopausal women based on cadmium body burden with biomarkers, dietary, or airborne cadmium. Conclusion: Findings from our meta-analysis suggest that exposure to high cadmium levels does not significantly increase the risk of breast cancer in women.

Tuesday PD2

Alcohol drinking, betel nut chewing and cigarette smoking associated with head and neck cancer mortality in Taiwanese population: a nationwide population-based cohort study

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Abstract

Background and Aim: The association between alcohol drinking, betel nut chewing and cigarette smoking (ABC) and mortality in patients with head and neck cancer (HNC) is inconsistent. Thus, we aim to simultaneously investigate whether the three ABC habits are associated with overall or cancer-specific mortality of HNC patients using a nationwide population-based cohort study in Taiwan.

Methods: Taiwan Cancer Registry and Taiwan's national health insurance research database were used to identify HNC patients from 2011 to 2017 (ICD-O-3 C00-C14). All patients were censored to date of death or the end of 2018. All the three ABC habits were evaluated by status, duration, and amount before cancer diagnosis. Cox proportional hazards regression models were used to calculate hazard ratios (HRs) and 95% confidence intervals (CIs) associated with the effect of ABCs on mortality.

Results: A total of 31,246 HNCs patients were included for analysis. The multivariable Cox model showed that all ABC habit combinations, except cigarette smoking alone, were significantly associated with an increased risk of overall mortality, with betel nut chewing alone having the strongest association [adjusted HR (aHR) = 1.38; 95% CI = 1.22-1.57; $P < 0.0001$]. In addition, betel nut chewing alone was also significantly associated with cancer-specific mortality (aHR = 1.42; 95% CI = 1.23-1.64; $P < 0.0001$). Furthermore, stratified analysis by sex and tumour location showed that the impact of betel nut chewing alone on total or cancer-specific mortality remained significant in both sexes or cancer developed in oral cavity.

Conclusion: Our results suggest that ABC habits, particularly betel nut chewing, were significantly associates with worse survival in HNC patients. An integrated betel nut chewing cessation campaign is the first priority to prevent HNC mortality.

Tuesday PD2

Impact of hypothetical policies to reduce outdoor air pollution or increase greenspace on breast cancer incidence in the UK Biobank cohort

Kuangyu Liu[1], Hari S. Iyer[2], Yujia Lu[3], Francine Laden[1], Mingyang Song[3], Charlotte Roscoe[1,4]
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Abstract

Background: Modifiable environmental exposures such as fine and coarse particulate matter air pollution (particles ≤ 2.5 µm [PM2.5] and ≤ 10 µm [PM10] in aerodynamic diameter) and greenspace have been associated with breast cancer risk, but disparities exist. We estimated the impact of hypothetical interventions to equalize air pollution and greenspace on breast cancer incidence among females in the prospective UK Biobank cohort.

Methods: We estimated reductions in breast cancer following hypothetical interventions to 1) reduce outdoor air pollution from high (2010 annual average PM in most socioeconomically deprived participants [75th percentile] PM2.5 = 9.01 µg /m3; PM10 = 14.9 µg /m3) to lower levels (2010 annual average PM in least socioeconomically deprived participants [25th percentile] PM2.5 = 11.4 µg /m3; PM10 = 17.8µg /m3); or 2) increase greenspace cover within a 300 m or 1000 m residential distance buffer from low (greenspace cover in most socioeconomically deprived participants [25th percentile] 300 m = 13.1%; 1000 m 19.6%) to higher levels (greenspace cover in least socioeconomically deprived participants [75th percentile] 300 m =57.3%; 1000 m = 67.5%). We applied standardization to estimate the 10-year risk difference associated with these hypothetical interventions. We separately estimated 10-year risk under contrasting exposure scenarios (e.g. high PM2.5 versus lower PM2.5) using Cox proportional-hazards models with age as the time scale, adjusted for sociodemographic and lifestyle factors. Confidence intervals were estimated using bootstrapping with 500 repetitions.

Results: There were 7,281 breast cancer cases over 4,121,066 person-years (2006-2021). The hypothetical intervention to reduce annual average PM10 resulted in fewer breast cancer cases (0.4/1000 95%CI=0.2, 0.7) Other hypothetical interventions showed no difference in breast cancer incidence.

Conclusion: Our findings suggest that reducing annual average PM10 at UK Biobank residential addresses could slightly reduce breast cancer incidence. We will explore a joint greenness and air pollution hypothetical intervention.

Tuesday PD2

Associations between somatic tumor alterations and neighborhood contextual factors in male health professionals diagnosed with prostate cancer

Hari S. Iyer[1], Kevin H. Kensler[2], Jane B. Vaselkiv[3], Konrad H. Stopsack[3], Charlotte J. Roscoe[3,4], Elisa V. Bandera[1], Bo Qin[1], Thomas V. Jang[1], Tamara L. Lotan[5], Massimo Loda[2], Peter James[6,3], Jaime E. Hart[3,7], Lorelei Mucci[3,7], Francine Laden[3,7], Timothy R. Rebbeck[3,4]
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Abstract

Background/Aims

Few consistent modifiable risk factors have been identified for prostate cancer (PCa). Unfavorable neighborhood context may influence PCa incidence and progression. Whether these associations may be explained in part by differences in tumor-level somatic alterations remain unclear.

Methods

Data on tumor markers (PTEN, p53, ERG, and SPINK1) were obtained from 1,157 participants with PCa in the Health Professionals Follow-up Study diagnosed between 1986 and 2009. Participant characteristics were reported through biennial questionnaires mailed to their home or work address. Neighborhood greenness, socioeconomic status (nSES), and the income Index of Concentration at Extremes (ICE) were linked to participants' address at diagnosis. Surrounding greenness exposure within 270m and 1230m was estimated from focal statistics applied to Landsat satellite data. Census Tract level nSES and Income ICE were calculated using data from the 2000 Decennial Census and 2006-2010 American Community Survey. Covariate adjusted logistic regression models were fit to estimate odds ratios and 95% confidence intervals for associations with presence of tumor marker alterations. We examined effect modification by population density (≥1000 people/mi2, <1000 people/mi2).

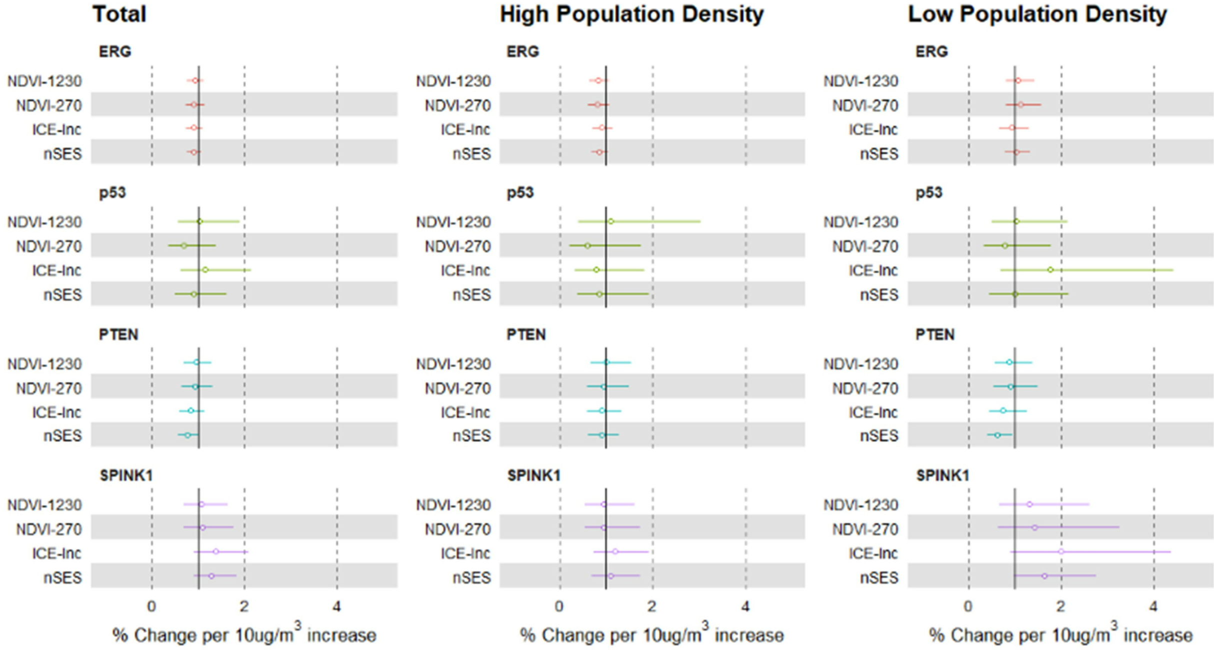
Results

Men with PCa had a mean age of 66 years at diagnosis and were mostly White (97%). In general, there was no association between any of the neighborhood contextual factors and PTEN, p53, ERG, or SPINK1. An IQR increase in nSES was associated with lower odds of PTEN loss (aOR: 0.76, 95% CI: 0.58, 1.01). Stratified analyses did not reveal major differences (Phet ≥ 0.14 for all neighborhood and tumor marker comparisons), though increasing NDVI was associated with lower ERG alterations in high but not low population density areas.

Conclusion

There were no clear associations between any neighborhood contextual factors or prostate tumor somatic alterations under investigations. Findings from this cross-sectional study suggest that neighborhood contributions to PCa risk may arise independently of these somatic alterations.

Odds Ratios and 95% Confidence Intervals for Association Between IQR Increase in Neighborhood Contextual Factor and Molecular Tumor Marker in 1,157 US Male Health Professionals Diagnosed with Prostate Cancer, Stratified by Population Density



Abbreviations: ICE-Inc=Index of Concentration at Extremes for Income, IQR=Interquartile Range, NDVI=Normalized Difference Vegetation Index , nSES=Neighborhood Socioeconomic Status. Estimates from models stratified by population density (High: ≥1000 people/mi²; Low: <1000 people/mi²).

Tuesday PD2

Chlorpyrifos use and human cancer risk: An Agricultural Health Study update

Kathryn Hughes Barry[1,2], Richard Remigio[3], Michael Alavanja[4], Gabriella Andreotti[5], Paul Albert[6], Won Jin Lee[7], Christine Parks[8], Dale Sandler[8], Jonathan Hofmann[3], Laura Beane Freeman[3]
[1]Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, MD, USA. [2]Program in Oncology, University of Maryland Marlene and Stewart Greenebaum Comprehensive Cancer Center, Baltimore, MD, USA. [3]Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, USA. [4]Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute (retired), Bethesda, MD, USA. [5]Occupational and Environmental Epidemiology Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda. MD, USA. [6]Biostatistics Branch, Division of Cancer Epidemiology and Genetics, National Cancer Institute, Bethesda, MD, USA. [7]Department of Preventive Medicine, Korea University College of Medicine,, Seoul, Korea, Republic of. [8]Epidemiology Branch, National Institute of Environmental Health Sciences, Research Triangle Park, NC, USA

Abstract

Background/Aims

Chlorpyrifos is an organophosphate insecticide recently banned in the US for use on food and animal feed crops due to associations with neurodevelopmental effects in children. Its relationship with cancer risk is unclear, but an earlier analysis of the U.S. Agricultural Health Study (AHS) found associations between chlorpyrifos and cancers of the lung, brain, and rectum, as well as leukemia. Here we incorporate more than 13 additional years of follow-up, updated exposure information, and >6700 additional cancer cases in the AHS to more comprehensively evaluate cancer risk associated with chlorpyrifos.

Methods

We included 52,848 AHS applicators with follow-up from enrollment (1993-1997) through 2017 (Iowa) or 2014 (North Carolina). We determined cumulative intensity-weighted lifetime days of chlorpyrifos use using self-reported data at enrollment and follow-up (1999-2005). Poisson regression was used to calculate rate ratios (RR) and 95% confidence intervals (CI) for all cancers combined and specific sites/subsites, adjusting for potential confounders.

Results

A total of 22,080 AHS applicators (41.8%) reported applying chlorpyrifos. We observed an increased risk of brain cancer (RR_{Q4} vs. no chlorpyrifos use=1.74, CI: 1.00-3.02; p-trend=0.38). Our findings also suggested an elevated risk of leukemia (RR_{Q4}=1.64, CI: 0.96-2.78; p-trend=0.13), which appeared to be driven by acute myeloid leukemia (AML) (RR_{Q4}=2.71, CI: 1.46-5.05; p-trend=0.005). We did not observe an association for non-Hodgkin lymphoma overall but found a positive association for follicular lymphoma (RR_{Q4}=1.95, CI: 1.07-3.56; p-trend=0.38). The previously observed findings for lung and rectal cancers did not persist with additional follow-up.

Conclusion

As the largest prospective study evaluating chlorpyrifos and cancer to date, our results provide additional evidence of positive associations with brain cancer, AML, and follicular lymphoma. These

findings are important in understanding cancer risk among individuals historically exposed to chlorpyrifos in the US, and in areas of the world where chlorpyrifos remains widely used.

Examining the association between ambient exposure to nitrogen dioxide and breast cancer risk among high-risk Canadian women

Katherine Pullella[1,2], Shana Kim[2,3], Raymond Kim[4,5], Andrea Eisen[6], Louise Bordeleau[7], Sophie Sun[8], William D. Foulkes[9], Steven A. Narod[2,3], Joanne Kotsopoulos[2,3]
[1]Department of Nutritional Sciences, Faculty of Medicine, Univeristy of Toronto, Toronto, Canada. [2]Women's College Hospital, Toronto, Canada. [3]Dalla Lana School of Public Health, University of Toronto, Toronto, Canada. [4]Princess Margaret Cancer Centre, University Health Network, Toronto, Canada. [5]Faculty of Medicine, University of Toronto, Toronto, Canada. [6]Sunnybrook Regional Cancer Center, Sunnybrook Hospital, Toronto, Canada. [7]Juravinski Cancer Centre, Hamilton Health Sciences, Hamilton, Canada. [8]BC Cancer, Vancouver, Canada. [9]Department of Oncology and Human Genetics, McGill University, Montreal, Canada

Abstract

Introduction: Air pollution, specifically nitrogen dioxide (NO_2), is a carcinogen that was recently associated with an increased risk of breast cancer among women with an elevated familial risk. Whether such an association exists among women with a pathogenic variant (mutation) in the *BRCA1* or *BRCA2* genes is unknown. Thus, we conducted a prospective analysis of annual NO_2 exposure and breast cancer risk among BRCA mutation carriers residing in Canada.

Methods: We identified BRCA mutation carriers from a longitudinal study which collects detailed information on various exposures and incident disease via biennial questionnaire. Women were eligible if they provided a postal code, did not have a preventive mastectomy or cancer at enrollment, and completed at least one follow-up questionnaire. Annual NO_2 concentrations (ppb) at enrolment address were obtained through linkage to the Canadian Urban Environmental Health Research Consortium (CANUE). Hazard ratios (HR) and 95% confidence intervals (CI) for the association between NO_2 and risk were estimated using Cox regression.

Results: This analysis included 1,129 women. After a mean follow-up of 7.1 years, 125 incident breast cancers were identified. The median annual NO_2 concentration was 13.0 ppb (range 0.2 – 43.8), indicating low overall exposure in the cohort. There was a significant association between increasing NO_2 exposure and breast cancer risk; each 8-ppb increase was associated with a 21% increased risk (HR= 1.21, 95%CI 1.01 – 1.43; P-trend =0.04). Although not statistically significant, women in the highest vs. lowest quartile of NO_2 had a 51% increased breast cancer risk (95%CI 0.92 – 2.51). Multivariate analyses are ongoing.

Significance: This is the first report of NO_2 exposure and *BRCA*-breast cancer risk in a pan-Canadian cohort and suggests environmental exposures may impact breast cancer risk among high-risk women. We will continue to leverage administrative databases to delineate the relationship between environmental toxins and breast cancer risk.

Tuesday PD2

Predicting Early-Onset Colorectal Cancer from Neighborhood Exposome Measures with Machine Learning

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Abstract

Background: Early onset colorectal cancer (EO-CRC) (diagnosed <55 years of age) accounts for 12% of all new colorectal cancer diagnoses, the 3rd leading cause of U.S. cancer deaths. Early evidence indicates the exposome, which includes environmental and societal factors, likely plays a role in CRC risk, but this is understudied. Here, we evaluate the effect of area-level exposome measures on CRC onset using supervised machine learning.

Methods: This study includes 14,301 patients diagnosed with CRC (24% EO-CRC) between 2010 – 2016 from the Pennsylvania State Cancer Registry in the five-county Greater Philadelphia Region. Patient address at the time of diagnosis was geocoded and linked to 63 different Census Tract-level environmental and sociodemographic variables representing the exposome. The outcome measure was defined as EO-CRC compared to late-onset CRC and to random pseudo-absences representing individuals never diagnosed with CRC. After exploratory analysis and data cleaning, Random Forest(RF) and Extreme Gradient Boosting(XGB) supervised machine learning classification algorithms were trained to predict early, late, or never CRC onset using sex, race, and remaining area measures. Models used 75 percent of the sample for training, Leave Location Out cross-validation to mitigate spatial dependencies, and weights to account for sample size imbalance.

Results: RF and XGB models produced similar accuracy scores, with a mean balanced accuracy of 66% for all outcomes. Both models found a variable related to access to green space to be the most important for improving model accuracy, followed by other environmental indicators such as forest cover and urbanicity.

Discussion: Characteristics of the built environment were more important for accurately predicting CRC onset than sociodemographic characteristics (including race, poverty, and education). While not a causal study, this finding supports prior research and implies that studies at the individual level are warranted to examine the link between the environment and EO-CRC.

Tuesday PD3

Associations between Air Pollutants, Brain Growth in Infancy, and Autism Spectrum Disorder

Irena Gorski-Steiner[1], Rashelle Musci[1], Mark Shen[2], Kelly N. Botteron[3], Annette M. Estes[4], Stephen R. Dager[4], Heather C. Hazlett[2], Guido Gerig[5], Robert McKinstry[3], Juhi Pandey[6], Robert T. Schultz[6], Tanya St. John[4], Lonnie Zwaigenbaum[7], Martin Styner[2], Joseph Piven[2], Heather Volk[1]

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Abstract

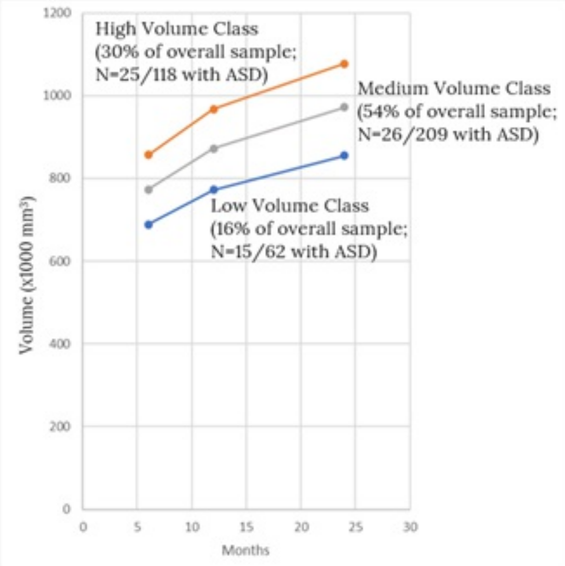
Background/Aims: Previous work has identified differing brain growth rates between infants who develop autism spectrum disorder (ASD) and those who do not. One risk factor known to contribute to both brain volume differences and ASD is air pollution exposure. We evaluated latent class trajectories of total brain volume (TBV) in participants from the Infant Brain Imaging Study (IBIS). We examined associations between prenatal residential exposure to three air pollutants (fine particulate matter [$PM_{2.5}$], nitrogen dioxide [NO_2], and ozone [O_3]), these trajectories, and ASD.

Methods: We conducted a latent class growth analysis to discern latent trajectories in TBV from 6-24 months of age (N=369). We built a growth mixture model, clustered on residential region, and adjusted for potential confounders. We then discerned differences in the prevalence of ASD by class.

Results: We identified three latent class trajectories of TBV: low (16% of participants), medium (54%), and high (30%) linear non-overlapping growth trajectories, each differing by ~10% in volume. Higher residential $PM_{2.5}$ was associated with the lower TBV trajectory, while higher residential NO_2 was associated with the higher trajectory, and O_3 was not associated (Figure 1). ASD participants were most likely to be in the lowest TBV trajectory class.

Conclusions: Prenatal exposure to $PM_{2.5}$ may contribute to lower brain volumes in infancy and increased risk of ASD, while NO_2 may contribute to higher brain volumes. Prior studies have found brain enlargement with ASD but also heterogeneity; these results can guide future studies on distinguishing phenotypes related to the well-known underlying heterogeneous (genetic and environmental) etiologic contributors to altered postnatal brain development and autism risk.

Figure 1. Total brain tissue volume trajectories and associations with air pollutants



	Adjusted* Odds Ratio
$PM_{2.5}$	
Low Volume Class	**1.13 (1.02, 1.25)**
Medium Volume Class	(ref)
High Volume Class	0.98 (0.77, 1.24)
NO_2	
Low Volume Class	1.02 (0.98, 1.07)
Medium Volume Class	(ref)
High Volume Class	**1.09 (1.01, 1.18)**
O_3	
Low Volume Class	0.99 (0.94, 1.03)
Medium Volume Class	(ref)
High Volume Class	0.93 (0.83, 1.04)

**Total N = 369; adjusted for sex (male/female), race/ethnicity (non-Hispanic white/other), maternal age (continuous), income (above vs. below $100k), birth season, and site; clustered on region.*

Tuesday PD3

Associations between air pollution, temperature, and seizures and epilepsy: a scoping review of the epidemiologic evidence.

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Abstract

BACKGROUND: Seizures and epilepsy are among the most debilitating neurologic conditions worldwide. Emerging evidence highlights potential associations of air pollution and ambient temperature exposures with seizures and epilepsy aggravation. We conducted a scoping review of the epidemiologic literature on air pollution and temperature exposures and seizures and epilepsy to summarize the existing evidence, identify literature gaps, and share insights for future research.

METHODS: Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines for conducting scoping reviews, we systematically searched PubMed, Embase, Web of Science, and PsychINFO databases for epidemiologic studies reporting relationships between air pollution and/or ambient temperature exposures and seizures and epilepsy. Peer-reviewed journal articles published in English up to October 31, 2022, were included. No restrictions by air pollution/ temperature metric type, seizure and epilepsy type, study design, geography, or demography were applied. Data on included studies' characteristics and their main findings were extracted.

RESULTS: From 5,897 initial search hits, 20 articles met the inclusion criteria. Eleven studies examined associations with air pollution exposures and 9 with temperature exposures. Studies were conducted in China, Taiwan, Japan, South Korea, Iran, Portugal, Australia, Chile, and the United States. All studies considered post-natal and daily exposures. Emergency department visits/ hospitalizations for seizures or epilepsy among adults were the most common outcome. Pollutants most studied were $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, and O_3. Daily mean temperature was the most frequently used temperature metric. Findings were mixed for air pollution-seizure/epilepsy association. Cold temperatures were the most consistently identified risk factor, supported by 6 independent studies.

CONCLUSION: Growing number of studies are exploring associations of air pollution and temperature with seizures and epilepsy. Future studies should consider assessing long-term, prenatal, and indoor/personal exposures, mixture effects, and interactions with psychosocial stressors, and focus on children and populations in developing nations.

Uncaptioned visual

Tuesday PD3

Wildfires, cardiovascular health and human behavior: a pilot study in Western Montana

Taylor Stewart, Dave Jones, Ethan Walker
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Abstract

Background

Wildfires are a growing public health concern as wildfire events continue to increase across the Western United States. While many studies have measured the association between wildfire smoke and health outcomes, real-time, household-level studies are limited. Mixed methods research is needed to understand gaps in how individual behaviors and beliefs impact wildfire exposures. The primary aim of this study was to assess household-level indoor and outdoor fine particulate matter (PM2.5) concentrations and self-reported health outcomes. Here, we report on qualitative aspects of the study aimed at understanding participant perspectives and how wildfire smoke impacts behaviors.

Methods

We conducted an entirely remote field study by mailing equipment to 20 Western Montana households during Summer 2022. Indoor and outdoor PM2.5 was measured every two minutes at each household using PurpleAir sensors (PAII-SD, PurpleAir, Inc, USA). Participants recorded blood pressure measurements, health symptoms, and activity levels in weekly electronic surveys. Once the study was completed, 20-minute end-of-study interviews consisting of 4 semi-structured questions and 7 scale questions specific to equipment use were conducted with 10 participants. Themes were assessed using NVivo software (Version 12) and feasibility was assessed using descriptive analysis.

Results

Preliminary results from NVivo analysis suggest recurring themes, indicating interview saturation. One major theme that emerged was that PurpleAir sensor data access increased awareness of air pollution and impacted participant behavior. Additional analysis of equipment-specific questions suggested that entirely remote, real-time air pollution studies are feasible. In future analyses, we will assess associations between PM2.5 concentrations at study households and participants’ self-reported behaviors and perceptions during wildfire season.

Conclusion

Our results highlight the feasibility of a remote field study and demonstrate the benefits of active engagement and real-time data access on participant behaviors. These findings will be applicable to future studies focused on household level interventions in wildfire-impacted communities.

Tuesday PD3

Wildfire smoke knows no borders: differential vulnerability to smoke effects on cardio-respiratory health in the San Diego-Tijuana region

Lara Schwarz[1,2], Rosana Aguilera[3], Javier Emmanuel Castillo Quiñones[4], Lizeth Carolina Aguilar-Dodier[4], María Evarista Arellano García[5], Tarik Benmarhnia[3]
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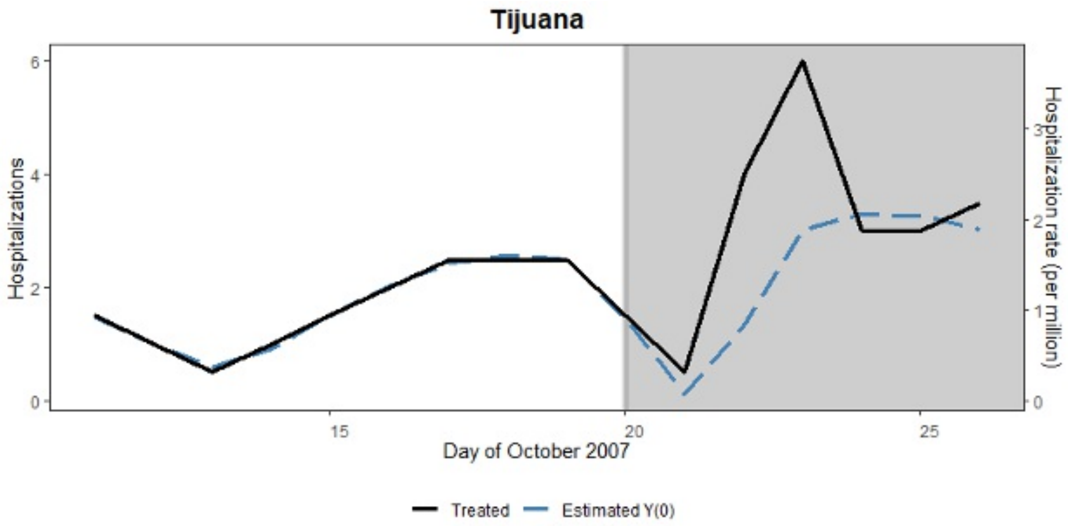
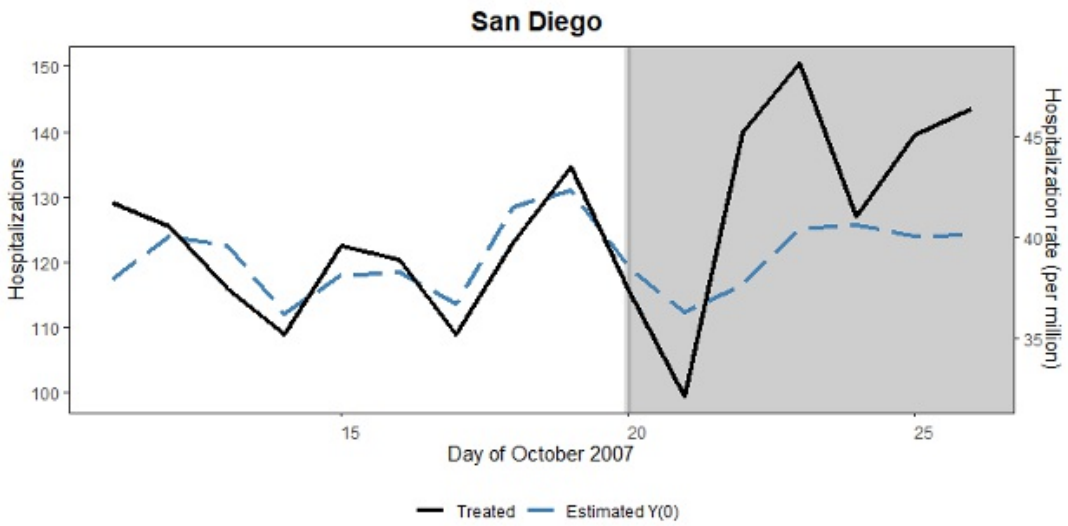
Abstract

Exposure to wildfire smoke is deleterious for human health and increases cardio-respiratory conditions and hospitalizations. Socio-economic risk factors increase susceptibility; the same exposure can lead to different health effects across populations. While the San Diego-Tijuana border can be exposed to the same wildfire smoke event, socio-demographic differences may drive differential effects. We used the October 2007 wildfires, one the most devastating wildfire events in California that brought smoke to the entire region, as a natural experiment to understand the differential effect of wildfire smoke on both sides of the border. We applied synthetic control methods to evaluate the effects of wildfire smoke on cardio-respiratory hospitalizations in the Municipality of Tijuana and San Diego County separately. Data on hospital admissions was obtained from Office of Statewide Health Planning and Development for California and from the Mexico Secretary of Health for Mexico. Smoke plumes were identified using the NOAA hazard mapping smoke product- by October 25th, the entire region was completely covered by smoke. During the study period (October 11th- October 26th, 2007), 2,009 hospital admissions for cardio-respiratory diseases occurred in San Diego County while 37 hospital admissions were reported in the Municipality of Tijuana. Although the number of cases in Tijuana was much lower than San Diego, the relative change in cardio-respiratory hospitalizations from wildfire smoke exposure resulted in a 10% increase in hospital admissions in San Diego and a 60% increase in Tijuana. This is likely due to social drivers- the poverty rate in Tijuana is more than three times that of San Diego. These results suggest an important role of socio-demographics in modulating the effects of wildfire smoke and we hope the results can be used to develop a concerted regional effort to protect populations on both sides of the border from the adverse health effects of wildfire smoke.


Tijuana
Hospitalizations
Hospitalization rate (per million)
Day of October 2007
Treated
Estimated Y(0)


San Diego
Hospitalizations
Hospitalization rate (per million)
Day of October 2007
Treated
Estimated Y(0)

Tuesday PD3

Association between Ultrafine Particle Exposure and Type 2 Diabetes Mellitus

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Abstract

According to the International Diabetes Federation, in 2019, approximately 463 million adults aged 20-79 years were affected by Type 2 Diabetes Mellitus (T2DM), with 374 million people living with an increased risk of developing T2DM. T2DM is a leading cause of cardiovascular disease which can often lead to fatal complications of coronary artery disease, high blood pressure, and elevated glucose levels as well as long-term complications of diabetic retinopathy, nephropathy, and neuropathy. Recent studies have demonstrated that ultrafine particles (UFP) can cross the pulmonary alveolar membrane and can have direct effects including systemic inflammation and autonomic dysfunction leading to metabolic disorders. Also, recent epidemiological studies have shown a relation between exposures to particulate matter and T2DM. However, the characterizing of the relationship between UFP exposure and T2DM in epidemiological studies is inconsistent, potentially due to ground-based monitors' inability to provide widespread UFP exposure measurements. Alternatively, a land-use regression model provides long-term, large-scale UFP exposure estimates that capture urban and rural variations. This land-use regression modeling framework estimates UFP as a particle number concentration (PNC). The PNC values are used to provide widespread UFP coverage for nearly 6 million residential census blocks in the contiguous United States. The yearly PNC geographic coordinates were matched with the county-level T2DM incidence data obtained from the Centers for Disease Control and Prevention for the subsequent year. We performed a linear regression to predict T2DM incidence subject to UFP exposure, with several controls including race, ethnicity, age, income, gender, and education level. With the results from this investigation, we hypothesize that we will attain a more thorough understanding of the validity of the relationship between UFP exposure and T2DM, and the limitations that the absence of widespread UFP measurements imposes on population exposure studies.

Tuesday PD3

Race, place, and health disparities in the Agricultural Health Study: mortality among Black and White licensed pesticide applicators in North Carolina

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Abstract

Farmers face a range of hazards including heavy equipment, pesticides, and farm-related stress. Racial disparities in agriculture, such as historic loan discrimination, are unique stressors for Black farmers that could further impact health. Farmers tend to be healthier than the general population, but little is known about racial health disparities. The Agricultural Health Study enrolled (1993-1997) 1,146 Black and 17,622 White pesticide applicators (mostly farmers) from North Carolina. We examined race, personal, and community-level factors associated with mortality through 2019; 43% of Black and 35% of White participants died (median age deceased 74.5 and 77 years). Analyses were restricted to central and eastern counties, where two-thirds of the study population lived, including most Black participants. In Cox regression models accounting for age and education, mortality risk was higher for Black compared to White participants (HR 1.14; 95%CI 1.03, 1.30). Differences in obesity, smoking, use of pesticides and personal protective equipment did not confound this association. Residential addresses at enrollment were linked to the Social Vulnerability Index (SoVI® 2010-2014), a county-level composite of factors impacting response and resiliency to environmental hazards. SoVI scores were higher (greater vulnerability) among Black (med 67.8; IQR 49.2, 83.6) vs. White farmers (med 59.9; IQR 36.4, 78.1). Mortality risk was higher for Black residents in counties with higher SoVI scores (Q4), compared to White residents in areas with lower (<Q4) scores (HR 1.37, 95%CI 1.12, 1.68), but not for Whites in Q4 counties (HR 1.09; 0.97, 1.23; interaction p=0.036). Overall cause of death was similar by race for cardiovascular disease (35%) and cancer (28%), but Black farmers had more deaths due to prostate and colorectal cancer, diabetes, and kidney disease. These findings suggest geographically patterned risk or resiliency factors, such as healthcare access, environmental exposures, or climate-related stressors, may contribute to racial health disparities in farmers.

Tuesday PD3

Fine particulate matter exposure, diabetes, metabolic syndrome, and cardiovascular disease in the Strong Heart Study

Maggie Li[1], Jada Brooks[2], Markus Hilpert[1], Jeff Goldsmith[3], Steven Chillrude[4], Tauqeer Ali[5], Lyle Best[6], Joseph Yracheta[6], Marcia O'Leary[6], Jason Umans[7,8], Aaron van Donkelaar[9], Randall Martin[9], Marianthi-Anna Kioumourtzoglou[1], Ana Navas-Acien[1]
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Abstract

Background/Aims: Long-term exposure to $PM_{2.5}$ is causally linked to risk of cardiovascular disease (CVD). While $PM_{2.5}$ has been studied quite extensively as a CVD risk factor, American Indians have been notably excluded from such studies, despite being a high-risk group to developing CVD. Our study estimates the long-term effects of $PM_{2.5}$ exposure on CVD outcomes in the Strong Heart Study (SHS), a longitudinal cohort of American Indians enrolled from three study centers in Arizona, North and South Dakota, and Oklahoma.

Methods: We pull $PM_{2.5}$ estimates from a satellite-based chemical transport model, incident CVD events from ongoing mortality and morbidity surveillance in the SHS, and baseline sociodemographic and clinical data from the SHS Phase 3 visit (1998–1999). We use Cox proportional-hazards models to evaluate the association between average residential $PM_{2.5}$ exposure from 1995–1999 and fatal and non-fatal coronary heart disease (CHD), heart failure, stroke, and any incident CVD event from 2000–2020. We adjust for participants' sex, BMI, smoking status, income, educational attainment, alcohol intake, and residential winter and summer average temperatures. We stratified the hazards by study center because CVD rates are markedly different across centers.

Results: We followed 2736 participants and examined incident CVD outcomes from 2000–2020. Average $PM_{2.5}$ exposure levels from 1995–1999 varied by study center, ranging from approximately 7.0 μg/m^3 (95%CI: 5.7, 8.4) in Arizona, 5.6 μg/m^3 (95%CI: 4.5, 6.7) in North and South Dakota, and 8.6 μg/m^3 (95%CI: 7.0, 10.2) in Oklahoma. By the end of the study period, there were a total of 581 CVD events reported.

Conclusion: This study will contribute to a greater understanding of air pollution exposure and related cardiovascular health effects in American Indian communities, addressing a critical gap in evidence representation in air pollution regulation.

Tuesday PD4

Occurrence of COVID-19 and serum per- and polyfluoroalkyl substances: a case-control study among workers with a wide range of exposures

Anna Porter[1], Sarah Kleinschmidt[2], Kara Andres[2], Courtney Reusch[2], Ryan Krisko[2], Oyebode Taiwo[2], Geary Olsen[2], Matthew Longnecker[1]
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Abstract

Per- and polyfluoroalkyl substances (PFAS) are a broad class of synthetic chemicals that are or were historically used in the manufacturing of industrial and consumer products; some are present in most humans in developed countries. Some studies suggest that certain PFAS may have immunotoxic effects in humans, which could put individuals with high exposure at increased risk for infectious diseases such as COVID-19. We conducted a case-control study to examine the association between COVID-19 diagnosis and PFAS serum concentrations among employees and retirees from two 3M facilities, one of which historically generated perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), and perfluorohexane sulfonic acid (PFHxS). Participants completed enrollment and follow-up study visits in the Spring of 2021. Cases were defined as a reported COVID-19 diagnosis or the presence at least one symptom of COVID-19 when someone else in their household was diagnosed. Case status was modeled in relation to concentration of serum PFAS measured at enrollment after adjusting for covariates. The analytic sample comprised 573 individuals, 111 cases (19.4%) and 462 controls (80.6%). In adjusted models, the odds ratio of COVID-19 was 0.94 per interquartile range (14.3 ng/mL) increase in PFOS (95% confidence interval 0.85, 1.04). PFOA, PFHxS, and perfluorononanoic acid (PFNA) showed similar inverse associations. Other PFAS present at lower concentrations were examined as categorical variables (above the limit of quantification, yes vs. no [referent]), and showed slightly more inverse associations, with wider confidence intervals. Quantitative bias analyses of unmeasured confounding and selection bias did not produce notable changes in results. In our sample, the serum concentration of all PFAS examined were associated with a small inverse odds ratio for COVID-19. Studies with individual-level data in populations with a wide range of exposures to PFAS might be the most informative about whether an association with risk of COVID-19 exists.

Tuesday PD4

The impact of enhanced indoor air quality strategies among LEED certified schools on in-person learning during the COVID-19 pandemic

Grace Kuiper[1], Ada Wilmer[1], Hannah Carter[2], Caroline Shannon[2], Hannah Curcio[1], Elicia Ratajczyk[1], Brian Dunbar[1], Ellison Carter[1], Anisa Heming[2], Sheryl Magzamen[1]
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Abstract

Background: The COVID-19 pandemic has emphasized the potential for public spaces, particularly schools, to enable viral transmission among communities. Improving indoor air quality (IAQ) is a critical undertaking for limiting disease spread. We used Leadership in Energy and Environmental Design (LEED)-certified school facilities to investigate the effect of enhanced IAQ strategies to improve the built environment on the mitigation of COVID-19 transmission. **Methods**: LASSO regression was used for variable selection for logistic regression treatment models. Propensity scores of the likelihood of school facilities to have achieved increased ventilation or outdoor air delivery monitoring LEED credits was predicted from treatment models. Inverse probability weights were then included in mixed effects Poisson models to control for confounding of the relationship between LEED enhanced IAQ credit achievement and the number of COVID-related school facility closure days during the 2021-22 academic year. **Results**: Although effect estimates for the enhanced IAQ LEED credit treatments were not significant in final models, they were consistently in the negative direction. Furthermore, the effect of IAQ credit achievement on school closure days was statistically significant in linear models; we hypothesize that models lacked power to detect significance due to a large proportion of schools with zero COVID-related closure days during the 2021-22 academic year. A 10% increase in the proportion of county residents who reported ‘Always’ using a mask in public was associated with 0.77 fewer COVID-related school closure days (95% CI: 1.46, 0.07). **Discussion**: This study contributes to the current literature on the effect of built environment on infectious disease transmission. Protecting students and staff health should be a priority during typical or atypical viral events to support children’s access to in-person learning. Efforts to improve the built environment, particularly those related to IAQ, among schools may be important avenues to support community health.

Tuesday PD4

Ecotonal disparities and the risk of West Nile virus in New York City

Matthew Ward[1], Yuxuan Chen[1], Meytar Sorek-Hamer[2], Aman Patel[1], Nicholas Steiner[3], Bajwa Waheed[4], Nicholas DeFelice[1]
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Abstract

Since its introduction in 1999, West Nile virus has established itself as the leading domestically acquired arbovirus in the United States. Transmission is driven by Culex spp. mosquitoes who predominantly feed on birds but also on mammals in the late summer resulting in West Nile virus spillover events in humans. In 2022, New York City experienced its worst West Nile virus outbreak on record since its introduction, with an upper bound estimate of long-term financial impact at $31.5 million. Mosquito abatement districts attempt to prevent these spillover events by disrupting West Nile virus transmission patterns though larvicide and adulticide applications. Additionally, throughout the world lower socio-economic status has been shown to be correlative with increased exposure to mosquitoes and WNV infections are commonly underreported, thus it is important to understand the spatial risk of this burden. This presentation will report the results of a fine scale built environmental profile describing the variability of hydrology and meteorology of New York City using the ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS). Our exposure profiles will characterize ecotonal fluctuations in mosquito habitats to identify the role land use and climate plays within mosquito development in the urban environment. Furthermore, we will characterize how these ecotonal conditions in the context of the built urban environment and socio-economic status increase the risk for West Nile virus human spill-over events in New York City.

Tuesday PD4

SARS-CoV-2 infection is associated with functional changes in resting-state neural mechanisms among Italian adolescents and young adults: a longitudinal case control study

Azzurra Invernizzi[1], Elza Rechtman[1], Stefano Renzetti[2], Alessandra Patrono[2], Christoph van Thriel[3], Elena Colicino[1], Claudia Ambrosi[4], Lorella Mascaro[5], Giuseppa Cagna[2], Roberto Gasparotti[2], Abraham Reichenberg[1], Cheuk Tang[1], Donald Smith[6], Donatella Placidi[2], Roberto Lucchini[7], Robert Wright[1], Megan Horton[1]

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Abstract

There is strong evidence for brain-related abnormalities in COVID-19. Neurologic, cognitive, and olfactory deficits demonstrate the potential neurotoxic impact of the virus. Recent studies of covid-related brain changes focus on severe infection or on older populations. To our knowledge, no studies have focused on brain changes in adolescents and young adults impacted by mild COVID-19. We take a data-driven approach to identify functional brain changes in COVID-19 cases and controls from Lombardy, Italy, a global hotspot of COVID-19. From our ongoing longitudinal neuroimaging study of adolescents in Northern Italy (the Public Health Impact of Metals Exposure (PHIME) study), we selected 10 participants (age 16-25y) tested positive for SARS-CoV-2 infection (via real-time reverse transcription polymerase chain reaction (RT-PCR) test) and 11 age- and sex-matched non-infected controls (RT-PCR negative; no close-contact or self-reported symptoms). None of the 10 positive subjects was hospitalized or suffered from pneumonia. All participants participated in resting state functional magnetic resonance imaging (rs-fMRI) prior to and after infection. Using graph theory metrics, we computed eigenvector centrality (EC) in 111 brain areas (Harvard Oxford Atlas) and computed ECdelta (i.e., the difference in EC values pre- and post-COVID-19). We used family wise error (FWE) corrected permutation statistics to quantify ECdelta differences between cases and controls. ECdelta in four brain regions (right posterior temporal gyrus; right planum temporale; left insular cortex and left central opercular cortex; p= 0.034, 0.047, 0.016, 0.038 respectively) differed significantly between COVID-cases and matched controls. To our knowledge, this is the first longitudinal imaging study of SARS- CoV-2 in adolescence where participants were scanned before and after COVID-19. Our results show that key brain areas associated with the primary gustatory cortex (insula and opercular cortex) and the ‘brain-fog’ (temporal gyrus and planum temporale) have altered functional connectivity patterns in adolescents infected by SARS-CoV-2.

Tuesday PD4

Changes in school mitigation strategies and disease transmission within an independent school in New York City.

Nicholas DeFelice, Alison Lee
Icahn School of Medicine at Mount Sinai, New York, USA

Abstract

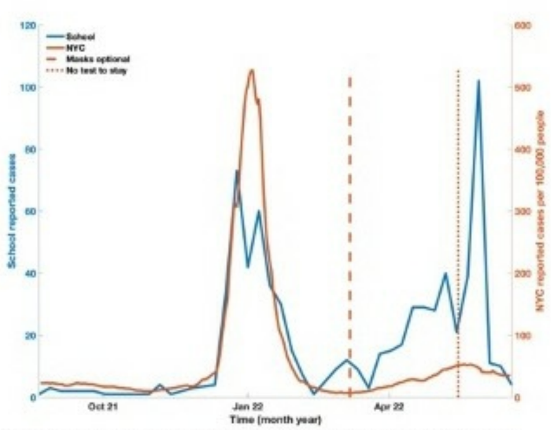

Figure. Weekly school reported SARS-CoV-2 infections (blue line) and the 7-day average reported SARS-CoV-2 infections per 100,000 residents in New York City (orange line). School infections rose after masks became optional (orange dash) and test to stay program was removed (orange dots) peaking 2 weeks after the test to stay program was removed with 7.5% of the school infected.

Background: During the COVID-19 pandemic, governments have implemented a range of public health measures including school closures to slow the spread of SARS-CoV-2. School closures, in particular, can have immediate and long-lasting impacts on child development and educational attainment thus it is important to understand the role of the built environment and mitigation strategies within schools play in respiratory disease transmission.

Methods: This presentation will report the results of a compartmental model that looks at the association between within-school risk of transmission, within-school mitigation strategies, and community level transmission. During the 2021-2022 school year, infection-control strategies and active and passive SARS-CoV-2 testing strategies were employed at an independent school in New York City (NYC). In Spring 2022, infection-control strategies were removed. On March 7th2022 the independent school went from mandator mask to masks optional, and removed the test to stay requirement on May 15th 2022. We present these data alongside the NYC community-level transmission data to understand the statistical relationship between community spread and within-school infection control.

Results: During the 2021-2022 school year 56 % and 51% of staff (n=231) and students (n=1,145) were infected, respectively. Following these policy changes, infection rates within the school increased relative to NYC. Twenty-eight percent occurred after mask option but with test to stay; 23% occurred after mask optional without test to stay. School infections peaked 2 weeks after the test to stay program was removed with 7.5% of the school infected.

Conclusions: We observed 53% of students and staff tested positive for SARS-CoV-2 over the school year; however, in school transmission was rare prior to the mask optional and removal of test-to-stay policies. Moving forward and the variability within community spread, it is important to maintain a test to stay policy to prevent within school transmission and keep children in healthy and in school.

Tuesday PD4

COVID-19 in NYC School Environments: Ventilation, poverty, and testing

Moira Bixby, Nicholas DeFelice
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Abstract

Background: To slow the spread of SARS-CoV-2, governments have implemented a range of public health measures including school closures. In New York City (NYC) the estimated student-level learning losses due to COVID-19, and the transition away from classroom-based instruction, was on average 125 (69%), and 212 (118%), days of reading and math, respectively, relative to a typical 180-day school year. Keeping schools open to in-person learning is an important step in a healthy economy; however, it comes with the risk of increasing contact networks and potential for disease spread. Keeping school environments open necessitates built environments with access to funding and, in the case of COVID, proper ventilation.

Aim: We aim to determine what associations exist between NYC school ventilation, school district demographics, and COVID-19 testing.

Methods: NYC Department of Education (DOE) reported data on school building ventilation (exhaust and supply fans, unit ventilators, and operable windows), 2020-2021 academic year NYC school district demographics, COVID tests, and remote versus blended learning. Associations between school ventilation, demographics, testing, and learning preference were assessed using correlations.

Results: Across NYC school districts, remote learning was not associated with percent poverty. The average number of operable windows per school district had a moderate positive correlation with COVID positivity ($r=0.5$, $p=0.007$) and a low positive correlation with percent poverty ($r=0.4$, $p=0.03$). Percent poverty had a moderately high positive correlation with COVID positivity ($r=0.6$, $p<0.001$) and a low positive correlation with number of tests per blended students ($r=0.4$, $p=0.04$).

Conclusion: Percent poverty may be a confounder between number of operable windows and student COVID-19 cases. Further analyses are needed to assess confounding to determine how poverty, ventilation, and learning preference influenced COVID positivity in schools.

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Tuesday PD4

Environmental exposure to per- and poly-fluorinated compounds (PFAS) and heavy metals and COVID-19 severity

Brittney Baumert[1], Jesse Goodrich[1], Hongxu Wang[1], Sung Park[2], Douglas Walker[3], Julio Landero[4], Dave Conti[1], Lida Chatzi[1], Howard Hu[1]
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Abstract

Background: Per- and poly-fluorinated compounds (PFAS) and heavy metals constitute two classes of environmental exposures with known immunotoxicant effects. The aims of this study were to evaluate the association between exposure to both heavy metals and PFAS and COVID-19 severity. We hypothesized that elevated plasma-PFAS concentrations and urinary heavy metal concentrations would be associated with increased odds of ICU admission in COVID-19+ hospitalized individuals.

Methods: In patients from the biorepository of hospitalized COVID-19 patients managed by the University of Southern California Clinical Translational Sciences Institute, urinary concentrations of 15 heavy metals and urinary creatinine were measured in n=101 patients and plasma concentrations of 13 PFAS were measured in n=126 patients. COVID-19 severity was determined based on whether a patient was admitted to the ICU during hospitalization. Odds of ICU admission were assessed using logistic regression models, controlling for age and other covariates.

Results: Average age of patients was 55±14.2 years. Among all participants, 54.5% (n=55) and 54.8% (n=69) were admitted to the ICU, respectively. For heavy metals, we observed higher levels of Cd, Cr, and Cu in ICU patients. The strongest associations were with Cadmium (Cd). After accounting for age and urinary dilution, each 1 SD increase in Cd was associated with a 4.3 (95% CI: 1.5-19.9; p=0.03) times higher odds of admission to the ICU. When adjusting for additional covariates, including sex, Hispanic ethnicity, and smoking status, the effect estimates between cadmium and ICU admission remained similar. For PFAS, we also observed elevated levels of perfluorodecanesulfonic acid (PFDS) in ICU patients, with each 1 SD increase in PFDS associated with 1.70 (95% CI: 1.00-2.80) increased odds of ICU admission for COVID-19 after adjusting for age.

Conclusions: This study supports the hypothesis that environmental exposures to cadmium and PFDS may impact COVID-19 severity.

Tuesday PD5

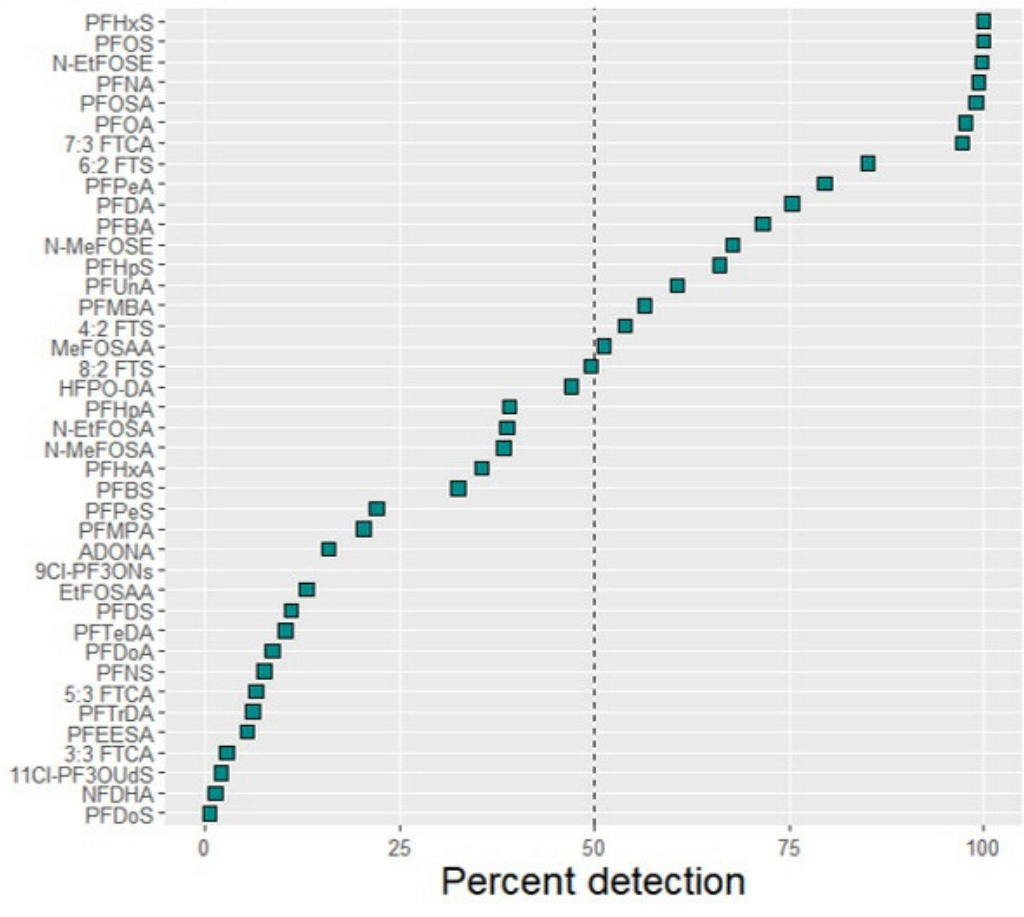
Descriptive analysis of legacy, replacement, alternative, and precursor perfluoroalkyl substances in the MIREC-ENDO study

Michael M Borghese[1], Alicia Ward[1], Susan MacPherson[1], Kate E Manz[2], Mandy Fisher[1], Tye E Arbuckle[1], Jillian Ashley-Martin[1]

[1]Health Canada, Ottawa, Canada. [2]Brown University, Providence, USA

Abstract

Figure – Detection rates of 40 perfluoroalkyl substances measured in serum samples from female participants in a 2018–2021 follow-up study of the Maternal-Infant Research on Environmental Chemicals (MIREC) Canadian pregnancy cohort



Background

Several legacy and emerging per- and polyfluoroalkyl substances (PFAS) have been regulated around the world. There is growing concern over the proliferation of replacement and alternative PFAS, as well as PFAS precursors. Biomonitoring data are needed to assess exposure and to inform analyses of potential health effects as well as risk assessment.

Methods

We collected serum samples from 289 adult female participants in a 2018–2021 follow-up study of the Maternal-Infant Research on Environmental Chemicals (MIREC) Canadian pregnancy cohort. Samples were analyzed for 40 legacy, replacement, alternative, and precursor PFAS using liquid chromatography

with tandem mass spectrometry with isotope dilution. We describe patterns of exposure according to sociodemographic and sample collection characteristics for those compounds with >50% detection.

Results

17 out of 40 PFAS were detected in >50% of samples with 7 of these detected in >97% of samples. Geometric mean (95%CI) concentrations (μg/L) were highest for PFOS (1.67 [1.56-1.79]), PFOA (0.50 [0.44-0.58]), PNFA (0.36 [0.34-0.39]), and PFHxS (0.32 [0.29-0.34]). Concentrations of PFOA, PFOS, PFHxS, and PFHpS were consistently lower among participants with more children, having breastfed more children, and with a higher lifetime duration of breastfeeding. Concentrations of PFOA were higher among White participants, while concentrations of N-MeFOSE, N-EtFOSE, 7:3FTCA, and 4:2FTS were higher among participants reporting a race or ethnicity other than White. Participants recruited in 2018–2019 (prior to the COVID-19 pandemic) had lower concentrations of PFOS, PFNA, PFDA, and PFPeA, but higher concentrations of PFUnA, PFBA, N-EtFOSE, 7:3FTCA, and 4:2FTS, than those recruited in 2020–2021.

Conclusion

We report the first Canadian biomonitoring data for several replacement, alternative, and precursor PFAS, and updated data for legacy PFAS. Our findings support the hypothesis that pregnancy and breastfeeding are excretion pathways for PFAS. These results will inform etiological analyses examining associations with health outcomes.

Tuesday PD5

Per- and polyfluoroalkyl substances and bone mineral content in early adolescence: modification by diet and physical activity

Junyi Zhou[1], Jordan Kuiper[1], Bruce Lanphear[2], Kim Cecil[3,4], Aimin Chen[5], Yingying Xu[3,4], Kimberly Yolton[3,4], Heidi Kalkwarf[3,4], Joseph Braun[6], Jessie Buckley[1]
[1]Johns Hopkins Bloomberg School of Public Health, Baltimore, USA. [2]Simon Fraser University, Vancouver, Canada. [3]Cincinnati Children's Hospital Medical Center, Cincinnati, USA. [4]University of Cincinnati College of Medicine, Cincinnati, USA. [5]University of Pennsylvania Perelman School of Medicine, Philadelphia, USA. [6]Brown University, Providence, USA

Abstract

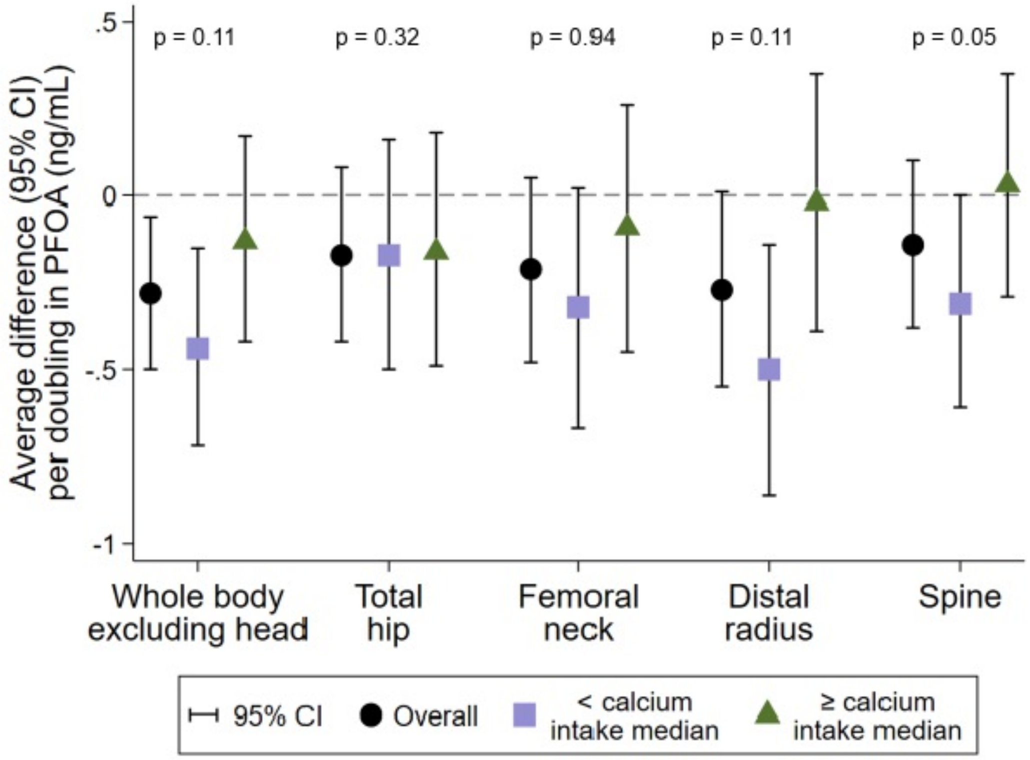
Background: Per- and polyfluoroalkyl substances (PFAS) have been associated with lower bone mineral content (BMC) in adolescents. We examined whether diet or physical activity modify these associations to identify potential interventions.

Methods: We conducted a cross-sectional study of 197 children enrolled in a prospective pregnancy cohort in Cincinnati, OH from 2003-2006. At age 12 years, we measured serum concentrations of perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexanesulfonic acid, and perfluorooctanesulfonic acid (PFOS). We measured calcium intake and Healthy Eating Index (HEI) scores using 24-hour dietary recalls and physical activity using the Physical Activity Questionnaire for Older Children (PAQ-C). We measured BMC with dual x-ray absorptiometry and calculated BMC Z-scores for five skeletal sites. We estimated covariate-adjusted differences in BMC Z-scores per doubling of PFAS concentrations using linear regression. We dichotomized calcium intake, HEI scores, and PAQ-C scores at the median and evaluated effect measure modification (EMM) using interaction terms.

Results: In adjusted models, we found that higher serum PFOA, PFNA, and PFOS concentrations were associated with lower BMC Z-scores at multiple skeletal sites. Each doubling in PFOA was associated with a −0.28 (95% CI: −0.50, −0.06) lower whole body BMC Z-score. We observed stronger adverse associations of PFOA and PFNA with BMC Z-scores among those with calcium intake or HEI scores below the median. The difference in whole body BMC Z-score per doubling in PFOA was −0.44 (95% CI: −0.72, −0.15) among adolescents with calcium intake < median vs −0.13 (95% CI: −0.42, 0.17) among those with calcium intake ≥ median (EMM p-value = 0.11). Similar patterns were shown for distal radius and spine BMC. Associations were not modified by PAQ-C score (all EMM p-values > 0.2).

Conclusion: In this cross-sectional study of adolescents, higher calcium intake and healthier diets mitigated associations of PFOA and PFNA with lower BMC.

Adjusted associations of serum PFOA concentrations with BMC Z−scores at age 12 years, overall and by calcium intake



Difference (95% CI) in BMC Z−score per log2 unit increase in serum PFOA concentrations adjusted for maternal parity, infant breastfeeding, child's sex, and child's 12-year household income, age in months, secondhand smoke exposure, PAQ-C, HEI score, calorie intake, fish intake, vitamin D intake, and dairy intake.

Tuesday PD5

Critical periods of susceptibility in the association of pregnancy phthalate exposure and preterm birth: a pooled study of 16 US cohorts

Alexa Friedman[1], Barrett Welch[2,1], Alexander P. Keil[3], Michael Bloom[4], Joseph Braun[5], Jessie Buckley[6], Dana Dabelea[7], Pam Factor-Litvak[8], John Meeker[9], Karin Michels[10], Vasantha Padmanabhan[9], Anne Starling[11], Kelly K. Ferguson[1], and the Phthalates and Preterm Birth Pooled Study Group[1]
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Abstract

Background/Aims: Phthalate exposure during pregnancy is a risk factor for preterm birth. Phthalate mechanisms of action may depend on the timing of exposure, but few studies have examined critical periods of susceptibility. Using data from a large, pooled study, we investigated trimester-specific associations between nine phthalate metabolites and odds of preterm birth and tested for differences in associations across trimesters.

Methods: Individual-level data were pooled from 16 US cohorts (N=6,045, n=539 preterm). Pregnancy urinary phthalate metabolites were standardized for urine dilution and repeated measurements, if available, were averaged within trimester. We used logistic multiple informant models to estimate trimester-specific associations between a pregnancy-average interquartile range (IQR) increase in phthalate metabolites and odds of preterm birth, and to test for ($p<0.20$) differences in associations across trimesters. Models were adjusted for participant race and ethnicity, age, education, pre-pregnancy body mass index and study cohort.

Results: Associations between phthalate metabolites and preterm birth were greatest in magnitude with measurements from the first and second trimesters, whereas associations later in pregnancy were mostly null. This pattern was most evident for di-2-ethylhexyl phthalate (DEHP) metabolites, where important differences by trimester were observed for all compounds. For example, mono(2-ethyl-5-carboxypentyl) phthalate (MECPP) concentrations in the first (OR= 1.21 [95% CI: 1.09, 1.36]) and second (OR = 1.23 [95% CI: 1.09, 1.38]) trimesters were associated with an increased odds of preterm birth, but there was no association for MECPP concentrations in the third trimester (OR= 1.01 [95% CI: 0.89, 1.15]) (p for difference across trimesters= 0.17).

Conclusions: Preliminary findings suggest differences in the associations between phthalate metabolites and preterm birth by exposure timing. The effect estimates for phthalate metabolites and preterm birth were greatest in magnitude for metabolites assessed in early and mid-pregnancy.

Uncaptioned visual

Tuesday PD5

Relations of Gestational and Childhood Phthalate Mixtures with Adolescent Sleep Characteristics in The HOME Study

Clara Sears[1,2], Jessie Buckley[3], Kim Cecil[4,5,6], Heidi Kalkwarf[5], Bruce Lanphear[7], Yingying Xu[8], Aimin Chen[9], Kimberly Yolton[5,6], Joseph Braun[2]

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Abstract

Background: The biological mechanisms linking early life phthalate exposure with adverse behaviors and cardiometabolic conditions are also instrumental for sleep health, but whether early-life exposure impacts adolescent sleep is unknown.

Objectives: We evaluated whether gestational and childhood phthalate metabolite mixtures were associated with sleep efficiency, fragmentation, and duration during adolescence. We also examined periods of heightened susceptibility to individual phthalates (HOME Study; 2003-2006; n=156).

Methods: We quantified urinary phthalate metabolites during pregnancy (16- and 26-weeks) and childhood (ages 1-, 2-, 3-, 4-, 5-, 8-, and 12-years). Using regression-calibration approaches, we estimated average measurement-error corrected phthalate metabolite concentrations during pregnancy and childhood. At age 12 years, we used wrist-actigraphy to assess sleep characteristics for one-week. Using quantile-based g-computation, we estimated covariate-adjusted differences in adolescent sleep characteristics per quartile increase in all phthalate metabolite concentrations (ψ), and weights indicating the contribution of each metabolite to ψ. Using multiple informant models, we examined whether associations between individual phthalate metabolites and sleep characteristics varied by timing of exposure.

Results: Increasing all gestational phthalate metabolites by a quartile was associated with lower sleep efficiency (ψ =-1.3%; 95%CI=-2.4, -0.3) and higher sleep fragmentation (ψ =1.6%; 95%CI=0.3, 3.0); MnBP and DEHP contributed most to these relations. Higher childhood phthalate metabolite mixture quartiles were associated with shorter sleep duration (ψ =-13 minutes; 95%CI= -26, -1); MEP, MnBP, MBzP, and MCOP contributed most to this association. We found that higher DEHP metabolite concentrations during pregnancy were more strongly related with higher sleep fragmentation than childhood concentrations. In contrast, higher childhood MEP and MnBP concentrations were more strongly associated with shorter sleep duration than pregnancy concentrations.

Discussion: Phthalate metabolite concentrations during pregnancy and childhood were associated with poorer sleep health in adolescence.

Tuesday PD5

Maternal organophosphate esters and sex steroid hormones in mid-pregnancy

Megan Hansel[1], Katherine A. Lubina[1], Pamela Ohman-Strickland[1], Kurunthachalam Kannan[2], Christina Wang[3], Richard K. Miller[4], Thomas O'Connor[4,5], Zorimar Rivera-Núñez[1,6], Emily Barrett[1,4,6]
[1]Department of Biostatistics and Epidemiology, Rutgers School of Public Health, Piscataway, USA. [2]Department of Pediatrics, and Department of Environmental Medicine, New York University, Grossman School of Medicine, New York, USA. [3]Clinical and Translational Science Institute, The Lundquist Institute at Harbor –UCLA Medical Center, Torrance, USA. [4]Department of Obstetrics and Gynecology, University of Rochester Medical Center, Rochester, USA. [5]Departments of Psychiatry, Psychology, Neuroscience, University of Rochester, Rochester, USA. [6]Environmental and Occupational Health Sciences Institute, Rutgers University, Piscataway, USA

Abstract

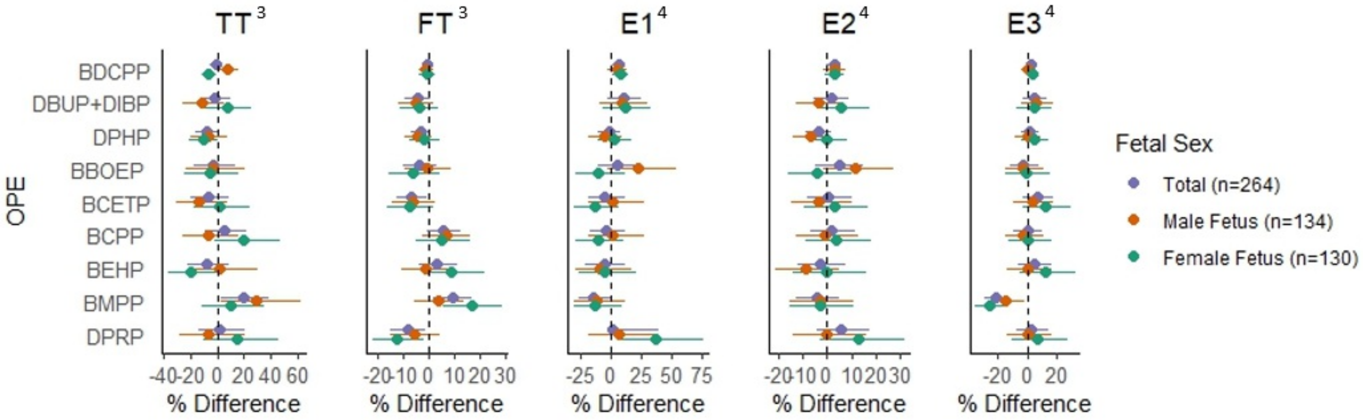
Background/Aims Organophosphate esters (OPEs) are synthetic chemicals used in consumer products as flame retardants and plasticizers. OPEs are hypothesized endocrine disruptors, but little is known about the relationship between gestational OPE exposure and maternal sex steroid hormones in pregnancy.

Methods Understanding Pregnancy Signals and Infant Development (UPSIDE) participants (n=264) provided biospecimens and completed questionnaires in each trimester. In second trimester samples, we measured nine urinary OPE metabolites concentrations using HPLC-MS. We measured sex steroids (serum total testosterone [TT]], estrone [E1], estradiol, and estriol [E3]) using LC/MS-MS, and free testosterone [fT] using equilibrium dialysis. We fit linear regression models examining sex steroid concentrations explained by specific gravity-adjusted OPE metabolites, adjusting for covariates. Three OPE metabolites with >70% detection were log-transformed and considered continuously; six rarer metabolites were dichotomized (above vs. below limit of detection [LOD]). Secondary models were stratified by fetal sex. Results are shown as percent difference (%Δ) in hormone levels.

Results Percent detection of OPEs ranged from 26% to 100%. Bis(1,3-dichloro-2-propyl) phosphate [BDCPP] was present at the highest concentration (median 1.1 ng/mL). Participants with detectable bis(methylphenyl) phosphate [BMPP] had higher TT (%Δ= 19, 95%CI: 2, 39) and fT (%Δ= 9, 95%CI: 2, 17), and lower E3 (%Δ= -21, 95%CI: -29, -13) than participants below the LOD. Participants with detectable concentrations of bis(2-chloroethyl) phosphate [BCETP] (%Δ= -7, 95%CI: -13, -0.5) and dipropyl phosphate [DPRP] (%Δ= -8, 95%CI: -15, -2) had lower fT compared to those below the LOD. A log-unit increase in BDCPP was associated with higher E1 (%Δ= 6, 95%CI: 1, 11). For most hormones, stronger associations were observed in women carrying female fetuses.

Conclusion This preliminary analysis suggests that OPEs may act as endocrine disruptors by altering maternal sex steroid hormones during pregnancy, with some differences observed by fetal sex.

Figure Percent difference in maternal sex steroid hormones[1] in mid-pregnancy associated with organophosphate ester exposure[2] in total cohort and by fetal sex



[1]Sex steroids measured in total testosterone (TT), free testosterone (FT), estrone (E1), estradiol (E2), estriol (E3).
[2]For bis(1,3-dichloro-2-propyl) phosphate (BDCPP), dibutyl phosphate/di-isobutyl phthalate (DBUP+DIBP), and diphenyl phosphate (DPHP), % difference corresponds to a 1 ln-unit increase in continuous OPE concentrations. For bis(2-butoxyethyl) phosphate (BBOEP), bis(2-chloroethyl) phosphate (BCETP), bis(1-chloro-2-propyl) phosphate (BCPP), bis(2-ethylhexyl) phosphate (BEHP), bis(methylphenyl) phosphate (BMPP) and dipropyl phosphate (DPRP), % difference corresponds to detectable vs. non-detectable OPE concentrations.
[3]Adjusted for maternal age, maternal pre-pregnancy body mass index, highest maternal education, maternal race, fetal sex, parity
[4]Adjusted for maternal age, maternal pre-pregnancy body mass index, highest maternal education, maternal race, fetal sex, parity, gestational age at visit, maternal smoking during pregnancy
*Stratified models do not adjust for fetal sex

Tuesday PD5

Per- and polyfluoroalkyl substances (PFAS), gestational weight gain, postpartum weight retention and body composition in the UPSIDE cohort

Carolyn Kinkade[1], Zorimar Rivera-Núñez[1,2], Kurunthachalam Kannan[3], Sally Thurston[4], Susan Groth[5], Thomas O'Connor[6,7], Emily Barrett[1,8,6]

[1]Environmental and Occupational Sciences Institute, Rutgers University, Piscataway, USA. [2]Department of Biostatistics and Epidemiology, Rutgers School of Public Health, Piscataway, USA. [3]Department of Environmental Medicine, Department of Pediatrics, New York University Grossman School of Medicine, New York, USA. [4]Department of Biostatistics and Computational Biology, University of Rochester Medical Center, Rochester, USA. [5]School of Nursing, University of Rochester, Rochester, USA. [6]Obstetrics and Gynecology, University of Rochester Medical Center, Rochester, USA. [7]Psychiatry, University of Rochester, Rochester, USA. [8]Department of Biostatistics and Computational Biology, University of Rochester Medical Center, Piscataway, USA

Abstract

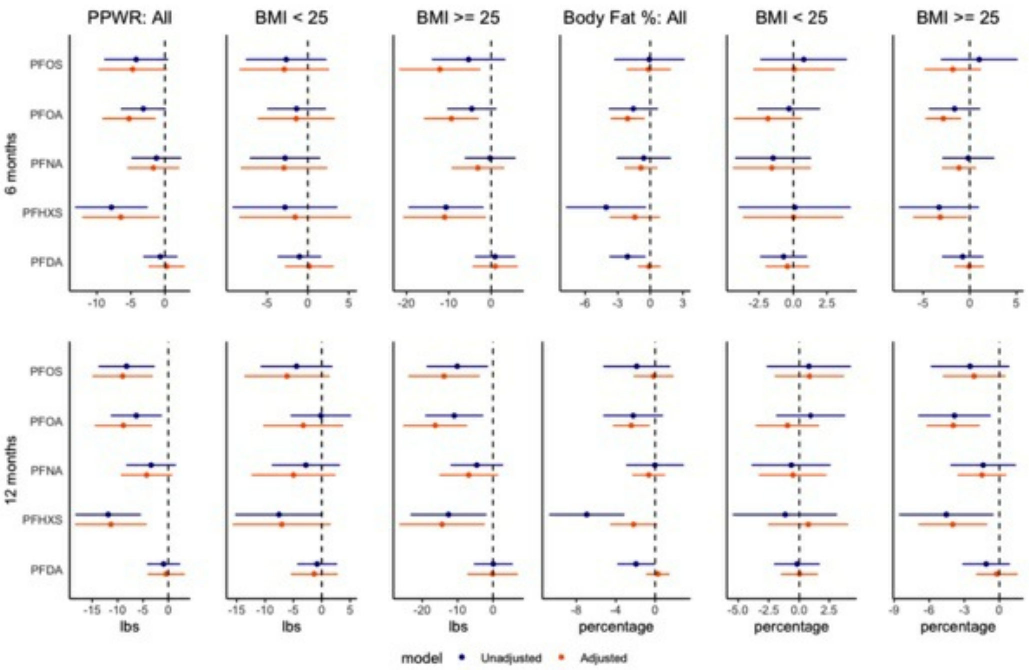
Background/Aims: Per- and polyfluoroalkyl substances (PFAS) are synthetic chemicals found in drinking water and consumer products, resulting in ubiquitous human exposure. PFAS have been linked to endocrine disruption and altered weight gain across the lifespan. Prior research suggests PFAS may impact gestational weight gain (GWG) and postpartum body mass index (BMI), which are important predictors of overall infant and maternal health, respectively.

Methods: In the Understanding Pregnancy Signals and Infant Development (UPSIDE/UPSIDE-MOMs) study (n=243; Rochester, NY), we examined second trimester serum PFAS (PFOS: perfluorooctanesulfonic acid, PFOA: perfluorooctanoic acid, PFNA: perfluorononanoic acid, PFHxS: perfluorohexanesulfonic acid, PFDA: perfluorodecanoic acid) in relation to GWG (lbs) and in the postpartum, weight retention (PPWR (lbs)) and adiposity (measured by bioelectrical impedance, total body fat %). We fit multivariable linear regression models examining these outcomes in relation to log-transformed PFAS in the whole cohort and stratified by maternal pre-pregnancy BMI (< 25 vs. =>25 kg/m2), adjusting for demographics and lifestyle factors (i.e. race/ethnicity, age, energy intake, physical activity, breastfeeding).

Results: PFOA and PFHXS were inversely associated with GWG (ß=-3.41, 95%CI: -6.15, -0.66; ß=-3.50, 95%CI: -7.47, 0.47) and PPWR at 6 and 12 months (PFOA 6m:ß=-5.27, 95%CI: -9.20, -1.35; 12m:ß=-8.86, 95%CI: -14.51, -3.21; PFHXS 6m:ß=-6.48, 95%CI: -12.18, -0.78; 12m:ß=-11.32, 95%CI: -18.38, -4.26). PFOA was additionally associated with lower body fat percentage at 6 and 12 months (6m:ß=-2.09, 95%CI: -3.66, -0.52; 12m:ß=-2.43, 95%CI: -4.30, -0.56) with stronger associations observed in women with higher pre-pregnancy BMI. In that group, PFHXS predicted lower body fat percentage at 6 and 12 months (6m:ß=-3.16, 95%CI: -6.07, -0.26; 12m:ß=-3.98, 95%CI: -6.93, -1.04).

Conclusion: PFOA and PFHXS may alter patterns of GWG and post-partum adiposity with potential implications for fetal development (i.e. growth) and long-term maternal cardiometabolic health.

Figure 1. Multivariable linear regression models† examining log(PFAS) concentrations in relation to post-partum weight retention (PPWR (lbs)) and total body fat percentage at 6 (All: n=117, BMI<25: 65, BMI>=25: 52) and 12 (n=99, BMI<25: 51, BMI>=25: 48) months post-delivery in the UPSIDE cohort.



Abbr: BMI: Body Mass Index (kg/m2); PFDA: perfluorodecanoic acid; PFHxS: perfluorohexanesulfonic acid, PFNA: perfluorononanoic acid; PFOA: perfluorooctanoic acid; PFOS: perfluorooctanesulfonic acid.

† Models adjusted for race/ethnicity, education, maternal age, parity, pre-pregnancy BMI, energy intake (kcal/day at 6m), physical activity (METs/day at 6 or 12 months), gestational age at PFAS sampling, gestational age at delivery, breastfeeding (any/none) and weeks post-partum as covariates.

Tuesday PD5

Exposure to perfluoroalkyl substances, incident Type 2 Diabetes risk and associated metabolic pathway dysregulation in a multiethnic population

Vishal Midya[1], Elena Colicino[1], Dinesh Barupal[1], Chris Gennings[1], Ruth J. F. Loos[2,1], Ryan W. Walker[1], Douglas I. Walker[1], Damaskini Valvi[1]

[1]Icahn School of Medicine at Mount Sinai, New York, USA. [2]University of Copenhagen, Copenhagen, Denmark

Abstract

BACKGROUND: Growing experimental and epidemiological evidence suggests that exposure to perfluoroalkyl substances (PFAS) may cause type 2 diabetes (T2D); however, the effects of PFAS-mixtures and underlying mechanisms are not fully understood. We examined the associations between PFAS-mixture exposure and incident T2D and underlying metabolic pathways.

METHODS: We conducted a nested case-control study within BioMe, an electronic health record-linked biobank of >65,000 patients seeking primary care at Mount Sinai Hospital, New York, since 2007. We selected 180 incident T2D cases (33% African Americans, 33% Hispanics, 33% Whites) that were matched to 180 T2D-free controls by age, sex, and ancestry. The average time between the blood draw and T2D diagnosis was six years among cases. We used liquid-chromatography high-resolution mass spectrometry in prediagnostic plasma to quantify seven PFAS and untargeted metabolomic profiles. We used Weighted Quantile Sum (WQS) regression to evaluate the PFAS-mixture association with incident T2D risk. We analyzed the associations between 650 annotated metabolites and the PFAS-mixture or T2D odds using metabolome-wide association analyses with Hierarchical Bayesian WQS and logistic regression, respectively, adjusting for matching factors and other confounders. Pathway enrichment analyses were performed using Mummichog. We used inverse probability weighting to account for the nested case-control design in PFAS-metabolites analysis.

RESULTS: Each tertile increase in the WQS PFAS-mixture was associated with increased odds of incident T2D (OR[95%CI]=1.31[0.92, 1.87]), with PFOS having the highest contribution to this association. Metabolites associated with the PFAS-mixture and T2D odds ($p<0.05$) were 5-hydroxytryptophan, glucoheptulose, and sulfolithocholylglycine; while associations with sulfolithocholylglycine survived multiple testing correction. Pathways associated with PFAS and T2D were glutamate metabolism, arginine and proline metabolism, and drug metabolism – cytochrome p450.

CONCLUSIONS: Exposure to PFAS mixtures may increase the risk for T2D in multiethnic populations via dysregulations in amino acid biosynthesis and steroid-hormone biosynthesis and metabolism.

Tuesday PD5

Proceedings from a PFAS Conference Workshop

Elizabeth Friedman[1,2], Sherri Homan[3], Andrea Amico[4]
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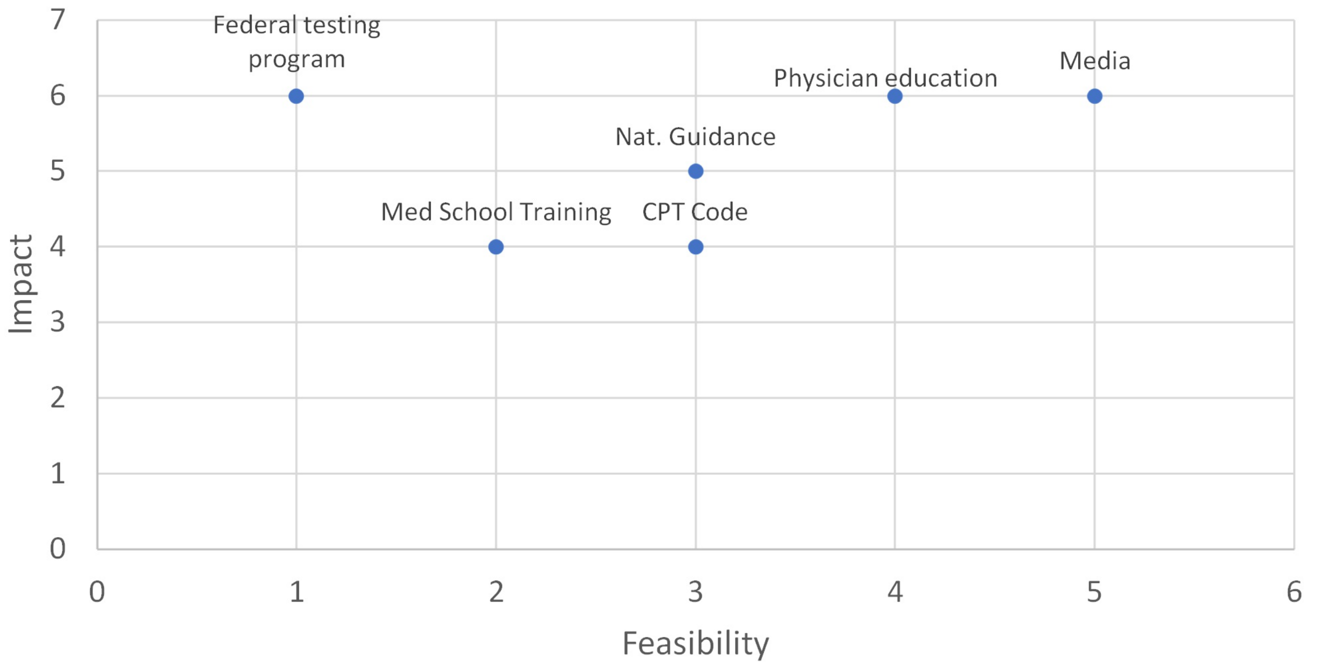
Abstract

PFAS are a chemical group of bio-persistent, human-made chemicals that have become ubiquitous in our environment, a number of which have been found to have harmful effects on human health. The recommendations to approach exposed and unexposed patients with the same clinical practice is being challenged by experts and highly exposed communities around the nation. To address this concern and improve patient access to acceptable healthcare services when addressing PFAS exposure, in June 2022 a data-gathering, participatory workshop was conducted at the Third National PFAS Conference. This workshop provided an opportunity for participants to discuss how to effectively address the health concerns and needs of patients who have had substantial PFAS exposure (i.e., the general public via contaminated drinking water or contaminated food sources, and fire fighters via AFFF foam and turnout gear). Human centered design activities were selected and modified to meet the needs of the facilitator and to accommodate the group size. The workshop was facilitated, and the structured agenda included introductions, a fishbowl activity, and development of thematic concepts from the discussion including common challenges or barriers, strengths and opportunities gleaned from these and other related stories shared at the conference. The attendees of this workshop included health professionals, including physicians and researchers, affected community members and public servants (N = 16). The table below shows the agreed-upon challenges, strengths, and opportunities. A graph showing how the participants rated each opportunity compared to the others in terms of impact and feasibility are presented. This analysis of participant perspectives, knowledge and insights provides a synthesis to drive strategies and patient-centered care now and into the future.

Challenges / Barriers	Strengths	Opportunities
Insurance coverage Limited knowledge among PCPs Confounders Quality testing (for PFAS levels) No concrete guidance(s) Geographic confusion – re: upstream and downstream of pollution sites Source accountability Dose response relationship Immediate vs long term health effects	Patient advocacy Moms Doctors who listen Actively finding solutions Translational research NH insurance coverage Local level collaboration Local media & tag lines Ongoing health studies Interdisciplinary collaboration	Federal testing program CPT code Physician / Clinician education (school, state advisories, medical societies, hospital associations, professional orgs, Film/Hollywood, medical alerts) More ways to test exposure (e.g. breastmilk) Education through media outlets



Tuesday PD6

Short-term exposure to air pollution and infant mortality: a systematic review and meta-analysis

Thomas Luben[1], Adrien Wilkie[2], Alison Krajewski[1], Fanny Njie[3], Kevin Park[3], Sarah Zelasky[3], Kristen Rappazzo[1]
[1]US EPA, RTP, USA. [2]ORISE at US EPA, RTP, USA. [3]ORAU at US EPA, RTP, USA

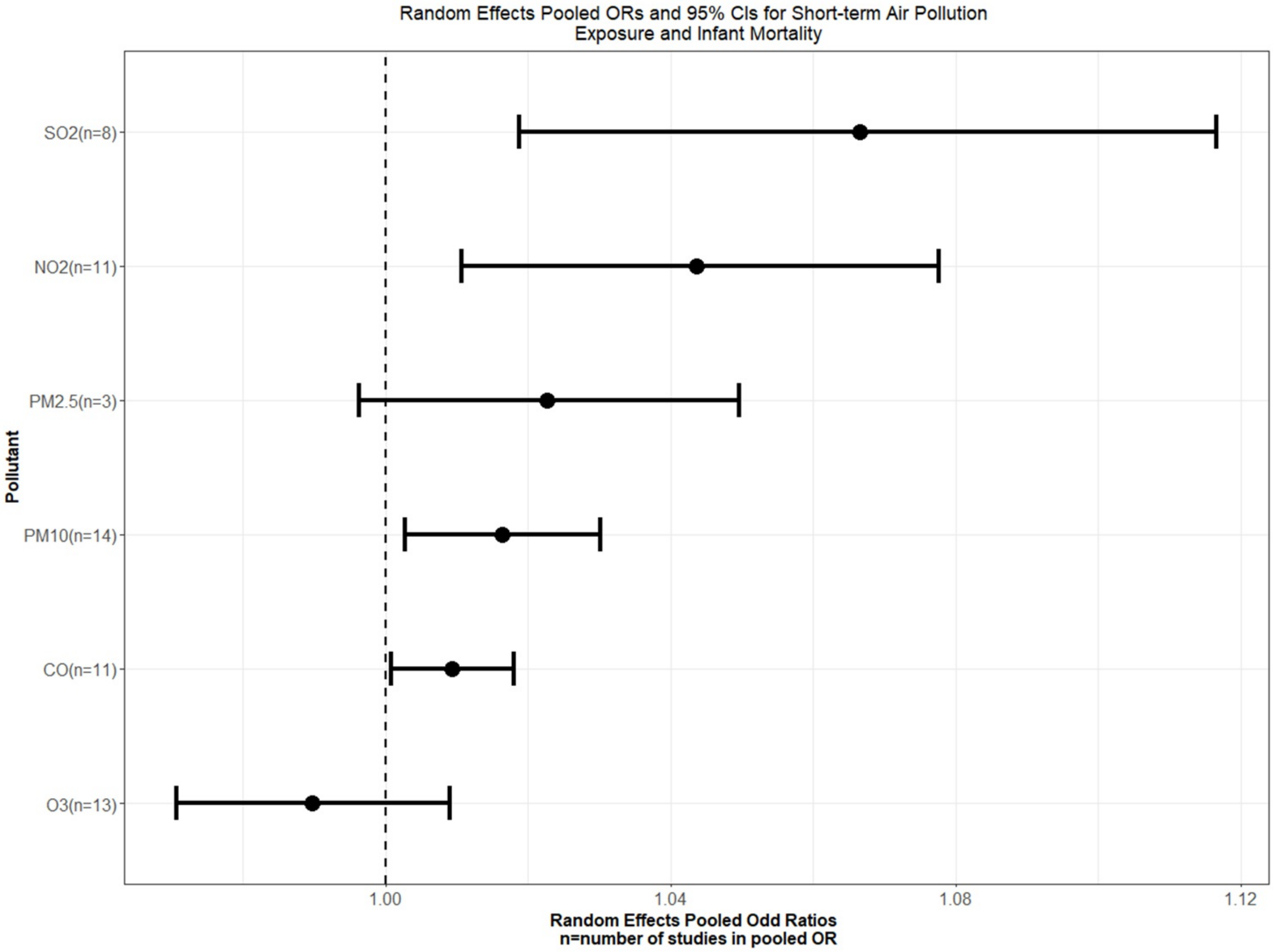
Abstract

Background and Aim: Infant mortality is a widely reported indicator of population health and a leading public health concern. In this systematic review and meta-analysis, we review the available literature for epidemiologic evidence of the association between short-term criteria air pollution exposure and infant mortality.

Methods: Relevant publications were identified through PubMed and Web of Science databases using comprehensive search terms and screened using predefined inclusion/exclusion criteria. We extracted data from included studies and applied a systematic rubric for evaluating study quality across domains including participant selection, outcome, exposure, confounding, analysis, selective reporting, sensitivity, and overall quality. We performed meta-analyses, using both fixed and random effects methods, and estimated pooled odds ratios (ORs) and 95% confidence intervals (95%CI) for criteria pollutants (nitrogen dioxide (NO2), sulfur dioxide (SO2), coarse particulate matter (PM10), fine particulate matter (PM2.5), ozone (O3), carbon monoxide (CO)) and infant mortality, neonatal mortality, or post-neonatal mortality.

Results: Our search returned 549 studies. We excluded 490 studies in the abstract screening phase and an additional 37 studies in the full text screening phase, leaving 22 studies for inclusion. Among these 22 studies, 14 included effect estimates for PM10, 13 for O3, 11 for both NO2 and CO, 8 for SO2, and 3 for PM2.5. The pooled ORs (95%CI) with the greatest magnitudes were for a 10 ppb increase in SO2 or NO2 concentration in the days before death (1.07 [95%CI: 1.02, 1.12], 1.04 [95%CI: 1.01, 1.08], respectively; Figure 1). The pooled ORs for PM10 and PM2.5 were 1.02 (95%CI: 1.00, 1.03) and 1.02 (95%CI: 1.00, 1.03), and the pooled ORs for CO and O3 were 1.01 (95%CI: 1.00, 1.02) and 0.99 (95%CI: 0.97, 1.01).

Conclusions: Increased exposure to SO2, NO2, PM10, PM2.5, or CO is associated with infant mortality across studies. This abstract does not reflect EPA policy.



Random Effects Pooled ORs and 95% CIs for Short-term Air Pollution
Exposure and Infant Mortality
SO2(n=8)
NO2(n=11)
PM2.5(n=3)
PM10(n=14)
CO(n=11)
O3(n=13)
Pollutant
1.00
1.04
1.08
1.12
Random Effects Pooled Odd Ratios
n=number of studies in pooled OR

Tuesday PD6

The effect of weekly prenatal $PM_{2.5}$ exposure on preterm and term birthweight

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Abstract

Background: Previous studies have observed associations between birthweight and prenatal exposure to some air pollutants. However, it is unclear if there are critical windows of susceptibility to air pollution exposure.

Objective: We estimated the difference in birthweight among preterm (gestational age 32-36 weeks), early term (37-38 weeks) and full term (39-42 weeks) infants associated with weekly exposure to $PM_{2.5}$ throughout gestation.

Methods: We included all singleton live births in the Lower Peninsula of Michigan (U.S.) between 2007 and 2012 (n=653,276). Weekly ambient $PM_{2.5}$ concentrations and temperature predictions were estimated on a 1-km grid from publicly available obtained from ensemble-based models. We utilized a distributed lag nonlinear model (DLNM) to estimate the difference in birthweight associated with weekly exposures from the last menstrual period to 32 weeks gestation (preterm birthweight); 37 weeks (early term birthweight); and 39 weeks (full term birthweight).

Results: We observed a negative difference in term birthweight associated with $PM_{2.5}$ exposure. Overall, an interquartile range (IQR) increase in prenatal $PM_{2.5}$ exposure (~5.3 μg/m3) was associated with a -46.1 g (95% CI –73.13 g, -19.15 g) reduction in birthweight among preterm infants; a -18.5 g (95% CI -33.15 g, -3.78 g) reduction in birthweight among early term infants; and a -9.7 g (-18.18 g, -1.15 g) reduction in birthweight among full term infants. Associations of $PM_{2.5}$ with birth weight tended to be larger in the early weeks of gestation (e.g., weeks 1-10) for both term and preterm births.

Conclusion: We observed associations between $PM_{2.5}$ exposure and lower preterm, early term, and term birth weights.

Tuesday PD6

Are associations between gestational exposure of air pollution and preterm birth modified by neighborhood deprivation in a North Carolina birth cohort?

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Abstract

Table 1: Risk Difference (95% Confidence Interval) of Preterm Births by Air Pollutant Stratified by Neighborhood Deprivation Index (NDI) per 10,000 births

	$PM_{2.5}$	NO_2	O_3
First Trimester			
Crude	-7 (-11, -2)	1 (-1, 2)	-1 (-2, 0)
Low NDI	-5 (-13, 3)	-4 (-6, -1)	4 (1, 7)
High NDI	-13 (-19, 7)	-2 (-4, 0)	0 (-2, 2)
Second Trimester			
Crude	-12 (-16, -7)	1 (0, 2)	-2 (-3, -1)
Low NDI	-17 (-25, 9)	-3 (-6, -1)	-2 (-5, 1)
High NDI	-19 (-25, -13)	-2 (-4, 0)	-4 (-6, -1)
Third Trimester			
Crude	3 (-2, 7)	1 (-1, 2)	2 (1, 3)
Low NDI	-4 (-13, 6)	-2 (-4, 1)	1 (-3, 5)
High NDI	1 (-6, 8)	0 (-2, 2)	5 (2, 7)

Background/Aims

Exposure to air pollutants is associated with preterm birth (PTB, <37 weeks completed gestation); however, there is limited research on whether these associations are modified by neighborhood-level risk factors. We evaluated whether associations between gestational exposure to fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and ozone (O_3) and PTB were modified by neighborhood deprivation in a North Carolina birth cohort from 2011-2015.

Methods

Modeled daily $PM_{2.5}$, NO_2, and O_3 concentrations were aggregated to census tract, linked to residential address at delivery, and averaged across each trimester of pregnancy. The Neighborhood Deprivation Index (NDI) was created using principal component analysis with census variables representing income/poverty, education, employment, housing, and occupation; with NDI dichotomized into high and low deprivation areas. Modified Poisson regression models were used to estimate risk differences (RDs) per 10,000 births stratified by NDI categories, adjusted for gestational parent marital status, race/ethnicity, age at delivery, Medicaid status, and month of conception.

Results

Of the 543,086 births, 7.7% were PTB. The daily median (IQR) concentration was 9.1 (1.2) µg/m^3 for $PM_{2.5}$, 14.0 (7.4) ppb for NO_2, and 40.4 (4.2) ppb for O_3. The RDs for $PM_{2.5}$ and NO_2 and PTB were generally null and did not show evidence of modification. The O_3 RDs per 10,000 births were small but there was some evidence of separation for first [4 (1,7) and 0 (-2, 2) in low and high NDI, respectively] and third [1 (-3, 5) and 5 (2, 7)] trimesters across strata.

Conclusion

Associations with air pollutant exposure and PTB were generally null across trimesters, but there was some evidence of effect modification by NDI with first and third trimester O_3 exposures. While changes were small, it is important to consider social context of environmental exposures.

Tuesday PD6

Exposure to air pollution during fetal development and early infancy is associated with altered reproductive development at birth and age 1.

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Abstract

Introduction: Air pollution may be a developmental endocrine disruptor. In animal models, gestational and perinatal air pollution alters anogenital distance (AGD), a marker of prenatal androgen activity, in both sexes; little is known in humans. We examined exposure to fine particulate matter (PM2.5) and nitrogen dioxide (NO2) in relation to AGD at birth and age one, focusing on exposures during critical windows of reproductive development: the male programming window (MPW; gestational weeks 8-14) and mini-puberty (postnatal days 30-90).

Methods: TIDES recruited first trimester pregnant women (n=738). At birth, we measured anus to clitoris(AGD-AC) and anus to fourchette(AGD-AF) in females; in males, we measured anus to penis(AGD-AP) and anus to scrotum(AGD-AS) at birth and age 1. Using advanced spatiotemporal models, we estimated maternal exposure to PM2.5 and NO2 in the MPW and mini-puberty, and in each trimester. Covariate-adjusted, sex-stratified linear regression models examined associations between PM2.5 and NO2 and AGD. Results are presented as changes associated with interquartile increases in exposure.

Results: In males, PM2.5 exposure during the MPW was associated with shorter AGD-AP at birth (β=-1.00mm, 95%CI:-1.78,-0.21); no associations with NO2 exposure were observed. Mini-pubertal PM2.5 exposure was also associated with shorter male AGD-AP (β=-1.14mm, 95%CI:-2.03,-0.24) at age one. PM2.5 and NO2 in various prenatal windows were associated with longer and shorter male AGD at age one, respectively. In females, third trimester PM2.5 was associated with longer AGD-AF (β=0.52mm, 95%CI:0.15,0.89). NO2 exposures in the MPW, first, and third trimesters were associated with longer AGD measures at birth in females.

Discussion: PM2.5 during critical windows was associated with shorter, less androgenized AGD in males. In females, PM2.5 and NO2 were associated with longer, more androgenized AGD. Air pollution may disrupt reproductive development during critical gestational and postnatal windows. Research is needed to confirm results and clarify mechanisms.

Tuesday PD6

Robust relationship between ambient air pollution and infant mortality in India

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Abstract

Background: Ambient exposure to fine particulate matter (PM2.5) is one of the top global health concerns. We estimate the associations between in-utero and perinatal exposure to PM2.5 and infant, neonatal and postneonatal mortality in India. We evaluate the sensitivity of this association to two widely-used exposure assessments.

Method: We linked nationally representative anthropometric data from India’s 2015-2016 Demographic and Health Survey (n= 259,627 children under five across 640 districts of India) with satellite-based PM2.5 concentrations during the month of birth of each child. We then estimated the associations between PM2.5 from each dataset and child mortality, after controlling for child, mother and household factors including trends in time and seasonality. We examined if factors: urban/rural, sex, wealth quintile and state modified the associations derived from the two datasets using Wald tests.

Results: We found evidence that PM2.5 impacts infant mortality primarily through neonatal mortality. The estimated association between neonatal mortality and PM2.5 in trimester 3 was OR: 1.016 (95% CI: 1.003, 1.030) for every 10 μg/m3 increase in exposure. This association was robust to the exposure assessment used. Child sex was a significant effect modifier, with PM2.5 impacting mortality in infant girls more than boys.

Conclusions: Our results revealed a robust association between ambient exposure to PM2.5 in the latter period of pregnancy and early life with infant and neonatal mortality in India. Urgent air pollution management plans are needed to improve infant mortality in India.

Tuesday PD6

Exploring Associations Between Phthalate Environmental Reproductive Health Literacy (PERHL) Scale Score, Biomarkers of Exposure, and Birth Outcomes: Results of a Pilot Study

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Abstract

Background: Perinatal phthalate exposure is associated with adverse health outcomes. Environmental health literacy (EHL) provides opportunity to reduce phthalate exposure by understanding how environmental information relates to behaviors. Methods: We explored whether Phthalate Environmental Reproductive Health Literacy (PERHL) Scale scores (31-items on a likert scale with a sum range: 6-30, higher score indicating higher EHL) and subscales (general phthalate knowledge, awareness of phthalate exposure route, protective behavior/risk control, and understanding of phthalate reproductive health impacts) were associated with phthalate metabolite concentrations (n=42) and birth outcomes (n=27). Participants were members of the Environmental Reproductive and Glucose Outcomes who gave birth in the last 5 years. Urine samples were collected 4 years prior to scale completion. Phthalate summary measures were calculated via the molar sums and log-transforming three metabolite groups: 1) ∑butyl-phthalate metabolites (i.e., MBP, MBzP, MiBP), 2) ∑PCP-associated phthalate metabolites (i.e., MBP, MEP, MiBP), and 3) ∑DEHP metabolites (i.e., MEHP, MEOHP, MECPP). We used linear regression for all metabolite models, adjusting for maternal age, race/ethnicity, and education. We explored whether mothers' PERHL scores were associated with birthing infants who were small for gestational age (SGA) vs. large for gestational age (LGA) via t-tests. Results: A one-point increase in the overall PERHL score was associated with decreased metabolite concentrations: 9.7% in ∑butyl (95%CI: -18.33%, -0.11%), and 7.1 % in ∑DEHP (95%CI: -15.03. 1.42%). A one-point increase in phthalate exposure awareness was associated with decreased metabolite concentrations: 31.4% in ∑butyl (95% CI: -55.5, 5.6), and 28% in ∑DEHP (95% CI: -50.9, 3.3). Mothers with SGA infants had lower scores on the awareness of phthalate exposure pathway than those with LGA infants (p = 0.036). Conclusion: Higher PERHL score was associated with lower phthalate metabolite concentrations, which may have implications for future EHL interventions to reduce phthalate exposure and improve associated health outcomes.

Wednesday LT1

Cumulative disaster exposure and hypertension among mothers who survived Hurricane Katrina

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Abstract

Background: Cumulative exposure to multiple weather-related disasters has been linked to mental health symptoms, but less is known about its association with physical health outcomes. More generally, few studies explore hypertension following multiple traumatic exposures.

Methods: To address this gap, we used data from the Resilience in Survivors of Katrina (RISK) Project, a longitudinal cohort of primarily Black, low-income mothers who experienced Hurricane Katrina in 2005. We focused on 505 mothers who were not diagnosed with hypertension prior to Katrina, but provided a hypertension diagnosis response in at least one of subsequent surveys over the next 12 years. Participants had experienced up to 7 hurricanes following Katrina.

Results: Approximately 80% of participants had only experienced Katrina, 13% had experienced Katrina and one other hurricane, and 7% had experienced 3 or more hurricanes. About 34% had been diagnosed with hypertension following Katrina. In an unadjusted logistic regression model, experiencing 2 hurricanes was associated with 1.62 times the odds of developing hypertension (95% CI: 1.02-2.58) and experiencing 3 or more hurricanes was associated with 1.88 times the odds of hypertension (95% CI: 1.04-3.37). Adjusting for race, age, marital status, BMI, self-rated health, number of Katrina traumas experienced, and psychological distress, experiencing 2 hurricanes was associated with 1.61 times the odds of hypertension (95% CI: 1.01-2.63) and experiencing 3 or more hurricanes was associated with 1.87 times the odds of hypertension (95% CI: 1.01-3.47).

Conclusion: These findings provide novel evidence that cumulative disaster exposure is associated with adverse physical health consequences and indicate a need for continued physical health care for individuals in disaster-prone areas.

Wednesday LT1

Wildfire exposure during pregnancy and adverse perinatal, obstetric, non-specific morbidity, and mortality outcomes: a systematic review and meta-analysis

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Abstract

Background/Aims: Climate change has led to severe environmental degradation, including the increased frequency, duration, and intensity of wildfires worldwide. The authors of a previous systematic review reported that maternal exposure to wildfire during pregnancy is associated with reduced birthweight and preterm birth. We performed an updated systematic review to evaluate the association between maternal exposure to wildfire during pregnancy and risk of adverse perinatal, obstetric, non-specific morbidity, and mortality outcomes.

Methods: We systematically searched eight electronic databases for articles indexed through November 2022 that evaluated the association between wildfire exposure during pregnancy and adverse outcomes. Titles, abstracts, and full-texts were independently screened by two independent reviewers. Data extraction and risk of bias assessment will be performed by two independent reviewers. The studies will be assessed using the National Toxicology Program's Office of Health Assessment and Translation risk of bias tool. If possible, a meta-analysis will be performed.

Results: The search yielded 13,284 records, of which 23 met the inclusion criteria. The identified articles revealed a paucity of studies evaluating the impact of wildfire exposure during pregnancy. Studies originated in North America (n = 10), South America (n = 5), Asia (n = 3), and Australia (n = 3), and two were multi-country studies. Studies examined perinatal, obstetric and non-specific morbidity, and mortality outcomes. The most common outcomes include birthweight (n = 9), low birthweight (n = 8), and preterm birth (n = 6).

Conclusion: Preliminary findings indicate that current epidemiological evidence suggests that maternal exposure to wildfires during pregnancy is associated with a higher risk of low birthweight and preterm birth. Once completed, our systematic review will inform scientists and decision makers regarding the health impacts of wildfire exposure during pregnancy.

Wednesday LT1

Gestational and postnatal exposure to wildfire smoke and prolonged use of respiratory medications in early life

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Abstract

Objective: Examine the association of gestational and postnatal exposure to wildfire smoke on prolonged use of prescription medication for respiratory conditions in early life.

Methods: We used MarketScan claims data to create cohorts of term children born in western United States between Jan 1, 2010 and Dec 31, 2014 who were included for at least one year or at least three years after three exposure periods. Exposure periods were gestational (280-197[T1], 196-99[T2], and 98-1[T3] days before birth) and postnatal periods (1-84[PN1] and 85-168[PN2] days post birth). Using the NOAA Hazard Mapping System at the Metropolitan Statistical Area (MSA) level, wildfire smoke exposure was quantified as average weekly number of smoke days within each exposure period, based on residential MSA at birth. Prolonged use (≥30 days; PU) of respiratory medications was assigned based on indication (upper respiratory, lower respiratory, any respiratory conditions) with additional assessment for multiple prolonged uses (2+ prolonged uses; MPU). We used logistic regression models with random intercepts for MSAs adjusted for child sex, birth season, and birth year to estimate odds ratios (OR) and associated 95% confidence intervals (CI) for PU and MPU per 1-day increase in average weekly smoke days exposure. We used likelihood ratio tests (LRT) to examine sex-specific associations.

Results: Smoke exposure during PN1 was positively associated with MPUs of any medications, as well as lower respiratory medications in both 1-yr and 3-yr cohorts. Notably, in the 3-yr cohort there were sex specific associations between PN1 exposure and PU of any respiratory medication (LRT $p = 0.02$), with females exhibiting a more positive response than males (female OR: 1.04 (95%CI 0.88, 1.23); male OR: 0.88 (95%CI 0.76, 1.02)).

Conclusion: We observed associations between gestational and postnatal smoke exposure and MPU of respiratory medications, differential on exposure period and sex.

Wednesday LT1

Polybrominated diphenyl ethers and gestational weight gain: A multi-center prospective cohort study of U.S. women

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Abstract

Background: Polybrominated diphenyl ethers (PBDEs) are chemicals that were used as flame retardants in the U.S. Studies show mixed evidence for the associations of PBDEs with birth weight and childhood adiposity. However, there are few studies of PBDEs and gestational weight gain (GWG).

Methods: We utilized data from 2052 women without obesity and 397 women with obesity from the NICHD Fetal Growth Studies – Singleton Cohort, with first trimester plasma PBDE concentrations and weight measurements throughout pregnancy. We applied generalized linear models and dimension reduction approaches including principal component (PC) analysis to evaluate the individual and joint associations of PBDEs with various measures of GWG, adjusting for confounders.

Results: Mean pre-pregnancy BMIs were 23.6 and 34.5 kg/m^2 for women without and with obesity, respectively. Among women without obesity, there were no associations of PBDEs with total GWG or total GWG velocity. However, a 1-standard deviation (SD) increase in log-transformed ΣPBDEs was associated with a 0.04 kg/week lower first-trimester GWG velocity (95% CI: -0.08, -0.01). Among women with obesity, a 1-SD increase in log-transformed PBDE 47 was associated with a 1.87 kg higher total GWG (95% CI: 0.39, 3.35), and a 1-SD increase in log-transformed PBDE 100 was associated with 3.33-fold higher odds of adequate GWG (95% CI: 1.15, 9.09) compared to inadequate GWG (classified based on the 2009 IOM guideline). Similar associations were found between co-exposure to PBDEs 47, 99, and 100 represented by PC scores and higher total GWG and GWG velocity among women with obesity.

Conclusion: PBDEs, specifically PBDE 47, 99 and 100, were associated with higher total GWG and GWG velocity measures among women with obesity, while PBDEs were associated with lower first-trimester GWG velocity among women without obesity. Though further validation is needed, PBDEs could be a modifiable factor for maintaining optimal weight gain during pregnancy.

Wednesday LT1

Early-pregnancy associations between consumer product chemicals and upstream inflammatory pathways

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Abstract

Background/Aims. Maternal exposure to consumer product chemicals may increase susceptibility to pregnancy disorders by dysregulating inflammation. However, existing evidence is unlikely to provide actionable evidence due to reliance on downstream and non-causal inflammatory markers. Oxylipins are upstream drivers of inflammation and are responsive to therapeutic intervention. Using a large early-pregnancy cohort, we aimed to determine preliminary associations between oxylipins and exposure biomarkers of phthalates, replacements of phthalates, and phenols.

Methods. Data come from 900 pregnant women within the LIFECODES Fetal Growth Study. Maternal plasma and urine were collected in early pregnancy (median: 11 weeks gestation). Plasma and urine were analyzed for 66 oxylipins. Urine was analyzed for 12 phthalate and 4 replacement metabolites, and 12 phenols. Associations were estimated using multivariate linear regression and significant associations after Bonferroni-correction were visualized with chord diagrams organized by chemical class and biosynthetic pathway. Pathways were defined by fatty acid precursor and enzyme pathway.

Results. Overall, several phthalate and phthalate alternative metabolites were associated with oxylipins with variation based on biosynthetic pathway of the production (**Figure**). In corrected models, no associations were observed for phenols. Several phthalates were positively associated with the oxylipin tetranor-PGE1, a metabolite of prostaglandins E1 and E2 produced by cyclooxygenase enzymes in response to inflammation. For example, a doubling in mono-isobutyl phthalate (MIBP) was associated with a 13% increase (95% CI: 7%, 18%) in urinary tetranor-PGE1. Additionally, monobenzyl phthalate (MBzP) was associated with 12% lower (95% CI: -19%, -5%) in 17-hydroxy-docosahexanoic acid (17-HDHA), an oxylipin produced from a separate pathway that promotes the resolution of inflammation.

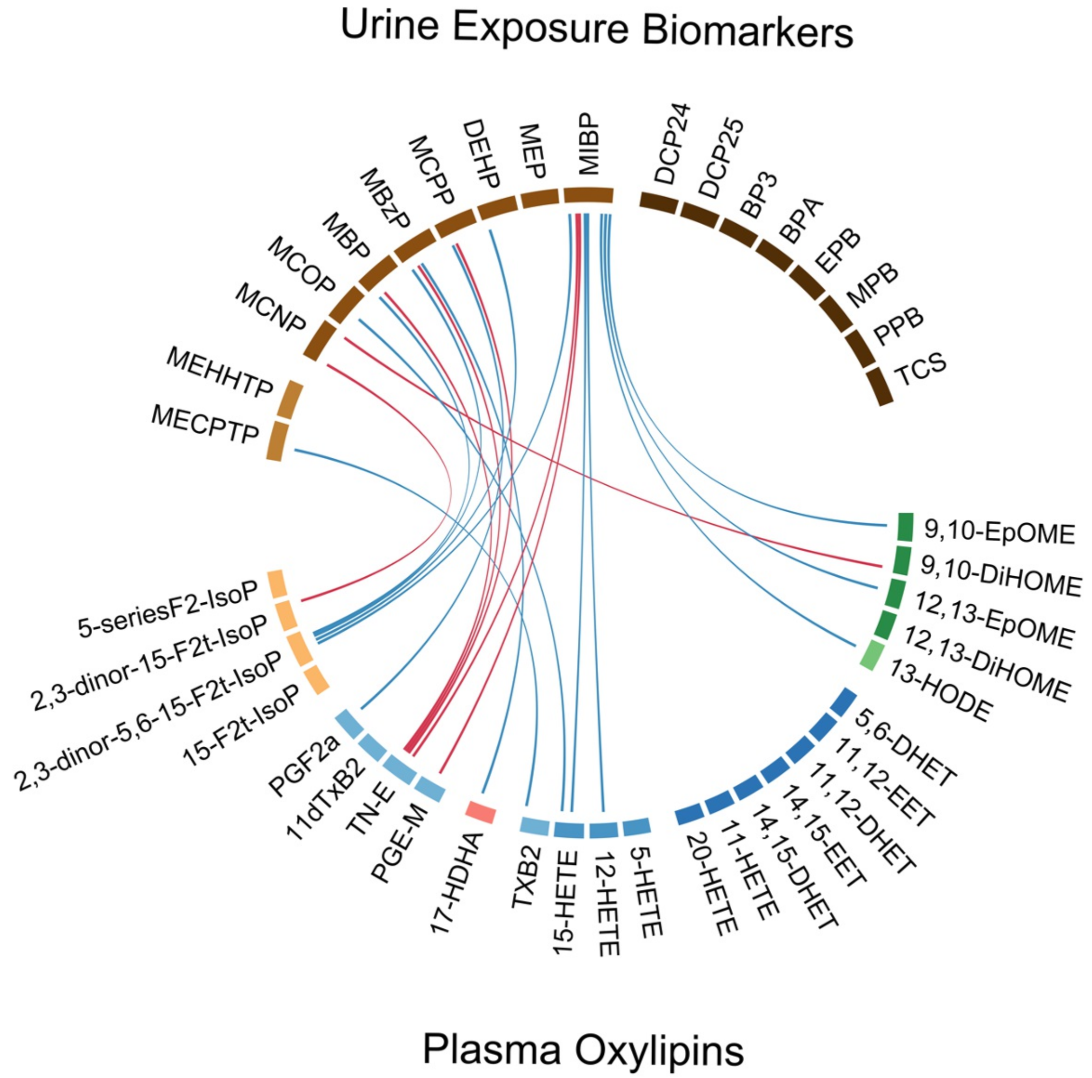

Figure. Cross-sectional associations between individual urinary biomarkers of consumer product chemicals and plasma or urinary oxylipins in early pregnancy. Red and blue connections in the chord diagram represent statistically significant positive and negative associations after Bonferroni-correction, respectively. Colored boxes for individual analytes represent different oxylipin biosynthetic pathways (bottom) or chemical classes (top).

Conclusion. We observed that exposure to several phthalate and phthalate replacements in early pregnancy were associated with eicosanoids involved with both pro-inflammatory and pro-resolving effects. These preliminary results provide evidence that exposure to these chemicals may have impacts on upstream drivers of inflammation.

Wednesday LT1

Transplacental transfer of cobalt: Evidence from a study of mothers and their neonates in the African Copperbelt

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Abstract

Transfer of the trace metal cobalt (Co) from mother to fetus has not been documented in populations with high environmental exposure to Co, as is the case in the African Copperbelt mining region.

We analyzed data obtained from 246 mother-infant pairs included (at delivery) in a previously published case-control study on birth defects, done in Lubumbashi (Democratic Republic of Congo) between March 1, 2013, and Feb 28, 2015. Co was measured by Inductively Coupled Plasma Mass Spectrometry in maternal blood, maternal urine, umbilical cord blood, and placental tissue, as available. The Co concentrations [geometric mean (GM) with interquartile range (IQR)] in maternal blood (GM 1.77 µg/L, IQR 1.07-2.93) and urine (GM 7.42 µg/g creatinine, IQR 4.41-11.0) were highly correlated (Spearman r=0.71, n=166; p<0.001) and considerably higher than reference values determined for general populations elsewhere in the world. The concentrations of Co in umbilical cord blood (GM 2.41 µg/L) were higher (Wilcoxon test, p<0.001) than in maternal blood (GM 1.76 µg/L), resulting in a GM ratio of 1.37, with a correlation between both values (Spearman r=0.34; n=127, p<0.001). Co concentrations in placental tissue (geometric mean 0.02 µg/g wet weight) correlated with concentrations in maternal blood (Spearman r=0.50, n=86, p<0.001) and in neonatal blood (Spearman r=0.23, n=83, p=0.039). This first study of maternal and neonatal Co concentrations in the African Copperbelt provides strong evidence of a high transfer of Co from mother to fetus.

Wednesday LT1

Effects of prenatal exposure to $PM_{2.5}$ chemical components on adverse birth outcomes and under-5 mortality in South Korea

Garam Byun, Michelle Bell
Yale University, New Haven, USA

Abstract

Background/Aims:

Exposure to fine particulate matter ($PM_{2.5}$) during pregnancy has been linked with increased risk of adverse birth outcomes, which can have negative effects on health throughout the lifespan. However, limited and inconclusive evidence exists on the effects of specific $PM_{2.5}$ components. The aim of this study was to investigate the association of prenatal exposure to $PM_{2.5}$ and its components with birth outcomes and under-five mortality in four metropolitan cities in South Korea.

Methods:

We obtained data linking birth records from 2013-2015 to death records under the age of 5 from Statistic Korea. Hourly measurements of $PM_{2.5}$ and its components were collected from four monitoring stations. We calculated exposure to $PM_{2.5}$ and 18 of its components during pregnancy and each trimester for a total of 336,709 births. Logistic regression was used to estimate the associations between exposure and low birth weight (LBW, < 2.5kg), preterm birth (<37 weeks), small for gestational age (SGA, birth weight <10th percentile for the same gestational age), and under-five mortality.

Results:

The preliminary results showed that an interquartile range (13.6 μg/m^3) increase in exposure to $PM_{2.5}$ during the third trimester was positively associated with increased risk of LBW (Odds Ratio, OR: 1.08; 95% Confidence Interval, CI: 1.01 to 1.16), SGA (OR: 1.04; 95% CI: 0.99 to 1.09), and under-five mortality (OR: 1.27; 95% CI: 0.99 to 1.63). Among the 18 $PM_{2.5}$ components, organic carbon and elemental carbon showed higher effect estimates for LBW, while ionic components including sulfate and nitrate had higher associations with SGA.

Conclusion:

This study provides suggestive evidence of the adverse effects of $PM_{2.5}$ and its components on birth outcomes and child mortality in metropolitan areas of South Korea. The specific components may have varying effects on different birth outcomes.

Wednesday LT2

Association between ambient wildfire smoke $PM_{2.5}$ and cause-specific mortality in the contiguous U.S.

Yiqun Ma[1], Emma Zang[2], Yuan Lu[3], Harlan Krumholz[3], Michelle Bell[4], Kai Chen[1]
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Abstract

Background:

Although growing evidence supports an association of wildfire smoke with mortality of all causes, cardiovascular, and respiratory diseases, evidence for other specific causes is limited. Specifically, it is unclear whether wildfire smoke would increase mental and external causes of mortality. This study aims to investigate the association between monthly ambient wildfire smoke $PM_{2.5}$ concentration and cause-specific mortality in all 3,108 counties in the contiguous U.S., 2006–2016.

Methods:

Monthly mortality counts for all causes, non-accidental causes, cardiovascular diseases, respiratory diseases, mental disorders, and external causes were collected from National Center for Health Statistics. Monthly county-level population-weighted average concentration of wildfire-driven $PM_{2.5}$ was derived from a 10×10 km^2 resolution spatiotemporal model. We applied two-way fixed effects models to estimate the association between smoke $PM_{2.5}$ concentration and cause-specific mortality, controlling for non-smoke $PM_{2.5}$, air temperature, and unmeasured spatial and temporal confounders. In subgroup analyses, we compared the smoke $PM_{2.5}$-related mortality risks by sex, age, and race/ethnicity.

Results:

A total of 27,812,837 deaths were included in the study. All counties have been exposed to wildfire smoke $PM_{2.5}$ in our study period. The estimated relative risks of mortality associated with each 10 $\mu g/m^3$ increase in current-month smoke $PM_{2.5}$ were 1.014 (95% confidence interval [CI]: 1.011, 1.017) for all-cause-mortality, 1.011 (95% CI: 1.008, 1.014) for non-accidental mortality, 1.013 (95% CI: 1.008, 1.018) for cardiovascular mortality, 1.016 (95% CI: 1.007, 1.026) for respiratory mortality, 1.113 (95% CI: 1.097, 1.130) for mental disorder mortality, and 1.056 (95% CI: 1.046, 1.066) for external mortality. Among subgroups, we found males, younger people (0 to 65 years old), and Black and Hispanic people are particularly vulnerable.

Conclusion:

Exposure to wildfire smoke $PM_{2.5}$ was associated with increased mortality risk of various causes, particularly mental disorders and external causes. Intervention-focused policies are needed to protect population health from wildfires.

Wednesday LT2

Development of a community-centered tool for assessing health impacts of intersecting climate hazards, wildfire smoke exposure, and social disparities in Alaskan communities

Micah Hahn
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Abstract

Background: Increasing exposure to wildfire smoke is a major issue in Alaska, alongside a number of intersecting climate-related hazards. In addition, the lack of roads, major gaps in water and sanitation infrastructure, reliance on wild foods, and high rates of chronic disease impact the sensitivity of Alaskan communities to these cumulative hazards, with disproportionate impacts experienced by Alaska Native people. Although Alaska is a frontline state for climate change, major data disparities prevent vulnerable Alaskan communities from developing the most effective adaptation plans, particularly in rural tribal communities. Our overall objective is to co-develop community-centered tools for assessing the complex interrelated challenges of increasing exposure to wildfire smoke in the context of additional climate stressors and existing social vulnerabilities that fill existing data gaps.

Methods: We will use a purposeful, co-development process that engages academic researchers, state, tribal, wildfire management, and public health entities, and community liaisons to envision, develop, and test locally-relevant and practical tools for climate adaptation. Specifically, the primary online tool will enable access to state-of-the art climate projections and health and social vulnerability data in a useful and understandable way that allows communities to assess compounding climate hazards and social vulnerabilities.

Results: We are in the early stages of this project and have completed the first of several co-development workshops. This presentation will focus on our methods for identifying state and community liaisons and our process for collaboratively developing the online tool. We will also share the results of our first group workshop.

Conclusions: Through this work, we expect to identify the major contributing factors to vulnerability to wildfire smoke exposure from the perspective of tribal, public health, and wildfire management stakeholders. Additionally, we will learn from the successes and limitations of our co-development process in order to inform best practices for community-engaged research.

Wednesday LT2

Wildfire PM2.5 exposure and infant mortality in California 2006-2015

Heather McBrien[1], Dan Malinsky[2], Tim Bruckner[3], Marianthi-Anna Kioumourtzoglou[1], Tarik Benmarhnia[4], Joan Casey[1]
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Abstract

Background: Climate change-induced wildfires expose 70% of the US population to smoke fine particulate matter (PM2.5) annually. Acute and chronic systemic inflammation, DNA damage, and methylation from this exposure may mediate a previously undescribed relationship between wildfire PM2.5 exposure and infant mortality. Here, we evaluate this relationship while considering race and poverty as effect modifiers.

Methods: We identified 5.2 million live births in California from 2006-2015 from individual-level vital statistics data, and linked all infant deaths (0.5%). We linked county of residence to average daily wildfire generated PM2.5 concentrations (based on 1-km resolution estimate) in the months following birth. We used a Directed Acyclic Graph to describe causal relationships between wildfire PM2.5 exposure and county-level SES variables, individual maternal characteristics, individual birth characteristics, and infant mortality, and Cox proportional hazards regression and a graph-generated adjustment set to estimate the association between wildfire PM2.5 exposure and infant death. In preliminary analyses, we tested for effect modification by census-measured area-level poverty and structural racism, using index of concentration at the extremes (ICE), a measure of race-based wealth inequality.

Results: Preliminary results showed a 10 g/m3 increase in county-level wildfire PM2.5 concentration after birth was associated with lower risk of infant death (HR = 0.95, 95% CI: 0.93 0.97). There was no evidence of effect modification by ICE, however, a 10 g/m3 increase in wildfire PM2.5 was associated with higher risk of infant death for families living in counties with higher levels of poverty (HR for interaction = 1.18, 95% CI: 1.03, 1.45). In future analyses, we will use address-level data and examine effect modification by individual-level race and SES.

Conclusion: Infants living in areas with high poverty may be at higher risk of death after wildfire PM2.5 exposure. Health care availability or differences in ultimate smoke exposure may explain these associations.

Figure: https://math.mit.edu/~caldermf/wildfire_smoke_gif.mp4

Wednesday LT2

Wildfire Disasters in California from 2000-2019

Benjamin Steiger[1], Milo Gordon[1], Alexander Northrop[1], Heather McBrien[1], Brittany Shea[1], Gabriella Meltzer[1], Neil Singh Bedi[2,3], Tarik Benmarhnia[4], Francesca Dominici[5], Danielle Braun[5], Joan Casey[1]
[1]Department of Environmental Health Sciences, Columbia University Mailman School of Public Health, New York, USA. [2]Boston University Medical Campus, Boston, USA. [3]CrisisReady, Harvard University & DirectRelief, Boston, USA. [4]Department of Epidemiology, University of California San Diego Herbert Wertheim School of Public Health, La Jolla, USA. [5]Department of Biostatistics, Harvard T. H. Chan School of Public Health, Boston, USA

Abstract

Background/Aims:

Wildfires are a widespread and expanding threat to public health. Previous studies have evaluated links between wildfire particulate matter exposure and adverse health outcomes. Few large-scale studies have considered other disaster-related health risks from wildfire exposure (e.g., stress or financial loss), largely due to a lack of state or national datasets that catalogue wildfire disaster location, size, and ignition and containment dates. We created such a wildfire disaster dataset in California spanning 2000-2019.

Methods:

We defined wildfire disasters as those that: 1) caused ≥ 1 civilian fatality; 2) destroyed ≥ 1 building structure; or 3) received a Fire Management Assistance (FM) declaration from the Federal Emergency Management Agency (FEMA) and overlapped a community, a location with ≥ 250 people per square mile. We assembled and harmonized wildfire fatality and structure destruction data from California Department of Forestry and Fire Protection (CAL FIRE) and disaster declaration summaries from FEMA. We matched these wildfires by name and year to GIS perimeter data from CAL FIRE's Fire and Resource Assessment Program (FRAP) and the Geospatial Multi-Agency Coordination Group (GeoMAC). When applicable, we aggregated wildfires that comprised a complex.

Results:

From 2000-2019 in California, a total of 417 unique wildfire incidents and complexes met our disaster criteria. Of these wildfires, 24 (5.8%) fires caused ≥ 1 civilian fatality; 338 (81.1%) fires destroyed ≥ 1 structure; and 197 (47.2%) received an FM declaration and met the population density requirement. The final dataset included the wildfire name, total burned area acreage, ignition and containment dates, and spatial boundary of the fire.

Conclusion:

We identified over 400 wildfire disasters that took place in California from 2000-2019 and created a reproducible GIS dataset available for download by others to advance wildfire research.

Figure:

Uncaptioned visual

Wednesday LT2

Wildfire-related $PM_{2.5}$ and mortality in California

Robbie M. Parks[1], Tarik Benmarhnia[2], Joan A. Casey[1], M. Maria Glymour[3], Marianthi-Anna Kioumourtzoglou[1], Mathew V. Kiang[4]
[1]Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, USA. [2]Scripps Institution of Oceanography, University of California, San Diego, USA.
[3]Department of Epidemiology and Biostatistics, University of California, San Francisco, USA.
[4]Department of Epidemiology and Population Health, Stanford University School of Medicine, Stanford, USA

Abstract

Background and aim
Wildfires and resulting smoke are critical public health concerns, particularly in California, the most populous US State. Previous studies have comprehensively demonstrated that elevations in overall fine particulate matter ($PM_{2.5}$) pollution increase population mortality. The impact of wildfire-related $PM_{2.5}$ may differ, however, due to potentially different composition. As wildfires increase in both intensity and frequency, comprehensive assessment of the association between wildfire-related $PM_{2.5}$ and all-cause and cause-specific mortality across multiple years of study is needed.

Methods
We used daily mortality data provided by the California Department of Public Health and a comprehensive well-validated record of wildfire-related $PM_{2.5}$ concentrations from an ensemble-based statistical approach at the daily census tract level in California over 4 years (2016–2019). We implemented a time-stratified case-crossover design with distributed lag non-linear terms (0-6 days) to estimate associations between daily census tract-level wildfire-related $PM_{2.5}$ and death rates in California, accounting for daily temperature with a similar distributed lag non-linear structure. We also examined how the association varied by cause of death, sex and age group.

Results
For wildfire days, wildfire-related $PM_{2.5}$ concentrations had an overall mean of 1.4 $\mu g/m^3$, standard deviation of 5.7 $\mu g/m^3$, and a maximal value of 203.2 $\mu g/m^3$. There were 1,069,078 million deaths in California during 2016–2019. In preliminary results, for all-cause deaths, a 10 $\mu g/m^3$ increase in wildfire-related $PM_{2.5}$ across 0-6 lag days was associated with a cumulative 7.8% (95%CI:-0.7%,16.3%) increase in death rates for females aged 65 years or older, with an 8.7% (95%CI:-0.3%,17.7%) increase for males aged 65 years or older.

Conclusions
Our findings demonstrate the potential deadly threat of wildfire smoke $PM_{2.5}$ to public health, and the need for targeted interventions and additional preparedness for wildfire-related $PM_{2.5}$, especially in the immediate days following elevated concentrations.

Wednesday LT2

The NIH Alliance for Community Engagement – Climate and Health (ACE-CH) initiative

Nishadi Rajapakse[1], Lawrence Fine[1], Xinzhi Zhang[1], George Mensah[1], Bryan Ampey[1], Erynn Huff[1], Liam O'Fallon[2], Gwen Collman[2]
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Abstract

The World Health Organization describes climate change as the biggest threat to health in the 21st century. Short and long-term impacts can lead to increases in the incidence and severity of chronic diseases including physical and mental health, and ultimately impact all people. Impacts of climate events can be felt directly on populations or through indirect impacts on environmental factors such as air pollution, distribution of toxics, or on social supports and structures. Certain populations will be at higher risk, for instance, groups that are economically disadvantaged, communities of color, immigrant groups, Indigenous peoples, children and pregnant women, older adults, vulnerable occupational groups, persons with disabilities, and persons with preexisting medical conditions.

The Alliance for Community Engagement- Climate and Health (ACE-CH) initiative seeks to work with communities to demonstrate how community knowledge, resilience, and local assets contribute to addressing health inequities related to climate change. This effort aims to develop community and academic research partnerships to focus on adaptation and mitigation through community-engaged research. This presentation will explore the intersection of climate change and health inequities in vulnerable communities and describe the vision of the ACE-CH initiative, focusing on current topics and priorities. We will highlight perceived challenges of the overwhelming changes brought on by climate impacts at the local level, discuss approaches to address health inequities through community engagement strategies, describe the role of community to identify and implement potential interventions that build resiliency, and discuss how these efforts will eventually inform policy and public health action.

Wednesday LT2

Monitoring wildfire and smoke inhalation-related health effects in the United States using the National Syndromic Surveillance Program

Cristin McArdle[1,2], Lakshmi Radhakrishnan[3], Audrey Pennington[2], Maria Mirabelli[2]
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Abstract

Background: Wildfire smoke exposure impacts respiratory and cardiovascular health. In 2021, the National Syndromic Surveillance Program (NSSP) in collaboration with community partners developed a refined query of patient reason for visit and administrative diagnostic codes from emergency department visits to monitor wildfire smoke inhalation-related health effects. This real-time detection of health events provides public health authorities with information to target mitigation and prevention efforts in areas experiencing wildfires and smoke. We conducted this evaluation to assess the use and functionality of NSSP's existing surveillance system to detect wildfire and smoke inhalation-related health effects.

Methods: Using a standardized framework to evaluate surveillance systems, we interviewed personnel at federal agencies, state health departments, and hospitals about their use of NSSP to detect wildfire-and smoke-related health outcomes using a semi-structured interview format. We also queried NSSP data for inhalation-related visits based on the refined query definition. The gathered information was used to assess how effectively syndromic surveillance captures wildfire smoke-related health events by meeting credible evidence of system performance.

Results: Overall, informants reported that the newly-implemented approach to monitor wildfire and smoke inhalation-related health effects benefits from the established NSSP system because of the high-level data monitoring and assurance of data quality, reliability, and rapid availability. While jurisdictions monitor NSSP for changes in wildfire and smoke inhalation, it is not currently a primary source for situational awareness. Limitations include the reliance on self-reported exposure recorded by health care professionals and that not all U.S. locations directly impacted by wildfires report data to NSSP.

Conclusions: We found that wildfire and smoke inhalation surveillance results in high-quality and timely data. Implementing a combined regional and national dashboard collection of refined queries, and continued onboarding of hospitals in regions most affected by wildfires might improve the representativeness and usefulness of wildfire and smoke inhalation surveillance.

Wednesday LT2

Severely underpowered: an assessment of severe weather-driven power outages in New York State, 2017-2020

Nina Flores[1], Alex Northrop[1], Vivian Do[1], Robbie Parks[1], Diana Hernández[1], Leo Jiang[2], Joan Casey[3,4]
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Abstract

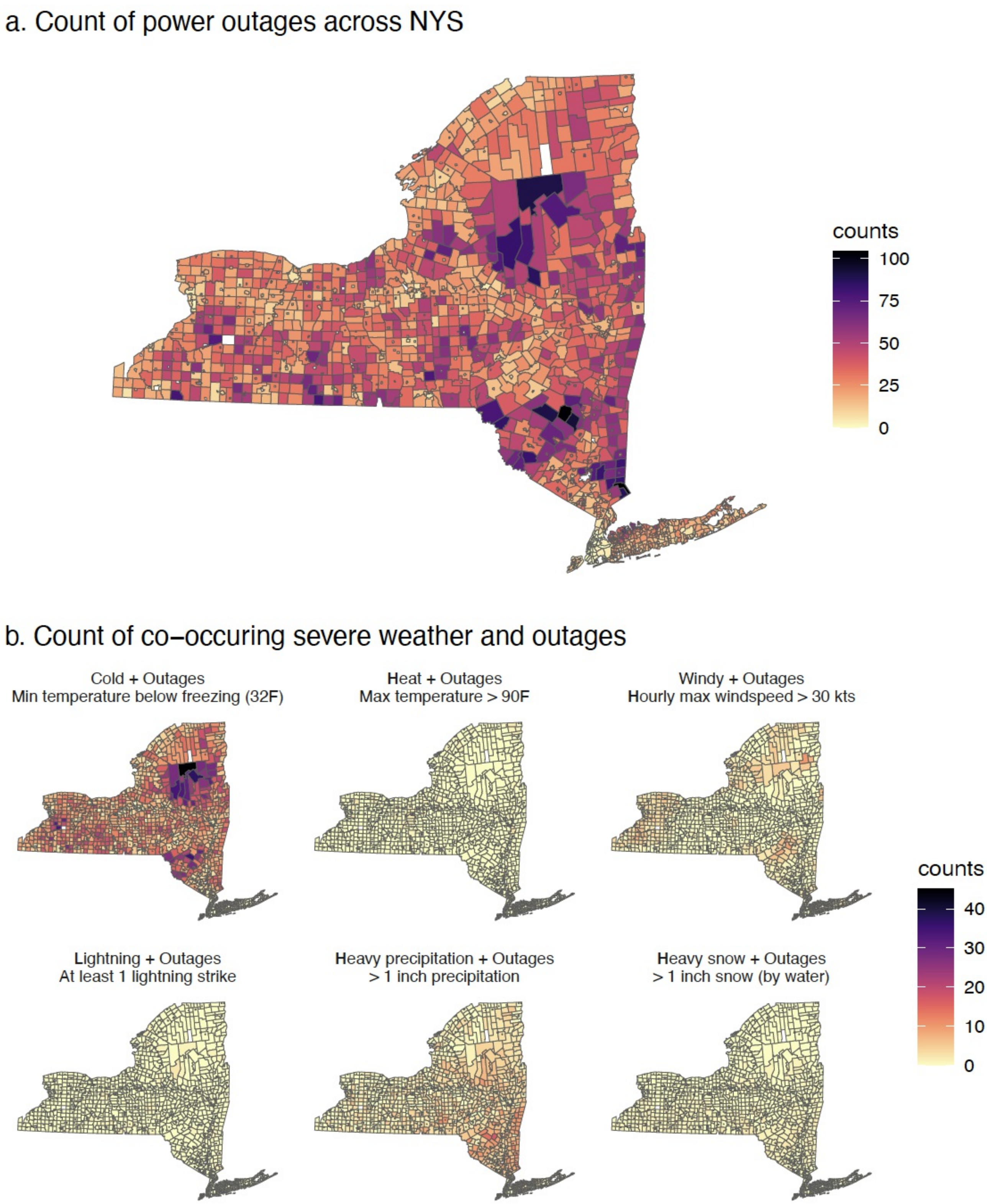
Background/Aims: Climate change will increase severe weather events, resulting in more power outages. Previous assessments of weather-driven outages (a) rarely included highly resolved data (temporally/spatially) and (b) often failed to consider regional heterogeneity in severe weather events, grid infrastructure, and population demographic/socioeconomic profiles, which affect outage severity and health consequences. We used granular data across New York State (NYS) to characterize the impact of severe weather events on power outages.

Methods: We obtained the hourly number of customers without power in electrical power operating districts (PODS; n=1865) throughout NYS from 2017-2020. We spatially aggregated hourly temperature, precipitation, wind speed, lightning, and snowfall to PODS and used quasi-Poisson regression with natural splines to describe the relationship between each weather metric and (a) the proportion of customers without power and (b) the number of hours to restore power. To investigate outage-related climate injustices, we repeated analyses stratified by urbanicity (rural, urban-non-New York City [NYC], NYC) and the CDC Social Vulnerability Index.

Results: We find that across NYS, outages are most frequent in the Hudson Valley, Adirondacks, and Long Island regions and less frequent in NYC (Figure 1a). Linking outages to severe weather events, we find that heavy precipitation largely contributes to outages in the Hudson Valley and Long Island regions; high wind speeds largely contribute in North and Central NY; and freezing temperatures are major contributors state-wide (Figure 1b). Using nonlinear models, we identify wind speed, temperature, and precipitation thresholds that largely increase outages (30kts, $<-10^{o}$C or $>30^{o}$C, >30mm, respectively); these thresholds vary across urbanicity and vulnerability (e.g., compared to NYC, windspeeds of 30kts are associated with 2x and 4x the rate of outages in urban-non-NYC regions and rural regions, respectively).

Conclusion: Different regions/subregions across NYS may need different policies and interventions to achieve equitable grid reliability.

Figure:


a. Count of power outages across NYS
counts
100
75
50
25
0
b. Count of co−occuring severe weather and outages
Cold + Outages
Min temperature below freezing (32F)
Heat + Outages
Max temperature > 90F
Windy + Outages
Hourly max windspeed > 30 kts
Lightning + Outages
At least 1 lightning strike
Heavy precipitation + Outages
> 1 inch precipitation
Heavy snow + Outages
> 1 inch snow (by water)
counts
40
30
20
10
0

Wednesday LT2

Power Outages and Pediatric Trauma Hospitalizations in New York State

Alexander Northrop[1], Vivian Do[2], Nina Flores[2], Perry Sheffield[3], Joan Casey[2,4]
[1]Vagelos College of Physicians and Surgeons, Columbia University, New York, NY, USA. [2]Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, NY, USA. [3]Department of Environmental Medicine and Public Health, Icahn School of Medicine at Mount Sinai, New York, NY, USA. [4]Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, WA, USA

Abstract

Background: Children face a disproportionate disease burden related to climate change and associated severe weather. Electric power disruptions (outages) during severe weather may increase exposure to extreme temperatures, gas-powered generators, open flames, and dimly lit spaces, all of which may cause injury. The effects of outages on children remain understudied. To fill this gap, we evaluated the relationship between outages and pediatric hospital admissions for trauma-related diagnoses.

Methods: We used a case-crossover study design paired with hourly outage data (2017-2020) from the New York Department of Public Service and inpatient trauma hospitalizations of children <18 from the New York Statewide Planning and Research Cooperative Systems (SPARCS). We stratified power operating districts (PODs; n = 1865) into rural, non-NYC urban, and New York City (NYC). Then, to characterize severe outages, we used the percent of hourly customers experiencing outages per POD, identifying 99th percentiles of customers out for each stratum and calculating daily cumulative hours above this threshold, assigning patients to a POD according to the population-weighted centroid of their reported residence block group. We employed non-linear conditional logistic regression models, controlling for meteorological variables (daily precipitation and mean temperature) and outage duration (≥ 8 hours, <8 hours).

Results: We identified 19,969 pediatric trauma hospitalizations. The 99th percentile outage threshold was 95% of customers in rural, 49% in non-NYC urban, and 1% in NYC. In non-NYC urban PODs, pediatric trauma admissions increased during outages (OR: 1.3, [95% CI, 1.1-1.6]), with no significant change in association with 8+ hour outages. We found no significant associations in rural or NYC PODs.

Conclusion: Outages affecting > 49% of customers pose a plausible risk to pediatric trauma hospitalizations in urban non-NYC regions of New York State. Future studies may consider different outage thresholds or outage definitions to study the effect of outages on pediatric trauma hospitalizations.

Uncaptioned visual

Wednesday LT2

Understanding Seasonal Variations of Building Energy Demand by U.S. State

Brian Sousa[1], Jonathan Buonocore[2], Parichehr Salimifard[3], Shivani Parikh[1], Mahala Lahvis[1], Joseph Allen[1]

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Abstract

Building electrification will play an essential role in many decarbonization plans that are aiming to achieve net zero emissions. Currently, U.S. economy-wide decarbonization plans and models only use annual energy consumption in their projections, not accounting for seasonal fluctuations in energy demand or the impacts that building electrification would have on the electrical grid. This oversight of added demand to the grid can lead to problems, including reliability issues. Previous work has examined the seasonal energy consumption of buildings at the national level, however the impacts that regional climates and seasonal consumption will have on electrical grids are unknown. Here we used historical energy data in the U.S to create seasonal energy profiles (Falcon Curves), evaluating historical seasonal fluctuation as well as potential seasonal fluctuation in total energy demand based on various electrification scenarios at the state level.

In Falcon Curves for Massachusetts (MA), Minnesota (MN), Oregon (OR), and Florida (FL), we observed the largest change in seasonal fluctuation of energy demand in MN (3.03x), followed by MA (2.67x), OR (2.09x), and FL (1.37x). This corresponds to differences in infrastructure and climatic conditions. We also observed the most substantial reductions in seasonal fluctuations using highly efficient coefficient of performance (COP) 6 electric heating technologies to electrify buildings in MN (45%), followed by MA (40%), OR (26%), and FL (1%). This indicates that building electrification for regions with high seasonal variations in energy demand, such as in MN and MA, will benefit from incorporating highly efficient heating and cooling technologies. Conversely, regions similar to OR and FL with smaller variation in seasonal energy demand have less need for extremely efficient heating and cooling technologies. This work can help inform future decarbonization plans, as different states and regions will need to implement different electrification technologies in order to effectively electrify their buildings.

Uncaptioned visual

Wednesday LT2

Increasing exposures to compound wildfire smoke and extreme heat hazards in California, 2011-2020

Caitlin Jones[1], Sara Ludwick[1], Mohammad Al-Hamdan[2], Jason Vargo[3], Erwan Monier[1], Kathryn Conlon[1]
[1]University of California, Davis, Davis, USA. [2]The University of Mississippi, Oxford, USA. [3]Federal Reserve Bank of San Francisco, San Francisco, USA

Abstract

Wildfire smoke and extreme heat hazards are inherently linked, yet the frequency and distribution of exposure to compound events, i.e., co-occurring wildfire smoke and extreme heat, is not well understood. Shared climatic drivers are worsening these hazards and the threat they pose to public health and safety; thus, there is a critical need to investigate exposure risks.

We examine compound hazard exposures to wildfire smoke and extreme heat from 2011-2020 in California to characterize populations at greater risk. We calculate population-weighted estimates of compound exposures within ZIP Code Tabulation Areas (ZCTA) using (a) fine-resolution population estimates (1-km resolution), (b) daily wildfire smoke-influenced fine particulate matter (wf-$PM_{2.5}$; 3-km resolution) and, (c) maximum temperature (4-km resolution), which were resampled to 1-km resolution to create population-weights, then aggregated to the ZCTA-level. We apply dichotomous exposure definitions for wf-$PM_{2.5}$ (presence/absence) and temperature (ZCTA- and month-specific 95th percentile threshold) to count annual exposure days to wildfire smoke only, heat only, and compound wildfire smoke and heat (CH days). CH days were classified if both exposures occurred within a 3-day exposure lag window, i.e., each may occur up to three days prior to the measured day. The distribution of CH days was then examined statewide and by ZCTA community characteristics: income, education, race/ethnicity, urbanicity, housing.

Results are presented in maps to illustrate the distribution of compound hazard exposure across 10 years. ZCTAs experienced differing degrees of exposure in each year, highlighting both Northern and Southern regions. Nonetheless, recent years (2017 and 2020) showed increasing exposures with the highest annual CH days. Additionally, we show community-level risk factors relate to differential exposure to compound hazards.

This research presents a robust method to assess exposure risk to compound hazards, as well as characterizing the worsening, yet unequal, threat of wildfire smoke and extreme heat events.

Wednesday OS1

Use of personal care product mixtures and incident hormone-sensitive cancers in the Sister Study.

Che-Jung Chang[1], Katie O'Brien[1], Alexander Keil[2], Mandy Goldberg[1], Kyla Taylor[3], Dale Sandler[1], Alexandra White[1]
[1]NIEHS, RTP, USA. [2]NCI, Bethesda, USA. [3]NTP, RTP, USA

Abstract

Background: Personal care products (PCPs) may be a source of endocrine-disrupting or carcinogenic chemical exposures and thus may be related to the risk of hormone-sensitive cancers. However, few studies have investigated associations between PCP use and cancer risk, particularly with consideration of the joint effect of multiple correlated PCPs.

Methods: Sister Study participants (N=49,899) self-reported frequency of use of 41 PCPs in the year before enrollment (2003-2009). Three product classes (beauty, hygiene, and skincare) were identified based on a priori knowledge and Spearman correlation coefficients for co-occurring product use. Using 5-level frequency categories based on questionnaire options in lieu of quantiles, hazard ratios (HRs) and 95% Confidence Intervals (CIs) were estimated for associations between single and multiple PCP exposures and incident breast, ovarian, and uterine cancer using Cox proportional hazard regression and quantile-based g-computation. We used Benjamini-Hochberg correction for multiple comparisons.

Results: Over an average of 11.6 years, 4226 breast, 277 ovarian, and 403 uterine cancer cases were identified. For single-product analyses, associations were not statistically significant after multiple comparison adjustment. In multi-PCP models, we observed no consistent associations with uterine cancer, and an inverse association between the skincare mixture and breast cancer (HR=0.91, 95%CI=0.83-0.99). Elevated associations were observed for the hygiene mixture and ovarian cancer (HR=1.35, 95%CI=1.00-1.83) and for the beauty mixture and breast cancer (HR=1.05, 95%CI=0.99-1.12).

Conclusion: PCP mixtures may be associated with incidence of hormone-sensitive cancers. Results from this multi-product joint effect approach were consistent with previous studies on breast and ovarian cancer using either single- or other multiple-product approaches.

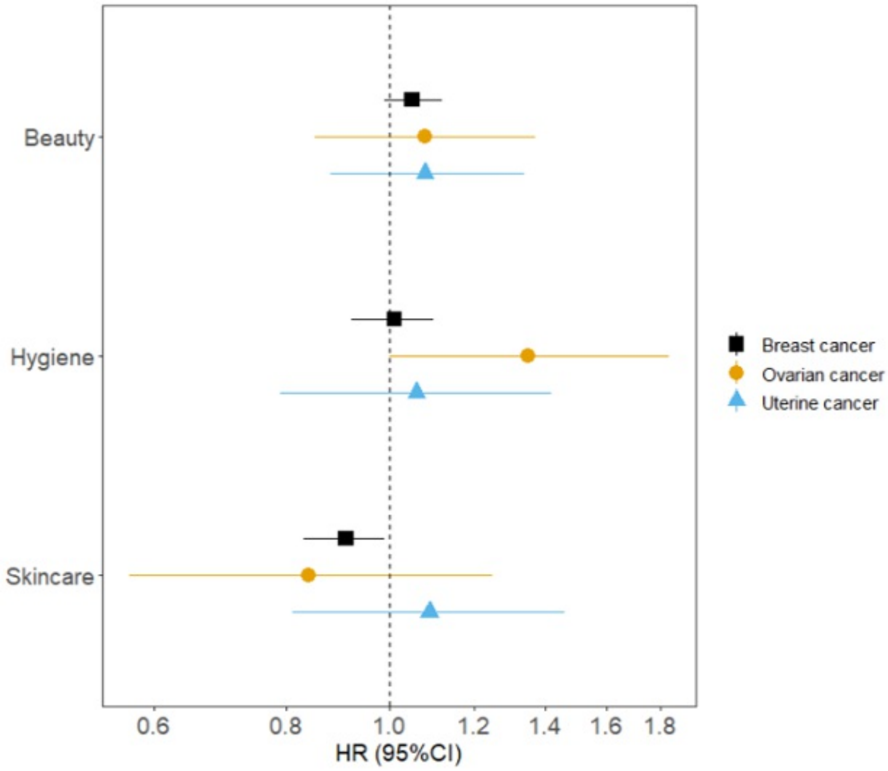

Figure 1. Associations between personal care product use mixture and hormone-sensitive cancers using quantile-based g-computation. [beauty products: blush, eyeliner, eye shadow, foundation, lipstick, mascara, makeup remover, perfume, artificial nail, cuticle cream, nail polish, nail polish remover; hygiene products: bath gel, deodorant, douche, mouthwash, shaving cream, talc (under arm), talc (vaginal), talc (other area); skincare products: anti-aging product, age spot lightener, baby oil, blemish, prodcut, body lotion, cleansing cream, face cream, facial mask, foot cream, hand lotion, lip moisturizer, petroleum jelly, skin lighener, self-tanner]

Wednesday OS1

Association of geospatially modeled exposure to dioxins with lymphoid malignancies

Jie Chen[1,2], Jaime Hart[1,2], Trang VoPham[3], Elise Elliott[4], Francine Laden[1,2,5], Brenda Birmann[2]
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Abstract

Background/Aims

The etiology of non-Hodgkin lymphoma (NHL) and multiple myeloma (MM) is still unclear. Studies have suggested an increased NHL risk with increasing proximity to dioxin-emitting facilities, but limited evidence is available from prospective cohorts. We aimed to assess the associations between exposure to dioxins in relation to incident NHL and MM in the prospective Nurses' Health Study (NHS, 1986-2014) and NHSII (1989-2013).

Methods

We used an US nationwide database of industrial dioxin-emitting facilities to estimate residential proximity, duration of residence and emissions from facilities within 3km, 5km, and 10km radii. We used time-varying Cox proportional hazards models to assess the associations between dioxin exposure estimates and risk of incident NHL and MM, adjusting for potential confounders including age, race, lifestyle factors, and individual- and area-level socioeconomic status. We pooled hazard ratios (HRs) and 95% confidence intervals (CIs) from the 2 cohorts using random-effects meta-analyses.

Results

In NHS, 1,207 NHL and 202 MM cases occurred during 2,520,293 person-years of follow-up, whereas in NHSII, 352 NHL and 48 MM cases occurred during 2,182,200 person-years of follow-up. Average age during follow-up was 64 years in NHS and 46 years in NHSII. The study participants were all female; most were white, married, and non-smokers. Living in proximity to dioxin-emitting facilities in all buffers was associated with increased risk of NHL and MM in NHSII, whereas only living within the 10km buffer was associated with increased MM risk in NHS. Participants living within 10km of any dioxin facility compared to none had increased MM risk (meta-analytic HR=1.42, 95% CI: 1.09, 1.85). Heterogeneity between the two cohorts was moderate. We also observed positive associations for the residential duration and emission metrics.

Conclusion

The results suggested a positive association between dioxin exposure and risk of NHL and MM in these prospective nationwide cohorts of women.

Wednesday OS1

Quantifying sociodemographic disparities in airborne exposure to industrial emissions of probable carcinogens across the United States

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Abstract

Background/Aim

Few studies have investigated how airborne carcinogenic exposures are distributed among the general population. We previously demonstrated sociodemographic disparities in airborne exposure to known carcinogens in the United States (US). Here, we describe disparities in exposure to industrial emissions of probable carcinogens among sociodemographic groups across the US.

Methods

We linked the US Environmental Protection Agency's 2018 Toxics Release Inventory to sociodemographic characteristics in 2010 Census tracts. Tract characteristics included total population, educational attainment, Yost deprivation index, family poverty, and percentages of Black, Hispanic, Asian, and White populations. We considered the tract population to be exposed if there were emissions of ≥1 of 33 probable carcinogens as classified by the International Agency for Research on Cancer. We estimated odds ratios (ORs) and 95% confidence intervals (CIs) using multinomial logistic regression, comparing Q5 to zero air emissions (sum of all chemicals and for 8 individual chemicals emitted in ≥50 tracts) per 10% increase in population characteristics.

Results

An estimated 16.3 million people lived in tracts with 4,530 facilities that emitted 871 million pounds of probable carcinogens. The odds of living in the highest exposed (Q5) tracts compared to unexposed were greater for Black (OR=1.05, 95%CI=1.01-1.09) and Hispanic populations (OR=1.09, 95%CI=1.05-1.13), whereas the pattern was inverse for White (OR=0.94, 95%CI=0.92-0.97) and Asian (OR=0.83, 95%CI=0.69-1.01) populations. The odds of being highly exposed were greater for populations with low educational attainment (OR=1.33, 95%CI=1.25-1.40) and experiencing poverty (OR=1.21, 95%CI=1.14-1.28), overall and for Whites, Blacks, and Hispanics. These patterns persisted for creosote, lead, and styrene.

Conclusions

Our novel assessment demonstrates that potential exposure to airborne probable carcinogenic emissions is not homogeneously distributed among the US population and that differences are driven by socioeconomic status. These findings indicate the importance of considering joint effects of sociodemographic and environmental factors when evaluating associated health disparities.

Wednesday OS1

Residential proximity to carcinogenic industrial air emissions and breast cancer incidence in a United States-wide prospective cohort

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Abstract

Aims: To evaluate whether residential proximity to air emissions of correlated industrial carcinogens, singly and in combination, are associated with breast cancer incidence.

Methods: Using the US Environmental Protection Agency's Toxics Release Inventory, we estimated the 10-year annual average air releases of 26 known or probable carcinogens within 3, 5, and 10-km of Sister Study participants' baseline residences (n=50,343, 2003-2009). We used Cox proportional hazards regression to estimate adjusted hazard ratios (HR) and 95% confidence intervals (CI) for the association between ambient concentrations of each individual compound and incident breast cancer. To assess mixtures, we applied an exposure continuum mapping (ECM) framework to identify latent mixture profiles via a self-organizing map and assessed whether these profiles were related to incident breast cancer by estimating a joint exposure-response function with generalized additive models.

Results: During follow-up (mean=11.6 years), 4,282 breast cancer cases were identified. The exposure prevalence for compounds emitted within 3-km of participants' residences varied from <1%-15%. For individual compounds, HRs for the association between quantiles of emission levels and breast cancer were largely null, except for cadmium, vinyl chloride and asbestos (e.g., asbestos 3-km HR>median vs. no exposure=2.61, 95% CI: 1.37-5.09). Our application of ECM identified 49 profiles that explained 79% of the variance in emissions observed within 3-km of residences. Profiles with relatively high emissions of several compounds were rare (<0.5%) and most participants resided in locations defined by low emissions patterns. Estimation of a joint exposure-response surface indicated that changing patterns of emission mixtures composition was not significantly related to breast cancer incidence (p=0.31).

Conclusions: Preliminary results suggest that breast cancer incidence may be related to emissions of certain industrial carcinogens, particularly asbestos. High simultaneous exposure to many compounds was rare, and our identified latent patterns of these emissions were not associated with breast cancer.

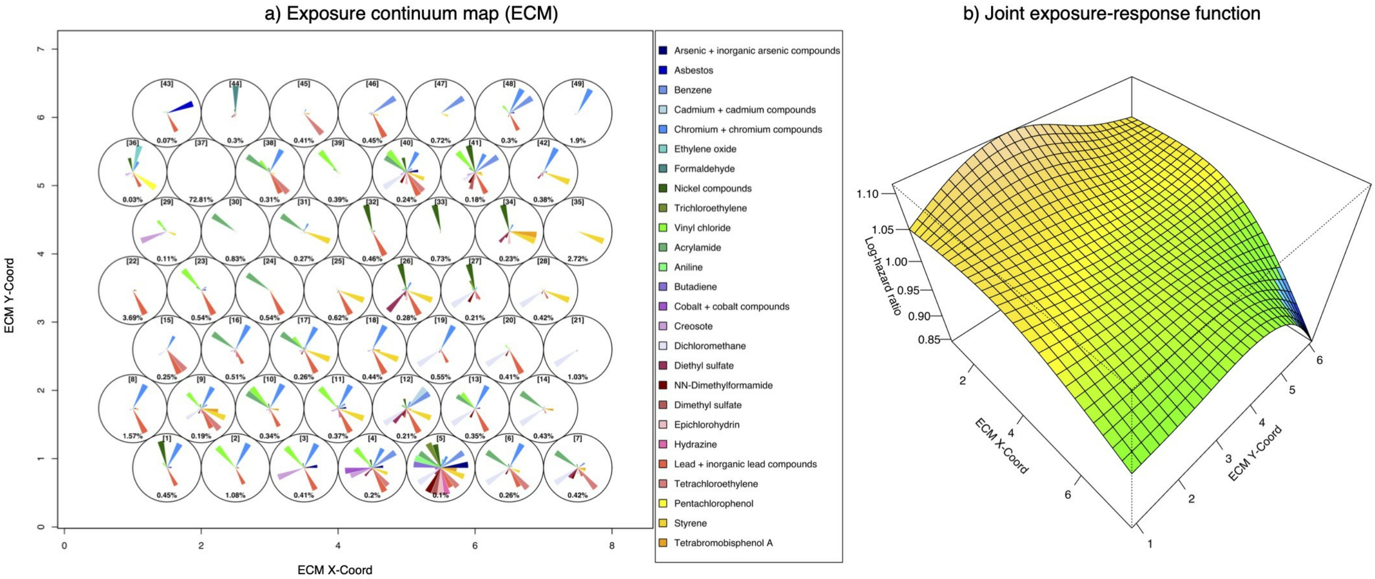

Figure 1. (a) An ECM that illustrates air emission mixture profiles identified among participants in the Sister Study cohort. Pie segments represent the mean percentile-rank transformed values of estimated annual average concentrations among participants assigned to each profile. Nodes [IDs] and relative frequencies (%) are provided for each profile. (b) The estimated joint exposure-response function that illustrates the relationship between incident breast cancer and location on the ECM (a) after adjusting for confounders.

Wednesday OS1

Impact of a hypothetical policy to reduce particulate matter air pollution on all-cause and cause-specific mortality in Black and white men with prostate cancer: A registry-based cohort study

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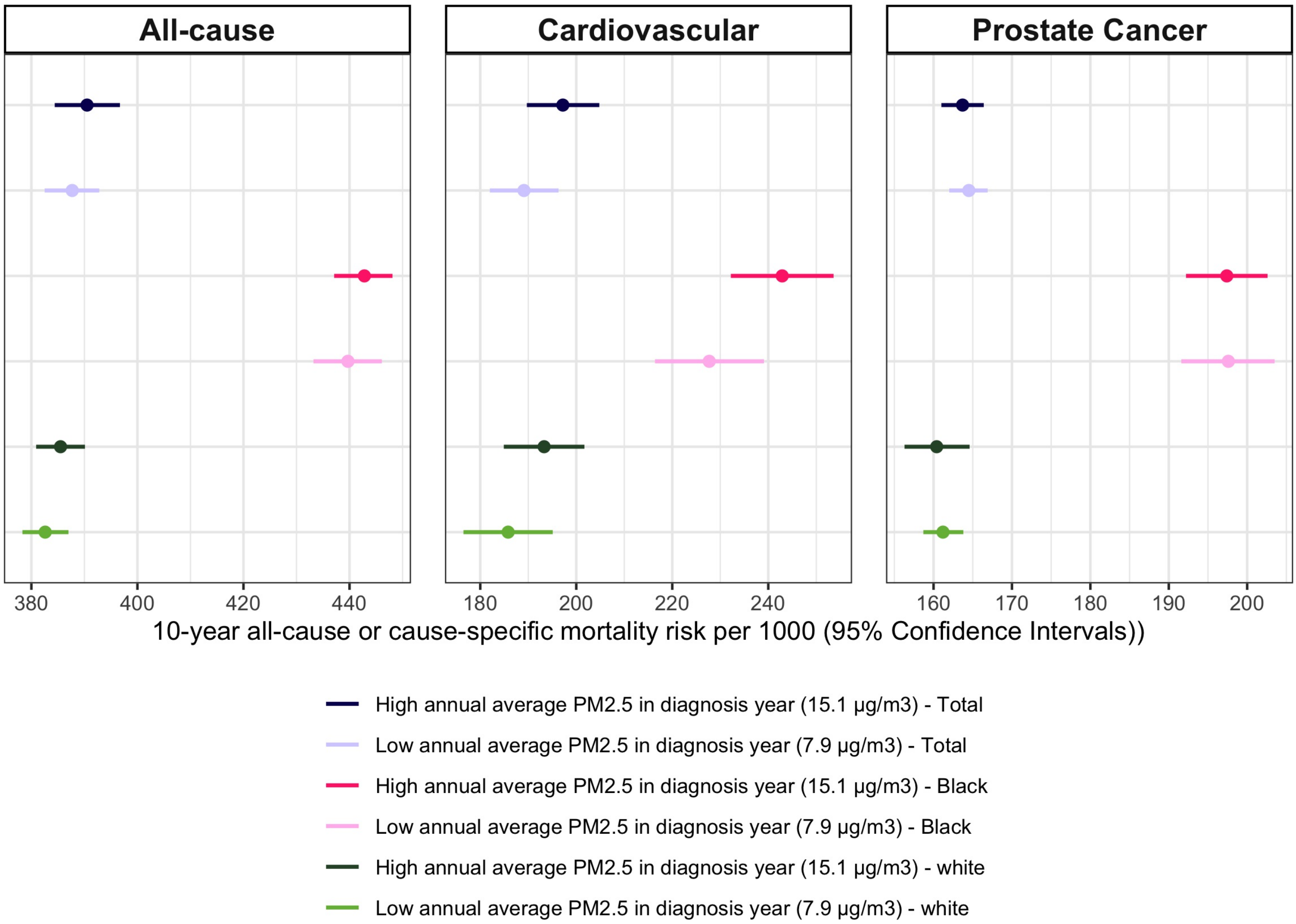
Abstract

Background: Fine particulate matter (PM2.5, particles ≤ 2.5 µm in aerodynamic diameter) air pollution is associated with racial segregation and CVD mortality in US cancer survivors. We estimated the impact of a hypothetical intervention to reduce outdoor PM2.5 on mortality in Black and White prostate cancer (CaP) survivors.

Methods: Using data from men diagnosed with CaP from 2000 to 2015 from California and Seattle-Puget Sound, Washington cancer registries, we estimated the reduction in all-cause and cause-specific (CVD and CaP) mortality following a hypothetical intervention to reduce PM2.5 from high (PM2.5 in diagnosis year among Black men [75th percentile] = 15.1 µg/m3) to low levels (PM2.5 in diagnosis year among white men [25th percentile] = 7.9 µg/m3). We linked annual averaged PM2.5 from spatiotemporal models (1km resolution) to residential addresses at diagnosis. We applied standardization to estimate the 10-year mortality risk difference associated with changing PM2.5 exposure using Cox Proportional Hazards models with age as the timescale, adjusting for diagnosis year, stage, marital status, neighborhood socioeconomic status, population density, and state. We evaluated effect modification by race on the additive scale. Confidence intervals were estimated using bootstrapping with 500 repetitions.

Results: From 2000 through 2015, 30,900 Black and 300,977 white men were diagnosed with CaP; approximately one-third died by the end of follow-up (December 31st, 2018). For all-cause and CaP mortality, there were 2.9/1000 (95% CI: 1.1, 4.6) fewer deaths and 0.7/1000 (95% CI: -0.5, 2) deaths associated with the hypothetical intervention, respectively, with no evidence of effect modification by race. The hypothetical intervention to reduce annual average PM2.5 resulted in 15.2/1000 (8.0, 22.4) and 7.5/1000 (4.2, 10.7) fewer CVD deaths among Black and white men, respectively.

Conclusion: Our findings suggest that reducing PM2.5 air pollution among men diagnosed with CaP could reduce mortality, but would have limited impact on racial disparities.



All-cause
Cardiovascular
Prostate Cancer
380
400
420
440
180
200
220
240
160
170
180
190
200
10-year all-cause or cause-specific mortality risk per 1000 (95% Confidence Intervals))
High annual average PM2.5 in diagnosis year (15.1 µg/m3) - Total
Low annual average PM2.5 in diagnosis year (7.9 µg/m3) - Total
High annual average PM2.5 in diagnosis year (15.1 µg/m3) - Black
Low annual average PM2.5 in diagnosis year (7.9 µg/m3) - Black
High annual average PM2.5 in diagnosis year (15.1 µg/m3) - white
Low annual average PM2.5 in diagnosis year (7.9 µg/m3) - white

Wednesday OS1

Neighborhood income inequality and colorectal cancer survivorship

Mimi Ton[1,2], Kelsey Chun[2], Rachel Malen[2], Shirley Beresford[2,1], Polly Newcomb[2,1], Trang VoPham[2,1]
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Abstract

BACKGROUND/AIMS

Neighborhood income inequality is the unequal distribution of household and/or individual income within a geographic area and has been associated with higher mortality and lower life expectancy. Colorectal cancer (CRC) is the third most common cancer and despite advancements in CRC prevention and treatment, there continue to be marked disparities in mortality that are not uniform across space and time. Social determinants of health and built environment factors have been associated with outcomes across the CRC continuum, although there is limited research on CRC survival. Our objective was to examine the association between neighborhood income inequality and mortality among CRC patients.

METHODS

We examined the association between census tract-level income inequality among participants in the US nationwide prospective Women's Health Initiative (WHI) cohort who were diagnosed with incident invasive CRC from 1994-2019 (n=2,796) and followed until 2019. Participant residential addresses at diagnosis were geocoded and linked with census tract-level information on household income inequality from the US Census Bureau (higher values indicate greater household income inequality). Cox proportional hazards regression models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs) for the associations between income inequality and overall and CRC-specific mortality, adjusting for age at diagnosis, education, race, ethnicity, body mass index, individual-level income, tumor stage, and region of residence.

RESULTS

There were n=1,564 deaths and n=729 CRC-specific deaths included in this analysis. There were suggestive positive associations between neighborhood income equality and overall mortality (highest vs. lowest quartile: HR 1.10, 95%CI 0.94-1.29) and CRC-specific mortality (highest vs. lowest quartile: HR 1.14, 95%CI 0.90-1.44).

CONCLUSION

Our results suggest an association between higher census tract-level income inequality and poorer overall and CRC-specific survival. Future research should investigate this association according to population subgroups disproportionately impacted by CRC mortality (e.g., sex, race/ethnicity, and location).

Wednesday OS2

Disruption to Test Scores after Tropical Cyclones in the United States

Gabriella Y. Meltzer[1], Joan A. Casey[1], Joel Schwartz[2], Michelle L. Bell[3], G. Brooke Anderson[4], Marianthi-Anna Kioumourtzoglou[1], Robbie M. Parks[1]
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Abstract

Background/Aim

Hurricanes and other tropical cyclones affect every element of the lives of impacted communities. How tropical cyclones impact educational attainment is essential to understanding the full burden of climate-related disasters; previous studies show wildfires have negatively impacted test scores. We aim to examine the association between tropical cyclones and educational attainment among elementary- and middle school-age students in all affected areas in the United States.

Methods

We based education on county-level average standardized test scores in math and reading/language arts (RLA) among third to eighth grade students during 2009–2018 from the Stanford Educational Data Archive. Our exposure of interest was tropical cyclones, developed from a record of tropical cyclone occurrence over 10 years, defined as counties with a sustained maximal wind speed ≥34 knots, as well as a subset of the data including only gale-to-violent storms (≥34 knots and <64 knots) or hurricanes (≥64 knots). We developed a difference-in-differences model, associating tropical cyclones and annual average test scores, controlling for time-varying covariates at the county and grade-cohort level, including student-level racial/ethnic composition and socioeconomic status, and county-level urbanicity and socioeconomic status. We also examined how associations varied by strength of tropical cyclone, state, and proportion of non-white and socioeconomically disadvantaged students.

Results

For initial results of hurricane-exposed counties in Florida during 2009–2018, hurricane force-wind was associated with a -0.10 SD (95% CrI: -0.17, -0.03) decrease in average math scores, equivalent to 13% of the average difference between grades three and four. We observed no association with RLA scores (0.00 SD [95% CrI: -0.05, 0.05]).

Conclusion

Initial results indicate that exposure to hurricane-force winds was associated with lower county-level math performance among elementary- and middle school-age students in Florida. Disaster preparedness may include resilience to the impacts of climate-related stressors on overall academic achievement.

Wednesday OS2

Shedding light on environmental justice and power outages in New York State

Vivian Do[1], Alexander Northrop[2], Nina Flores[1], Diana Hernández[3], Joan Casey[1,4]
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Abstract

Background

Climate change, population growth, and aging electrical infrastructure will likely result in more outages. Outages jeopardize access to vital resources with health implications (e.g., non-functioning temperature-controlling devices during extremely hot/cold periods leading to illness). Historic policies reflected and perpetuated discriminatory practices that may have led to inequitable infrastructure improvements and known environmental justice (EJ) issues exist related to many exposures. We examine the relationship between EJ and outages in New York State (NYS).

Methods

We calculated census tract-level outage frequency and duration using hourly 2017-2020 data from the NYS Department of Public Service. We considered a tract to experience an outage when the hourly percent of customers without power was ≥90th percentile of all customers without power. Outage frequency was total outage count, and duration was average outage time. For EJ, we created quartiles of the CDC's Environmental Justice Index (EJI), which ranges from 0 (least burden) to 1 (greatest burden). For New York City (NYC), other urban areas, and rural areas, we ran negative-binomial regressions evaluating the role of EJI on outage frequency and duration.

Results

Outage data were available for 4,467 (91% of all NYS) tracts (NYC: 2,117, Urban: 1,876, Rural: 474). There were 862,955 outages lasting ≥1 hour (NYC: 18,941, Urban: 828,977, Rural: 15,037). We observed spatial patterns of EJI and outage metrics (Figure). For NYC and other urban tracts, the highest EJI quartile (greatest burden) experienced fewer outages than the lowest EJI quartile (NYC RR: -0.17, 95%CI: -0.34, -0.00; Urban RR: -0.63, 95%CI: -0.73, -0.52). The highest EJI quartile was associated with longer outages compared to the lowest (NYC RR: 0.35, 95%CI: 0.13, 0.57; Urban RR: 0.17, 95%CI: 0.06, 0.28). Rural areas had no significant associations.

Conclusion

EJI were associated with longer outages in urban NYS; future energy policy should center equity.

Uncaptioned visual

Wednesday OS2

Disparities in climate change-related health and economic impacts for populations served by community health centers in the United States

Carolyn Fahey
University of Washington, Seattle, USA

Abstract

Background: Growing evidence shows that climate change disproportionately imposes health risks on socially vulnerable populations, including people of color and low-income communities in the United States. National safety net community health centers (CHCs) provide crucial services for these populations; therefore, it is imperative that CHCs understand potential consequences of climate change. This study investigated the likelihood that CHC patients face heightened risks of exposure to anticipated climate change impacts.

Methods: Data from various sources were obtained for all ZIP Code Tabulation Areas (ZCTAs) in the contiguous United States, including the number of residents who receive care from a CHC (2020 Uniform Data System), the total population (American Community Survey 2016-2020), and projected health and economic outcomes for global warming scenarios of 2 or 4°C (EPA 2021 Climate Change and Social Vulnerability report). Population-weighted log binomial regression models were used to estimate the relative risk that health center patients currently reside in ZCTAs within the top tercile of projected impacts for each outcome, compared to individuals not served by CHCs.

Results: With 2°C global warming, CHC patients are more likely to live in areas with the highest projected increases in premature mortality, (RR: 1.14, 95% CI: 1.10, 1.19), childhood asthma incidence (RR: 1.12, 95% CI: 1.08, 1.17), and asthma emergency department visits (RR: 1.10, 95% CI: 1.06, 1.14) related to climate-driven changes in particulate air pollution ($PM_{2.5}$); traffic delays due to weather-related road damages (RR: 1.18, 95% CI: 1.10, 1.27); and property loss from inland flooding (RR: 1.05, 95% CI: 1.0, 1.11). These disparities further increased under a 4°C global warming scenario.

Conclusions: Populations served by CHCs have a higher risk of exposure to climate change-related health and economic impacts. CHCs could play a vital role in helping patients and communities prepare, respond, and recover from climate hazards.

Wednesday OS2

Building tools and capacity to support climate change and health research at NIEHS

Kyle Messier[1], David Balshaw[1], Regina Bures[2], Trisha Castranio[1], Lara Clark[1], Gwen Collman[1], David Fargo[1], Michelle Heacock[1], Erin Iturriaga[3], Patricia Keenan[4], Richard Kwok[5], Alison Motsinger-Reif[1], Pam Owens[4], David Reif[1], Asif Rizwan[3], Charles Schmitt[1], Aubrey Miller[1]
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Abstract

Uncaptioned visual

Figure1

Background: Harmonized, accessible data are critical to allow researchers to identify health effects associated with climate-related events, to create and evaluate evidence-based implementation and adaptation plans to protect at-risk individuals and groups, and to respond to potential adverse health outcomes.

Methods: With funding from the Patient-Centered Outcomes Research Trust Fund (PCORTF) and commitment from National Institute of Environmental Health Sciences (NIEHS) in the Climate Change Health initiative, we are leading the development a multi-objective plan (See Figure 1) to create a sustainable data ecosystem and resource for environmental health researchers. This project will identify, catalog, and link relevant environmental, social factors, climate, and health data, and provide resources and datasets to explore use cases focused on addressing wildfires and the health impacts of climate change.

Results: This research and support plan is beginning in early 2023. Interagency partners include the National Heart Lung and Blood Institute, the National Institute on Aging, the National Institute of Child Health and Human Development, and the Agency for Healthcare Research and Quality. The overarching goal is to empower patient-centered outcome and population health research by creating a data ecosystem which contains longitudinal data that are practical, user-friendly, and accessible for transdisciplinary research. Briefly, the project will develop a web-based catalog for environment, climate, and health data (Figure 1, Objective 1); provide linked climate and health datasets (Objective 2); provide code and tools for climate and health research (Objective 3); and demonstrate a case-study on wildfire and human health (Objective 4). Moreover, tutorials, educational resources, and analytical tools will be designed to aide implementation from environmental health researchers.

Conclusion: This is a critical stepping-stone towards the longer-term development of an accessible, sustainable, and robust climate data ecosystem focused on furthering our ability to address and mitigate the wider ranging health impacts of climate change.

Wednesday OS2

Climate health vulnerability index: a modeling framework and sensitivity analysis of methodology

Pin Wang[1], Fiona O'Brien[2], Jiyoung Son[3], Seulkee Heo[3], Michelle L. Bell[3], Robert Dubrow[1], Kai Chen[1]
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Abstract

Background/Aims. To address concerns about climate justice, researchers have used indicator-based composite indices to quantify population vulnerability to climate change. We aimed to systematically detail a modeling framework for index construction and to elaborate the sensitivity of the final index to each methodological choice in the process.

Methods. We discussed the key modeling steps in the construction of a climate health vulnerability index (CHVI), as well as the most common methodological options and their advantages and disadvantages. We then used the State of New York as an illustrative example to create a census tract level CHVI using two alternative structural designs: hierarchical inductive (principal component analysis) versus deductive (indicator aggregation). Further, for each design, we performed multiple sensitivity analyses to examine the influence of various choices of each modeling step by comparing the changes in both CHVI scores and the distribution of disadvantaged communities across sensitivity analyses.

Results. The inductive design was more sensitive than the deductive design to model input and specification. The most influential step was the geometric aggregation of principal component scores for the inductive design and maximum normalization of indicators for the deductive design. The identified disadvantaged communities were largely consistent across sensitivity analyses for both designs, with a higher percentage of overall agreement for the deductive design.

Conclusion. Our study demonstrates the robustness of both inductive and deductive designs, but especially the deductive design, in the development of a CHVI. Justification of methodological choices in the development of a CHVI is required to secure the validity of indices and hence to inform equitable climate change mitigation and adaptation policymaking.

Wednesday OS2

Long-term exposure to wildfire particulate matter: does the particular metric matter for health and environmental justice?

Joan Casey[1], Marianthi-Anna Kioumourtzoglou[1], Amy Padula[2], David Gonzalez[3], Holly Elser[4], Rosana Aguilera[5], Alex Northrop[6], Sara Tartof[7], Elizabeth Rose Mayeda[8], Timothy Frankland[7], Danielle Braun[9], Francesca Dominici[9], Ellen Eisen[3], Rachel Morello-Frosch[3], Tarik Bnmarhnia[10]
[1]Columbia University Mailman School of Public Health, New York, USA. [2]University of California San Francisco, San Francisco, USA. [3]University of California Berkeley, Berkeley, USA. [4]University of Pennsylvania School of Medicine, Philadelphia, USA. [5]University of California, San Diego, San Diego, USA. [6]Columbia University, New York, USA. [7]Kaiser Permanente Southern California, Pasadena, USA. [8]UCLA, Los Angeles, USA. [9]Harvard University, Boston, USA. [10]University of California San Diego, San Diego, USA

Abstract

Introduction: Wildfires—anticipated to lengthen, strengthen, and expand in a changing climate—can produce extreme short-term fine particulate matter ($PM_{2.5}$) concentrations and elevated long-term average exposures. Much wildfire research has focused on acute health consequences; less has considered the potential impacts of long-term exposure. We proposed long-term wildfire $PM_{2.5}$ exposure measures, assessed trends, and evaluated environmental injustice.

Methods: Analysis used 2006-2020 daily California census tract-level wildfire $PM_{2.5}$ concentrations generated from monitoring data and statistical techniques. We classified tracts based on CalEnviroScreen (CES) score, a measure of environmental burden and population vulnerability, dichotomized at the fourth quartile (disadvantaged vs. not). To determine the association between CES score and five long-term wildfire $PM_{2.5}$ measures, we used separate mixed-effects models accounting for year and population density. To assess trends, models included a CES X year interaction.

Results: We generated five annual wildfire $PM_{2.5}$ exposure measures based on frequency, duration, and intensity of exposure: (1) weeks with wildfire $PM_{2.5}$ > 5µg/m^3; (2) days with non-zero wildfire $PM_{2.5}$; (3) annual average wildfire $PM_{2.5}$ concentration; (4) smoke-waves (2+ days over the long-term 98th percentile wildfire $PM_{2.5}$ level), (5) average wildfire $PM_{2.5}$ during peak exposure week. Spearman correlations across measures ranged 0.3-0.8 and levels varied considerably by year. For example, the highest mean number of days with smoke waves was in 2008 (5 days), 2007 (2 days), and 2018 (1 day); the 2010 average was 0 days. Whether or not we observed disparities in long-term wildfire PM2.5 exposure varied by measure and year (e.g., in 2007 and 2014, high CES was related to 48% more [95% CI: 32, 67%] and 98% fewer [95% CI: 95, 100%] smoke-waves, respectively).

Conclusion: With five long-term wildfire $PM_{2.5}$ measures, and in contrast to prior work, we identified time-varying and measure-specific environmental justice concerns related to long-term wildfire $PM_{2.5}$ exposure.

Wednesday OS3

Placental Metal/Metalloid Mixtures and Infant Infections

Catherine Bulka[1], Emily Barrett[2,3], Carolyn Salafia[4], Lauren Aleksunes[2], Brian Buckley[2], Cathleen Doherty[2], Catherine Yount[3], Allison Ciesla[3], Tom O'Connor[3], Richard Miller[3], Tracy Punshon[5], Rebecca Fry[6], Margaret Karagas[5]
[1]University of South Florida, Tampa, FL, USA. [2]Rutgers University, Piscataway, NJ, USA. [3]University of Rochester Medical Center, Rochester, NY, USA. [4]Placental Analytics LLC, Rochelle, NY, USA. [5]Dartmouth College, Hanover, NH, USA. [6]University of North Carolina, Chapel Hill, NC, USA

Abstract

Background/Aims: During infancy, protection from pathogens is primarily conferred by maternal antibodies that were transferred *in utero* across the placenta. However, metals/metalloids from the environment also pass through and accumulate in the placenta, potentially altering maternal-fetal antibody transfer, with implications for infectious disease susceptibility. Here, we examined metal/metalloid mixtures, measured in placental tissue, in relation to infection symptoms in infancy.

Methods: The New Hampshire Birth Cohort Study (NHBCS, n=1,078) measured placental arsenic, cadmium, chromium, manganese, and lead by ICP-MS and interviewed caregivers about any cough, fever, and runny nose since last contact when infants were 4, 8, and 12 months of age. For validation, we obtained data from the Rochester, NY-based Understanding Pregnancy Signals and Infant Development cohort (UPSIDE, n=154); however, this cohort assessed symptoms only within the past 2 weeks, albeit 3 times (1, 6, and 12 months). We fit quantile g-computation models for metal/metalloid mixtures with each symptom, adjusting for potential confounders and using cluster-based bootstrapping for repeated measures.

Results: The overall mixture was not associated with any symptom in either cohort, however, separating the metals/metalloids by essentiality revealed that a mixture of arsenic, cadmium, and lead was associated with a higher risk of fever in NHBCS (RR: 1.10, 95% CI: 1.01-1.19) and UPSIDE (RR: 1.10, 95% CI: 1.00-1.20). Conversely, chromium and manganese together were associated with a lower risk of fever (RR_{NHBCS}: 0.90, 95% CI: 0.83-0.97; RR_{UPSIDE}: 0.90, 95% CI: 0.83-0.98) and marginally lower risk of cough (RR_{NHBCS}: 0.94, 95% CI: 0.87-1.00; RR_{UPSIDE}: 0.94, 95% CI: 0.86-1.01).

Conclusion: Greater prenatal exposures to non-essential metals/metalloids may increase the risk of fever, whereas chromium and manganese may provide protection against both fever and cough during infancy. More research is needed to investigate whether these findings are explained by metals/metalloids altering transplacental antibody transfers.

Wednesday OS3

The COVID-19-wildfire smoke paradox: reduced risk of all-cause mortality due to wildfire smoke in Colorado during the first year of the COVID-19 pandemic

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Abstract

Background and Aim

In 2020, Colorado experienced the worst wildfire season in its history along with the COVID-19 pandemic. Previous work has examined how wildfire smoke (WFS) impacts COVID-19 morbidity and mortality, but there is limited examination of interactions between WFS and COVID-19 on other causes of death. Here we used a time-series design to assess daily mortality risk attributable to WFS exposure before and during the pandemic.

Methods

We obtained daily mortality data over an eleven-year period (2010-2020) for 11 counties in Colorado from the Colorado Department of Public Health and Environment. WFS exposures were assessed using plume data from the National Oceanic and Atmospheric Administration. We considered same-day and lagged exposures in separate models. We modeled associations between WFS and mortality for each county using generalized additive models adjusted for year, day of week, fine particulate matter, ozone, temperature, a smoothed term for day of year, and an interaction term between WFS and an indicator variable for the pandemic. County-specific results were pooled to generate overall estimates of risk.

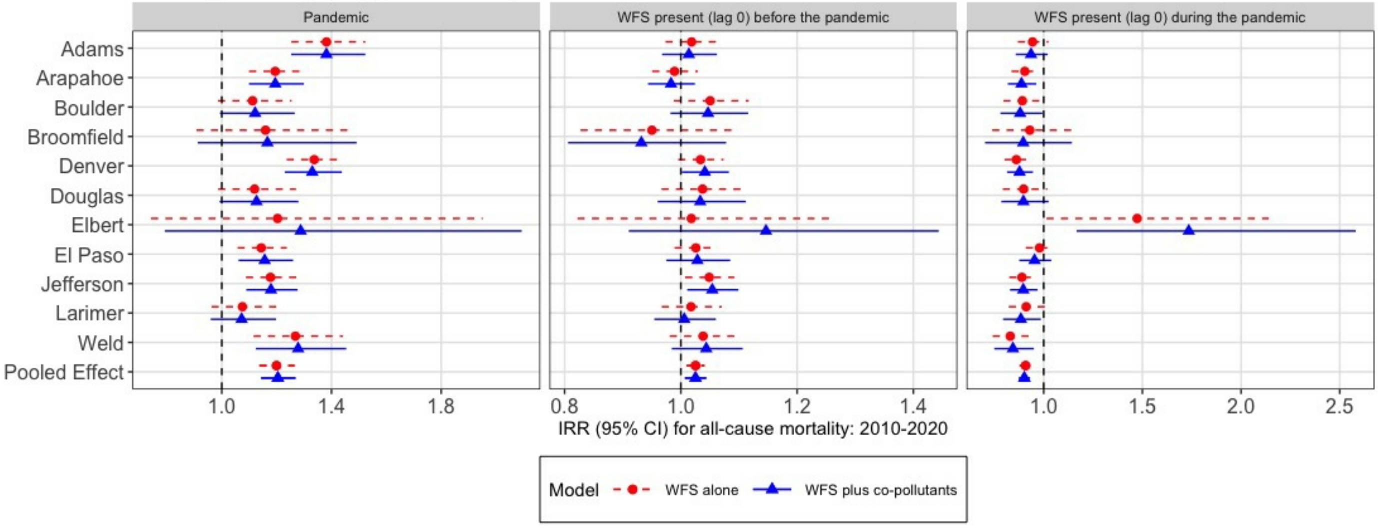
Results

Prior to the pandemic, we observed a positive association between WFS exposure and all-cause mortality (incidence rate ratio (IRR) = 1.03, 95%CI: 1.01 – 1.04 for same-day exposures)). During the pandemic, however, WFS exposure was associated with an IRR below 1 for all-cause mortality (IRR = 0.90, 95%CI: 0.87 – 0.93 for same-day exposures).

Conclusions

Our findings of reduced mortality due to WFS during the pandemic suggest mitigation efforts to slow the spread of the virus and high ambient WFS concentrations may have promoted health behaviors that reduced overall WFS exposures, resulting in fewer all-cause deaths. Future work should examine how pandemic-related factors impact associations between WFS and mortality. Additionally, there is a need to explore how lessons from the pandemic may be translated into health-protective policies during WFS events.

Figure 1: Incidence rate ratios for all-cause mortality associated with the COVID-19 pandemic, the presence of wildfire smoke (lag 0)before the pandemic, and the presence of wildfire smoke during the pandemic (lag 0) for each county in the study area and the pooled estimate. Results for models for WFS alone (red dashed line) and adjusted for PM2.5, ozone, and temperature (lag 0) (blue solid line) are shown.



Wednesday OS3

Effect modification of associations between aeroallergens and childhood asthma exacerbation by rhinovirus (RV)/respiratory syncytial virus (RSV) infections, Philadelphia, PA, 2011 – 2016

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Abstract

Background/Aims: Respiratory virus infections contribute over 80% of childhood asthma exacerbations (AE). They enhance pro-inflammatory mediator release, especially for sensitized individuals exposed to pollen/molds. We evaluated modification of associations between aeroallergens and childhood AE by respiratory viral infections, within a time-series framework.

Methods: AE visits (outpatient/inpatient clinical settings) with asthma diagnoses and systemic steroid prescriptions, as well as monthly viral infection counts at the Children's Hospital of Philadelphia, were obtained from the electronic health record (EHR) system. Daily aeroallergen data came from a National Allergy Bureau-certified monitor in the Center City. We estimated associations between aeroallergens and daily AE rates using quasi-Poisson regression models with distributed lag nonlinear functions of aeroallergens (lag 0-14). We included viral effect modifiers (tertile-based) as multiplicative interaction terms. We estimated AE rate ratios (RRs) for aeroallergens at each RV/RSV teritile, adjusting for daily temperature, relative humidity, long-term/seasonal trends, day-of-week, and holidays.

Results: Except for a few aeroallergen/virus combinations, results suggested little evidence supporting effect modification by viral infections. Results suggested higher AE rates when circulating RV levels in the community were high, comparing 90th percentile vs. zero oak tree/grass pollen (late-season) counts – although with low precision. Specifically, AE for oak tree pollen was RR (95% CI) 1.16 (0.82 – 1.64, RV 3rd tertile) vs. 0.96 (0.82 – 1.11, RV 1st tertile); and AE for grass pollen was RR 1.00 (0.85 – 1.17, RSV 1st tertile), 1.04 (0.95 – 1.15, RSV 2nd tertile), 1.12 (0.96 – 1.32, RSV 3rd tertile). Results did not suggest higher AE rates for combinations of RV/RSV and weed pollens/molds.

Conclusion: Our study provides weak evidence, supporting effect modification by RV/RSV, on the effects of aeroallergens for AE. Nevertheless, considering limited previous work, more epidemiologic studies are needed to explore these hypotheses in other pediatric populations.

Wednesday OS3

SARS-CoV-2 and other respiratory viruses among industrial livestock operation workers, North Carolina, 2021-2022

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Abstract

Background/Aims: Meat and poultry processing plants emerged as centers of COVID-19 outbreaks across the United States early in spring 2020. We aimed to investigate associations between work and respiratory viruses, including COVID-19, in a North Carolina study population predominantly working at or living near industrial livestock operations (ILOs), and to investigate workplace health and safety protections relevant to infectious disease reported by in-person workers.

Methods: We enrolled 279 participants in North Carolina from February 2021 to July 2022, including 77 ILO workers and 75 people working in person in other industries. Participants completed a baseline questionnaire on demographic and job characteristics, COVID-19, and recent symptoms. We also analyzed participant-collected saliva swab samples for IgG antibodies specific to SARS-CoV-2; human coronaviruses 229E, OC43, HKU1, and NL63; and RSV using a multiplex immunoassay based on Luminex technology. We used GEE logistic regression clustered by household to identify associations of ILO work with antibody responses.

Results: The prevalence of infection-induced SARS-CoV-2 antibody was high in our study population (53%). More ILO workers (66%) had SARS-CoV-2 infection-induced IgG compared to participants working in person in other industries (45%) (prevalence ratio [PR]=2.2, 95% confidence interval [CI]=1.1, 4.4) and participants either not working or working from home (45%) (PR=2.3, 95% CI=1.2, 4.5). Most ILO workers (89%) and other in-person workers (81%) reported face masks were required at the workplace, but other controls were less frequently reported. More ILO workers reported COVID-19 testing available at work (44%) compared to other in-person workers (26%), but fewer ILO workers reported any changes in absence policies (18%) compared to other in-person workers (26%).

Conclusion: Questionnaire results suggest low rates of the most effective COVID-19 and infectious disease workplace controls, which may explain the some of the relatively high rates of SARS-CoV-2 infection among ILO workers.

Wednesday OS3

The Association Between Political Environment and COVID-19 Mortality in Selected Colorado Counties

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Abstract

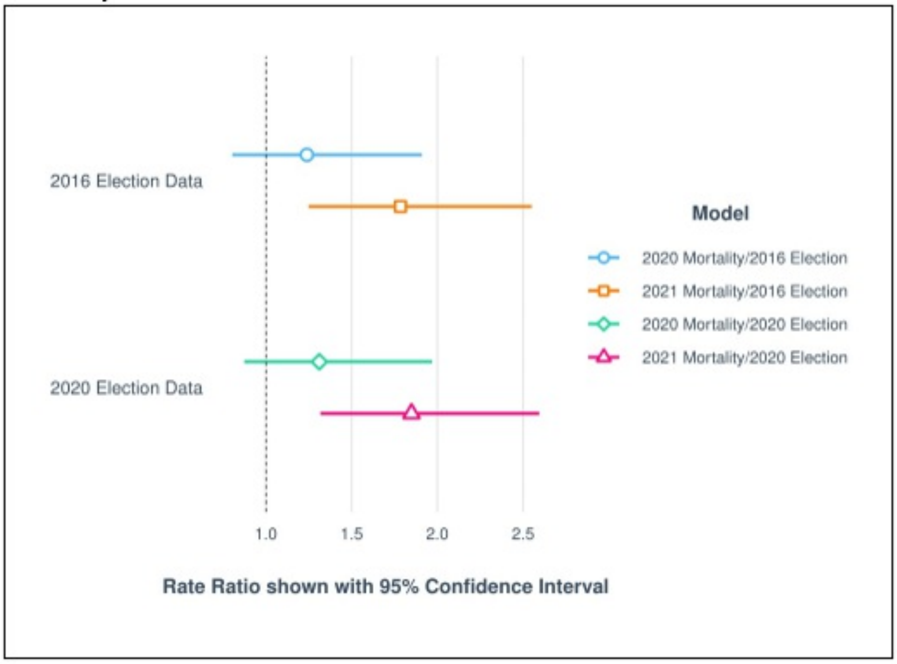
Background/Aims: The COVID-19 pandemic occurred during a time of political division in the United States. Variation in COVID-19 outcomes, including mortality, may be associated with differences in political views, but few studies have evaluated this question using county-level data. Our objective was to investigate whether county-level political environment, as measured by election results in the 2016 Presidential election in the state of Colorado, was associated with COVID-19 mortality in Colorado, while adjusting for differential environmental and socioeconomic burdens.

Methods: We examined the association of county-level 2016 Presidential election results and county-level age-adjusted COVID-19 mortality using Quasi-Poisson regression models, separately for 2020 and 2021. Models were adjusted for population density, percentage of the population uninsured, and demographics percentile from the Colorado EnviroScreen Environmental Justice Tool.

Results: Age-adjusted mortality rates ranged from 14.3-458.0 per 100,000 . For 2021 mortality data, the estimated mean adjusted mortality rate was 78% higher among counties voting for Donald Trump as compared to counties voting for Hilary Clinton in the 2016 election. (Rate ratio = 1.78; 95% confidence interval (CI): 1.26-2.59). For 2020, the estimated mean adjusted mortality rate was 24% higher among counties voting for Donald Trump as compared to counties voting for Hilary Clinton, although this association was not statistically significant. (RR=1.24; 95% CI: 0.81-1.94). Similar results were observed for the 2020 election data for mortality in 2020 and 2021.

Conclusions: This study provides evidence to support an ecologic level association between county-level political environment and age-adjusted COVID-19 mortality rates, building on a growing body of evidence linking ecologic-level political environment and COVID-19 outcomes. This study also provides evidence of the utility of the EnviroScreen Environmental Justice Tool in research, extending beyond the primary goal of public access to geographical risk data.

Figure: Quasi-Poisson adjusted models showing the association between political environment, measured by 2016 & 2020 Presidential election outcome data, and the age-adjusted COVID-19 mortality rates for 2020 & 2021.



Wednesday OS3

Associations between nitrogen dioxide and routine vaccine antibody levels in children

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Abstract

Background: The worldwide COVID-19 pandemic has magnified the public health importance of vaccine antibody response. Existing research suggests that vaccine antibody response is modified by environmental factors, although the association with NO_2 has not been assessed, despite evidence linking NO_2 with other immune-mediate outcomes.

Methods: We assessed nitrogen dioxide (NO_2) at 1-km^2 spatial resolution via novel hybrid models we developed, and serum antibody levels of diphtheria, tetanus, and pertussis measured postpartum in vaccinated children ages 4-6 years enrolled in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) cohort in Mexico. Spatiotemporally resolved NO_2 levels were assigned to study participants based on their geocoded home addresses. Using linear mixed-effects models, we examined the association between prenatal (trimester average) exposure and long-term postnatal (one-year average) exposure to NO_2 and log-transformed 4- and 6-year antibody levels to diphtheria, tetanus, and pertussis vaccinations. All models included random intercepts for participant to account for multiple visits and were further adjusted for temperature, child age at blood draw, sex, maternal socioeconomic status, and maternal age and BMI.

Results: 216 children contributed antibody levels at 4 years (n=207) and 6 years (n=9) (mean age = 4.74 years). Per 1 µg/m^3 increase in trimester average NO_2, diphtheria, tetanus, and pertussis antibody levels increased by 5.02% (95%CI: 2.43, 7.68%), 5.00% (95%CI: 2.33, 7.73%), and 5.00% (95%CI: 2.04, 8.05%) respectively. Per 1 µg/m3 increase in one-year postnatal NO_2, diphtheria, tetanus, and pertussis antibody levels decreased by 3.86% (95%CI: -6.36, -1.29%), 3.71% (95%CI: -6.29, -1.07%), and 2.49% (95%CI: -5.39, 0.50%) respectively.

Conclusions: We found evidence of increased antibody levels to prenatal NO_2 exposure and decreased antibody levels to postnatal NO_2 exposure. Although exposure to environmental toxicants during and after pregnancy may impact children’s immune systems, the positive associations observed in our study require further exploration.

Wednesday OS4

Progress on Implementing CDC’s updated Blood Lead Reference Value (BLRV)

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Abstract

Background

In 2012, the Centers for Disease Control and Prevention (CDC) introduced a blood lead reference value (BLRV) to identify children with higher levels of lead in their blood compared with most children. The BLRV is not a health-based standard or a toxicity threshold.

The BLRV is based on the 97.5th percentile of the blood lead distribution in U.S. children ages 1–5 years from the National Health and Nutrition Examination Survey (NHANES) data. The initial BLRV of 5 micrograms per deciliter (µg/dL) was based on NHANES data from the 2007–2010 cycles. In 2021, the Lead Exposure Prevention Advisory Committee (LEPAC) voted to lower the BLRV from 5 µg/dL to 3.5 µg/dL based on data from NHANES 2015–2018, and CDC accepted this recommendation.

Methods

CDC’s Lead Poisoning Prevention and Surveillance (LPPS) Branch (proposed) is reviewing progress of CDC-funded state health departments (48 states, DC, and PR) one year after announcement of the updated BLRV. This analysis includes evaluating status of implementing the BLRV, date of implementation and method (law/statute, policy, guidance, or practice) if applicable. Analyses by region and other census data will also be conducted.

Results

Preliminary results indicate that 22 states have implemented the new BLRV, and 15 states have partially implemented it as of October 2022. We will present data on the number and characteristics of programs who have implemented or are in process of implementing the updated BLRV. Regional patterns will also be presented.

Conclusion

Results of this analysis will be used by CDC to better understand the successes and challenges related to implementing the updated BLRV and associated impacts. CDC could use this information to develop additional guidance and provide technical assistance to assist state health departments in using the updated BLRV.

Wednesday OS4

Urinary metal concentrations during pregnancy, placental cell composition, and placental DNA methylation in two prospective birth cohorts.

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Abstract

Background: Metals exposure during pregnancy is associated with adverse health outcomes and perturbations to placental DNA methylation (DNAm) or cellular composition may play a role.

Objective: Identify effects of prenatal manganese exposure on placental cell composition and DNAm.

Methods: We analyzed samples from the Markers of Autism Risk in Babies and Learning Early Signs (MARBLES) and Early Autism Risk Longitudinal Investigation (EARLI) ($n_{MARBLES}$=90; n_{EARLI}=118) cohort studies. Urinary metals choncentrations were collected during pregnancy. Placental DNAm at birth was measured with Illumina microarrays. We estimated cellular composition and principal components via a deconvolution external reference. Linear models tested associations between metals concentrations and cell composition (adjusted for sex, gestational age, child race/ethnicity, maternal age, and maternal education), or metals and site-specific DNAm ($n_{MARBLES}$=821,008; n_{EARLI}=455,650) with and without additional adjustment for cell composition.

Results: In MARBLES, median (n, IQR) second trimester manganese concentration was 0.267µg/L (n=59, 0.193µg/L) and 0.272µg/L (n=79, 0.290µg/L) in third trimester. In EARLI, concentrations were 0.238µg/L (n=85, 0.219µg/L) and 0.237µg/L (n=81, 0.359µg/L) in first and third trimesters. Pooled mean (SD) estimated cell composition was 62.7% (8.5%) Syncytiotrophoblast, 17.5% (6.8%) Stromal, 7.7% (5.0%) Cytotrophoblast, 6.1% (2.7%) Endothelial, and 2.2% (1.9%) Hofbauers. A doubling in second trimester MARBLES (n=59) manganese was associated with 0.30 (95% CI: -0.003, 0.67) Z-score increase in cell composition principal component one (68.9% variance explained). A doubling in manganese was also associated with 4.2% higher DNAm at cg00345059 (p-value=8.1×10^{-6}) and 4.3% higher DNAm at cg14602960 (p-value=9.5×10^{-6}). Without cell composition, adjusted differential methylation at cg00345059 (2.6%, p-value=0.011) and cg14602960 (3.7%, p-value=3.7×10^{-5}) was attenuated.

Conclusion: Prenatal exposure to manganese during the second trimester may alter placental cell composition and DNAm. To further elucidate biological effects of prenatal metals exposure, future directions will test additional metals, meta-analysis, and whether cell composition mediates metals exposure on placental DNAm.

Wednesday OS4

Modification of the associations between gestational lead exposure and autistic behaviors by maternal folate status

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Abstract

Background: Maternal folic acid (FA) intake may attenuate associations between gestational exposure to certain chemicals and autism or its associated behaviors. But this potential attenuation has not been assessed for lead, a well-established neurotoxicant. We examined whether the relationship between gestational lead exposure and dimensional autistic behaviors was modified by folate, child sex, and maternal methylenetetrahydrofolate reductase (MTHFR) 677C>T genotype.

Methods: We used data from the Maternal-Infant Research on Environmental Chemicals (MIREC) study, a Canadian pregnancy and birth cohort (2008-2011). We assessed autistic behaviors in 601 3-4-year-old children using the Social Responsiveness Scale-2 (SRS-2), where higher scores denote more autistic-like behaviors. We measured blood-lead levels (BLLs) and plasma total-folate concentrations during the first and third trimesters of pregnancy. We also considered self-reported FA intake from supplements (12-16th weeks' gestation) and maternal MTHFR 677C>T genotype. We estimated confounder-adjusted associations between log2-transformed BLL and SRS scores by child sex, maternal folate status, and maternal MTHFR 677C>T genotype using linear regression models with interaction terms.

Results: Each two-fold increase in third trimester BLLs was associated with a 2.68-point increase in SRS scores (95% CI: 0.36, 5.00) among mothers who consumed <400 µg FA/day. Associations were null (β = -0.23, 95% CI: -1.16, 0.69) among mothers with adequate FA supplementation (400-1000 µg FA/day) (p-interaction = 0.02). Plasma total-folate concentrations (<10th percentile versus 10th – 80th percentile) similarly modified these associations (p-interaction < 0.001). Third trimester BLL-SRS associations were also stronger among mothers who possessed two MTHFR 677C>T single nucleotide polymorphisms than those with none (p-interaction = 0.05). These variables also modified first trimester BLL-SRS associations, but to a lesser extent.

Conclusion: Our results suggest that maternal folate status – measured with self-reported FA supplementation, gestational plasma total-folate concentrations, and MTHFR 677C>T genotype – modified the associations between gestational lead exposure and childhood autistic behaviours.

Wednesday OS4

Breastfeeding and early childhood erythrocyte concentrations of non-essential and essential metals in the Project Viva cohort

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Abstract

Background: Some non-essential and essential metals pass through breastmilk to the infant, critically impacting development. The potential long-term impacts of breastfeeding on circulating metals months or years after breastfeeding has ended remains unexplored.

Methods: We analyzed data from Project Viva, a pre-birth cohort in Boston, Massachusetts. We categorized maternal-reported breastfeeding practice at six months post-partum as never-breastfed (reference group), weaned from breastfeeding to formula, mixed breastfeeding and formula, or exclusive breastfeeding. We measured six essential (Cu, Mg, Mn, Mo, Se, and Zn) and nine non-essential (As, Ba, Cd, Co, Cs, Hg, Pb, Sn, and Sr) metals in child erythrocytes at the early childhood study visit [mean age (range): 3.2 years (2.8-6.2)]. We used linear regression to regress log-transformed metal concentrations on breastfeeding history, with adjustment for socioeconomic variables and maternal diet during pregnancy.

Results: We analyzed 330 mother-child pairs. Compared to never-breastfed infants, early childhood erythrocyte Mg was higher in infants who, at 6 months, were weaned (8.6%; 95% confidence interval (CI): 0.4, 17.5), mixed fed (10.2%; 95% CI: 1.5, 19.6), and exclusively breastfed (10.2%; 95% CI: 1.6, 19.6). Similarly, compared to never-breastfed infants, Se was higher in weaned (7.1%; 95% CI: -2.1, 17.2), mixed fed (17.4%; 95% CI: 6.9, 28.9), and exclusively breastfed (16.0%; 95% CI: 5.6, 27.4) infants. Infants that were exclusively breastfed or mixed fed had greater levels of both Cu and Zn compared to never-breastfed infants. Among non-essential elements, only total As was associated with exclusive breastfeeding (52.7%; 95% CI: 7.7, 116.6).

Conclusion: Breastfeeding in the first six months of life was associated with higher child erythrocyte concentrations of essential metals, including Mg, Se, Zn and Cu, at age 3 years, whereas associations for non-essential metals were null except for As. Early-life breastfeeding was associated with circulating elements months or years later.

Wednesday OS4

Prenatal Lead Exposure and the Gut Microbiome in Childhood

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Abstract

Introduction: Metal exposures are associated with gut microbiome (GM) composition and function, and exposures early in development may be particularly important. Considering the role of the GM in association with many adverse health outcomes, understanding the relationship between prenatal metal exposures and the GM is critically important. However, there is sparse knowledge of the association between prenatal metal exposure and the GM later in childhood. This analysis aims to identify associations between prenatal lead (Pb) exposure and GM composition and function at 9-10 years old.

Methods: Data come from the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) cohort based in Mexico City, Mexico. Prenatal metal concentrations were measured in maternal whole blood drawn during the second and third trimesters of pregnancy. Stool samples collected at 9-10 years old underwent metagenomic sequencing to assess the GM. This preliminary analysis uses a linear model to estimate the association between maternal blood Pb during pregnancy and Shannon diversity of the child GM at 9-10 years old, adjusted for child sex, and a similar model used weighted quantile sum regression with random subsets (WQSRS) with a weighted index of microbiome taxa.

Results: Of the 50 child participants in this preliminary analysis, 31 were male and 19 were female. Median prenatal maternal blood Pb was 21.4 ug/dL. Initial analysis suggests a negative relationship between prenatal maternal blood Pb and the GM at age 10, however estimates adjusted for sex were not significant (prenatal Pb and alpha diversity $\beta=-0.22$, $p=0.28$, prenatal Pb and GM WQSRS $\beta=-0.20$, $p=0.48$).

Conclusion: Preliminary analysis suggests a negative association between prenatal Pb exposure and the gut microbiome later in childhood; however, additional investigation is needed.

Wednesday OS4

Early life metal exposure is associated with reduced fractional anisotropy in the corpus callosum in children

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Abstract

Background: The corpus callosum (CC) is the largest white matter structure in the brain, connecting the left and right hemispheres into functional networks subserving cognition and behavior. Neuroimaging studies demonstrate rapid CC development during the first years of life. During these early-life critical windows, the CC is vulnerable to perturbation by neurotoxicants including heavy metals. Most environmental studies consider single neurotoxicant exposures at a single time point, potentially missing the effects of joint exposure across a developmental stage. Here, we investigated associations between early-life metal mixture exposure and CC white matter microstructure integrity in children.

Methods: In a preliminary analysis of 47 children (8-13 years; 22 females) enrolled in a neuroimaging substudy within the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study, we estimated weekly exposure (22nd week gestation through 43rd week postnatal) to manganese (Mn), zinc (Zn), and lead (Pb) using laser ablation-inductively coupled plasma-mass spectrometry of teeth. We estimated CC white matter microstructure integrity using fractional anisotropy (FA) from diffusion tensor imaging (DTI) acquired in a 3T Siemens scanner. We used lagged weighted quantile sum (lWQS) regression to estimate the time-varying mixture effect on FA in the CC.

Results: A higher metal mixture index in the 24th-43rd postnatal weeks was associated with decreased FA in the CC genu, body, and splenium (maximum $\beta = -0.65$ [95% CI -0.25, -1.07]), driven mainly by Zn and Pb.

Conclusion: The CC may demonstrate a postnatal critical window to metals, with higher exposure to Zn and Pb associated with reduced FA. These results may help understand the role of exposure timing in driving neurodevelopmental outcomes, pointing to future optimal and timely public health interventions.

Wednesday OS5

Objectively measured greenneess and sleep: a daily longitudinal assessment using the Nurses' Health Study 3 Mobile Health Study

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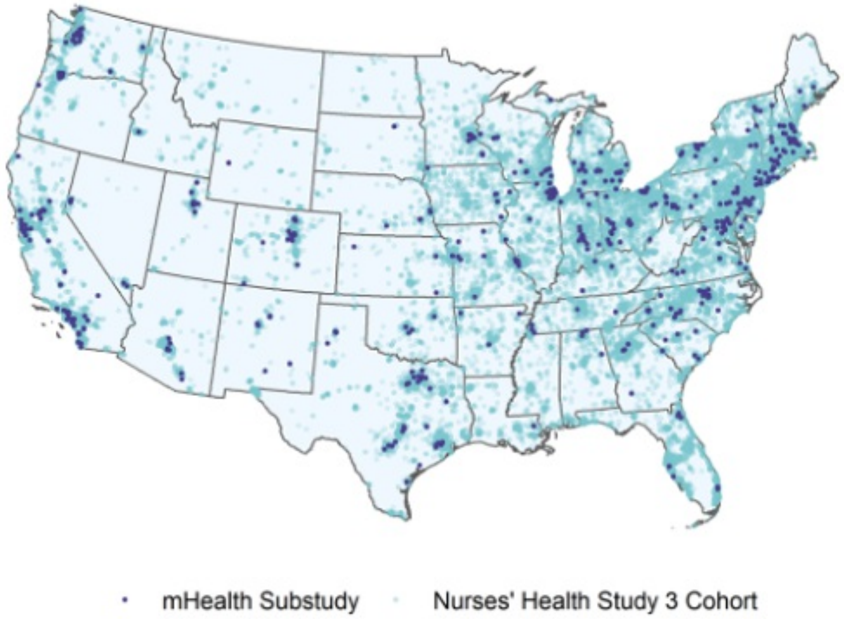
Abstract

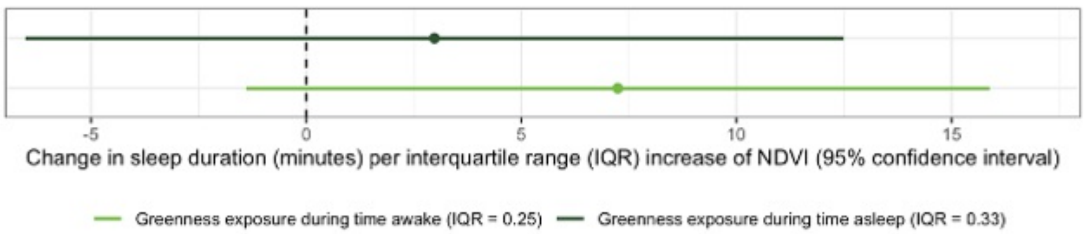
Background: Sleep is an important determinant of health that may be impacted by environmental exposures, including vegetation (greenness), which may facilitate relaxation/exercise during waketime or buffer pollution during sleep. Prior analyses used greenness exposure around the residence or self-reported sleep. Using mHealth tools, we tracked individual mobility to spatiotemporally refine greenness assessment and objectively measure sleep.

Methods: We passively collected Global Positioning System (GPS) data (10-minute intervals) using a custom-designed smartphone application and sleep data using Fitbit wrist-worn wearable devices (30-second intervals) from Mobile Health Substudy participants, embedded in the nationwide Nurses' Health Study 3 cohort. We assessed greenness – based on GPS every 10 minutes during 7-day sampling periods across 4 seasons (2018-2020) – using Landsat satellite-derived 30 m resolution Normalized Difference Vegetation Index data (n = 447,120 GPS-located exposure points). To assess associations of waketime greenness with sleep duration, we aggregated daily waketime GPS-located greenness and derived total sleep minutes during the consecutive main sleep period. Additionally, we assessed sleeptime GPS-located greenness while the participant was asleep. Analyses were restricted to participants with ≥8 hours waketime data on ≥3 days with consecutive sleep records (n participants = 209 (57.4%); n sleep records = 2446). We used a generalized linear mixed model fitted with a random intercept for participant, adjusted for age, BMI, GPS-based walkability, temperature, noise, light-at-night, and neighborhood socioeconomic status, weekday, season, and an autoregressive covariance matrix to account for correlation in adjacent time points.

Results: In adjusted models, an interquartile range (IQR) increase in waketime NDVI (IQR 0.25) was associated with 7.24 additional sleep minutes during the consecutive sleep (95% CIs: -1.40, +15.88). An IQR increase in sleeptime NDVI (IQR 0.33) was associated with 2.98 additional minutes during that sleep (95% CIs: -6.53, +12.49).

Conclusion: Waketime and sleeptime greenness may impact sleep duration. Mediation will be explored.


mHealth Substudy
Nurses' Health Study 3 Cohort


-5
0
5
10
15
Change in sleep duration (minutes) per interquartile range (IQR) increase of NDVI (95% confidence interval)
Greenness exposure during time awake (IQR = 0.25)
Greenness exposure during time asleep (IQR = 0.33)

Wednesday OS5

Organophosphate flame retardants in house dust and mental health outcomes among Canadian mothers: a nested prospective cohort study in CHILD

Stephanie Foster[1], Molly Kile[1], Perry Hystad[1], Jeffrey Brook[2]
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Abstract

Background: Organophosphate flame retardants (OFPRs) are a common exposure in modern built environments. Toxicological models show some OPFR congeners reduce dopamine and serotonin in the brain. Deficiencies in these neurotransmitters are associated with mental health disorders in humans, including anxiety and depression. While epidemiological evidence suggests OPFR exposures affect neurocognition and behavior in children, impacts on maternal mental health have not been explored. We hypothesized that higher concentrations of OPFRs in house dust would be associated with higher depression and stress levels in mothers across the prenatal and postpartum time periods.

Methods: We conducted a nested prospective cohort study using data collected on mothers (N=718) in the CHILD Cohort Study, a longitudinal multi-city prospective Canadian birth cohort (2008-2012). OPFRs were measured in house dust sampled at 3-4 months postpartum. Linear and logistic mixed models examined the association between a summed Z-Score OPFR index, a clinically relevant depression score (Centre for Epidemiologic Studies for Depression Scale), and stress levels (Perceived Stress Scale). Mental health outcomes were measured at 18 and 36 weeks gestation and at 6 months and 1 year postpartum.

Results: OPFRs were associated with maternal PSS score. One standard deviation increase in OPFRs was associated with a 0.07-point (95% CI: 0.01, 0.13, p=0.023) increase in PSS score, after adjusting for covariates. There was a small non-significant effect on the odds of a clinically relevant CES-D score (OR: 1.03, 95% CI: 0.99, 1.07, p=0.11). The effect of OFPRs on PSS score was strongest at 36 weeks gestation and weakest at 1 year postpartum.

Conclusion: There was a small but statistically significant relationship between OPFRs and maternal perceived stress levels but not clinical depression. Given the prevalence of postpartum depression and anxiety and the ubiquity of OPFR exposures, additional research is warranted to understand if these chemicals affect maternal mental health.

Uncaptioned visual

Wednesday OS5

Greenspace exposure and inequality in urban China

Yimeng Song[1], Bin Chen[2], Michelle L. Bell[1]
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Abstract

BACKGROUND: A growing literature highlights the important role of greenspace in living environments and human health, however, there are fewer studies to quantify greenspace exposure disparities for regions with different urbanization levels, especially for cities in rapidly industrializing countries. Furthermore, commonly used inequality measures do not fully incorporate the impact of human mobility in exposure assessment.

METHODS: To help fill this knowledge gap, we evaluated the inequality in urban greenspace exposure for 303 cities in China for 2016. We conducted greenspace exposure assessment by leveraging a modified dynamic environmental exposure assessment framework with multi-source geospatial big data, such as fine-resolution remote sensing data, and social sensing data. The inequality in greenspace exposure was evaluated by the Gini index.

RESULTS: Our preliminary findings reveal that the majority of Chinese cities have high inequality in greenspace exposure, with 207 cities having a Gini index larger than 0.6. Driven by the spatiotemporal variability of human mobility, the magnitude of inequality varies slightly over different times of the day. We also find that greenspace exposure inequality is correlated with low greenspace provision with a statistical significance (p-value < 0.05). The inadequate provision may result from various factors, such as dry cold climate and urbanization patterns.

CONCLUSION: Our study provides evidence and insights for the equitable distribution of greenspace in Chinese cities. Findings can inform central and local governments in China to implement more effective and sustainable greening programs, accounting for local circumstances and incorporating public engagement for developing healthy cities.

Wednesday OS5

Environmental Impact of Switching Natural Gas Furnaces to Heat Pumps

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Abstract

Background

Building emissions are significant contributors to climate and public health. Emissions from on-site fuel combustion in buildings alone resulted in ~17-23K premature deaths in the U.S. in 2017. In the same year, building energy use – including both on-site fuel combustion and delivered electricity– accounted for 27% of the greenhouse gas (GHG) emissions in the U.S. As building electrification is a major part of climate plans, switching gas-fired heating systems to heat pump heating systems in buildings is a major focus of climate plans in building sectors. However, environmental impacts of this transition are not fully investigated. This study aims to investigate emission impacts of switching from natural gas furnaces to heat pumps with different coefficients of performance (COPs) in different locations within the U.S.

Methods

Since COP is a function of the outdoor air temperature, heat pumps have different efficiencies in different U.S. climate regions. To compare the amount of emission produced by heat pumps versus natural gas furnaces, we used data from the U.S. Environmental Protection Agency and Energy Information Administration.

Results

Results show that despite climate region differences, high COP heat pumps produce lower emissions and save more energy than natural gas furnaces. Furthermore, within the same climate region, the minimum COP threshold at which heat pumps have lower emissions than natural gas furnaces is highly dependent on the regional grid emission rate. For instance, in New York City in the year 2020, the annual average COP of heat pumps should be ~2 or higher for heat pumps to have lower CO_2 emissions than that of natural gas furnaces with annual fuel utilization efficiency (AFUE) of 95%.

Conclusion

The results of this study help guide building electrification planning that is tailored to each region to ensure reduction of emissions leading to both climate and health co-benefits.

Wednesday OS5

Multiple environmental and social factors associated with height-for-age in children under five years old in Uganda.

Kayan Clarke, Tara Sabo-Attwood, Eric Coker
University of Florida, Gainesville, USA

Abstract

Stunting has been linked with a variety of nutritional and environmental (poor sanitation, water, air pollution and hygiene practices) factors. Given the complex web of multi-level environmental stressors for poor childhood growth, there is a need to leverage emerging data science tools to better understand risk factors for child growth failure. This study applied Bayesian profile regression modeling to explore combined effects of multiple environmental stressors to identify children most susceptible to low height-for-age. Three waves of the Ugandan Demographic Health Surveys (UDHS) was used to determine the height-for-age z-score for children under five years old. Environmental indicators included in the individual-level analysis are prenatal and postnatal PM2.5 exposure, agricultural land use, precipitation, mean temperature, and other area-level covariates (e.g., rurality). Our analysis also included child level (eg. birth weight, hemoglobin level), parental-level (eg. parental education level, teenage pregnancy), and household-level covariates (eg. improved water and sanitation practices). Bivariate analysis using ANOVA with Bonferroni correction indicated 28 of the 48 covariates were significantly associated with height-for-age among children under five years old. Preliminary Bayesian cluster analysis results revealed that clusters with significantly lower height-for-age were characterized by profiles with significantly higher combined exposure to environmental and social stressors. Specifically, elevated stressors included high prenatal and postnatal PM2.5 exposure, unimproved sanitation facilities, homes that did not use mosquito nets, lower parental education, lower wealth index, and children that were not delivered at a hospital. Clusters with higher height-for-age had the converse type of profile for environmental and social stressors. There is a combination of adverse environmental and social factors that drive the risk of lower height-for-age in children under five years old in Uganda.

Wednesday OS5

Short-term ambient PM2.5 exposure and mortality in Massachusetts: Effect modification by structural air exchange rates

Futu Chen[1], Jaime Hart[2,1], Jarvis Chen[3], Brent Coull[4,1], Patricia Fabian[5], Gary Adamkiewicz[1]
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Abstract

Background:

Air Exchange Rate (AER) is a building ventilation factor determining the infiltration of ambient air pollution indoors. However, little is known regarding AER as a source of effect heterogeneity. Therefore, we incorporated parcel-level structural AER estimates as a modifier of the association between short-term ambient PM2.5 exposure and cause-specific mortality in Massachusetts (MA).

Methods:

In this time-stratified case-crossover study, we included 770,826 non-accidental deaths aged 40 years or older between January 5th, 2000, and December 31, 2015. For each death, the case day was the date of death, and control days were every third day before and after the case day in the same month/year. Exposure was ambient average daily level of PM2.5 estimated from a spatial model with 0-1 lag. Confounders included ambient average daily temperature, relative humidity, and day of the week. Effect modification by seasonal parcel-level AER estimated from an extension of the Lawrence Berkeley Laboratory model. Data were analyzed with conditional logistic regression and generalized additive models. Effect measure modification on the multiplicative scale was examined with an AER and PM2.5 product term each season.

Results:

Effect modification was most significant during the warm season among multifamily parcels for all-cause and respiratory mortality, where we observed an increase in ambient PM2.5-associated mortality risk among higher AER parcels (interaction p-value = 0.04, 0.004, respectively). Similarly, among residential parcels, we found an increased risk with higher AER parcels among respiratory mortality parcels (interaction p-value = 0.035). No significant effect measure modification was observed during the cool season.

Conclusion:

Parcel-level AER was a modifier of the association between short-term ambient PM2.5 and mortality during warm seasons. Including parcel-level AER may help us to better quantify associations with pollution by reducing measurement error especially when it is differential.

Uncaptioned visual

Note: * p<0.05; ** p<0.01;

Wednesday OS6

Environmental Justice at Ezra Prentice Homes: The South End Community Health Survey

Stacy Pettigrew[1,2], Sara Adams[3], Wendy Parker[1], Dorcey Applyrs[4]

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Abstract

Background: Located in the industrial, southernmost tip of Albany, NY, Ezra Prentice Homes (EP) is a 176-unit public housing complex. Adjacent to the Port of Albany, it is dissected by a busy state highway. Residents requested a community-based health survey as residents, community leaders, and environmental activists drew attention to environmental health concerns. The New York State Department of Environmental Conservation concluded in the Albany South End Community Air Quality Study that compared to the rest of the neighborhood, in the EP community traffic related air pollutants (TRAPs) were observed at 'considerably higher' levels.

Methods: In 2016, a community and academic partnership began the South End Community Health Survey of EP households. A Resident Outreach Worker (ROWs) model was utilized: ROWs introduced the survey to neighbors and created appointments for in-depth health surveys. To capture data from a demographically similar group, the survey expanded to Creighton Storey Homes (CS), a nearby public housing complex surrounded by residential green space.

Results: 119 households (301 individuals) from EP (68%) and 66 households (164 individuals) from CS (52%) participated. Previously analysis observed elevated odds of asthma at Ezra Prentice (OR 1.85, CI 1.18, 2.91). Health impacts were tested by z-score for 2 population proportions. Allergies were significantly higher at EP (34%) than CS (18%) (p=.02) among both adults (43% v. 30%, p= .0444) and children under 18 (38% v. 18%, p=.0042). Higher levels of cancer, heart disease, COPD, rash, neurological disorders, wheeze, sinus, and throat problems were observed at EP but failed to reach significance. Other prevalence observed among all adults included: high blood pressure (21%); T2DM (16%); and psychological disorders (22%).

Conclusion: Significantly higher rates of allergy have been observed at a public housing complex where elevated TRAPs have been documented. Results will continue to be shared with the community.

Wednesday OS6

Environmental Exposures and Pulmonary Function among Adult Residents of Rural Appalachian Kentucky

John Flunker[1], Wayne Sanderson[2], Jay Christian[2], David Mannino[2], Browning Steven[2]
[1]University of Washington, Seattle, USA. [2]University of Kentucky, Lexington, USA

Abstract

Uncaptioned visual

Background

Rural Appalachian Kentucky residents experience a high regional prevalence of respiratory disease. Environmental exposures, especially resource extraction, encountered in residential valleys are hypothesized to be contributing factors. We aimed to validate a novel metric of small-area geographic variation in residential environmental exposures and determine how such exposures impact pulmonary function among adults in a community-based study.

Methods

Associations between residential environmental respiratory exposures and pulmonary function were examined among 827 adult participants of the “The Mountain Air Project”, a community-based, cross-sectional study in Southeastern Kentucky during 2016-2018. Exposures characterized the density of roadways, oil/gas wells, or current/past surface and underground coal mining at the level of 14-digit hydrologic unit code (HUC), or valley “hollow”, where participants resided. Nanoparticle concentrations (TSI Nanoscan) were measured in representative HUCs. Each participant completed an in-person interview obtaining extensive background data on risk factors, health history, and occupational and environmental exposures, as well as a spirometry test administered by experienced study staff at their place of residence. Multivariable linear regression was used to model the adjusted association between each HUC environmental exposure versus nanoparticle concentrations and, separately, percent predicted forced expiratory volume in one second (FEV1PP) and forced vital capacity (FVCPP).

Results

Nanoparticle concentrations increased by 0.095 log particles/cc with every one unit increase in HUC roadway density (95% CI: 0.03, 0.16). Adjusted regression models indicate participants living in HUCs with the highest level of roadway density experienced a reduction in both FEV1PP (-4.3: 95% CI: -7.44 -1.15;) and FVCPP (-3.8: 95% CI: -6.38, -1.21) relative to participants in HUCs with the lowest roadway density. No associations were detected between exposure metrics for resource extraction and individual pulmonary function.

Conclusion

Roadway density at the level of the HUC of a residence may contribute to reduced lung function among rural Appalachia adults.

Wednesday OS6

Cardiovascular Health and Urban Oil Drilling in Los Angeles, California

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[1]University of Southern California, Los Angeles, USA. [2]LA Grit Media, Los Angeles, USA. [3]Occidental College, Los Angeles, USA

Abstract

Background: Although approximately 18 million people live within a mile of active oil and gas development (OGD) sites in the United States, epidemiological research on how OGD affects the health of nearby urban residents is sparse. Air pollution and noise from OGD may contribute to cardiovascular morbidity. Thousands of OGD sites are spread across Los Angeles (LA) County, California, home to the largest urban oil production in the country. We examined the association between proximity to OGD and blood pressure (BP) in a diverse cohort of residents in LA.

Methods: We worked with community partners to recruit participants in South LA who lived <1 km from an active or idle OGD site. We averaged two systolic BP (SBP) and two diastolic BP (DBP) measurements for each participant. We adjusted measurements for participants who were taking anti-hypertension medications (+15 mm Hg for SBP, +10 for DBP). We conducted multivariable linear regression to examine the relationship between distance to OGD sites and continuous SBP and DBP, adjusting for body mass index (BMI), smoking status, distance to freeway, sex, and age. We examined effect measure modification by BMI category and smoking category.

Results: Among the 626 adult participants, the median distance from home to OGD site was 260 meters. We found that for every 100 m increase in distance from the OGD site, DBP was reduced by an average of 0.72 mm Hg (95% CI: -1.26, -0.19) in this population. We observed stronger effects of distance to OGD site on DBP among never smokers and among participants with a healthy BMI. The associations observed between proximity to OGD site and SBP were weaker but followed the same patterns as DBP.

Conclusion: Living further from OGD was associated with lower DBP, suggesting an adverse relationship between residential proximity to OGD sites and cardiovascular health.

Wednesday OS6

Translating community-based participatory research into broadscale social and political change: Insights from a coalition of women firefighters, scientists, and environmental health advocates

Jennifer Ohayon[1], Sharima Rasanayagam[2], Ruthann Rudel[3], Sharyle Patton[4], Heather Buren[5], Tony Stefani[6], Jessica Trowbridge[7], Cassidy Clarity[8], Julia Brody[3], Rachel Morello-Frosch[7]
[1]SIlent Spring Institute, Newton, USA. [2]California Breast Cancer Research Program, University of California Office of the President, Oakland, USA. [3]Silent Spring Institute, Newton, USA. [4]Commonweal Biomonitoring Resource Center, Bolinas, USA. [5]United Fire Service Women, San Francisco, USA. [6]San Francisco Firefighters Cancer Prevention Foundation, San Francisco, USA. [7]School of Public Health, University of California, Berkeley, USA. [8]Department of Environmental Science, Policy, and Management, University of California, Berkeley, USA

Abstract

Background: We report on community-based participatory research (CBPR) initiated by women firefighters in order to share successful elements that can be instructive for other community-engaged research. This CBPR initiative is the first to investigate links between occupational exposures and health outcomes for a cohort of exclusively women firefighters.

Methods: We collected input from leaders of the initiative via recorded meeting sessions, emails, and a shared online document. We also conducted interviews (N=10) with key research participants and community leaders to include additional perspectives.

Results: Successes from this CBPR initiative include upgraded fire station decontamination protocols, new legislation restricting firefighter exposures to toxic chemicals, and improved workers compensation for firefighters diagnosed with breast cancer. Factors contributing to the initiative's success in enacting broad social change and advancing science include 1) forming a diverse coalition of impacted community leaders, labor unions, scientists, and advocacy organizations, 2) focusing on impacts at multiple scales of action, 3) adopting innovative communication strategies for study participants, research partners, and the broader community, and 4) cultivating a prevention-based ethos in the research, including taking early action to reduce exposures based on existing evidence of harm. Furthermore, we discuss external factors that contribute to success, including funding programs that elevate scientist-community-advocacy partnerships, as well as institutional structures responsive to worker concerns.

Conclusions: While WWBC shares characteristics with other successful CBPR partnerships, this initiative also advances new approaches that increase CBPR impacts. This includes incorporating partners with particular skills and resources beyond the traditional researcher-community partnerships, and designing studies so they support community action in the beginning stages of research. Moreover, in contrast to the prevailing focus on internal characteristics of partnerships, we emphasize external factors that can contribute to CBPR success, demonstrating the importance of advocating for institutional factors that better support this research.

Wednesday OS6

South Philadelphia Community Air Monitoring Project: Community-Based Participatory Study Design

Lisa Frueh[1], Sheila Tripathy[1,2], Karlin Moore[3], Carol Jackson-Foy[2], Debbie Robinson[2], Mark Clincy[2], Carol White[2], Jeannette Miller[2], James Mullison[2], Peter Winslow[2], Amy Jerslid[2], Craig Johnson[2], Jane Clougherty[1]

[1]Drexel University Dornsife School of Public Health Department of Environmental and Occupational Health, Philadelphia, USA. [2]Philly Thrive, Philadelphia, USA. [3]Drexel University Dornsife School of Public Health Department of Epidemiology and Biostatistics, Philadelphia, USA

Abstract

Background: Several majority-Black, low-income neighborhoods in South/Southwest Philadelphia bear a disproportionate burden of air pollution from multiple spatially clustered sources, including highway traffic and a recently decommissioned oil refinery. The refinery made headlines when it exploded in 2019, and remained the second highest benzene- emitting refinery in the US in 2020 and 2021. For communities surrounding the refinery, benzene, particulate matter (PM), and metal pollution are of major concern. Philly Thrive, an environmental justice organization based in Southwest Philadelphia, worked to shut down the refinery and continues to advocate for residents while the site is redeveloped. We partnered with Philly Thrive to monitor volatile organic compounds (VOC), PM2.5 and metal constituents using a Community Based Participatory Research (CBPR) approach.

Methods: We held five virtual meetings over two months with Philly Thrive members to develop the air monitoring study design, i.e., monitor locations, study area, and report-back methods. Meetings were supplemented by one-on-one conversations with fenceline group members to ensure their input was represented in the study design. Additionally, community members were trained as research technicians.

Results: Philly Thrive members identified the refinery site and automobile traffic as primary pollution sources of concern. A total of 8 stationary VOC monitoring sites were selected to maximize source-driven spatial variation and will be sampled weekly for one year, beginning January 2023. An additional 10 rotating VOC and PM2.5 monitoring sites were selected based on locations of community concern, including schools, churches, and playgrounds. Report-back methods and materials will be co-developed with Philly Thrive throughout the monitoring period.

Conclusion: Using CBPR methods, we co-designed a one-year community air monitoring campaign in South Philadelphia. Air monitoring results will be used by Philly Thrive to continue to advocate for the health and safety of Philadelphia residents.

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Wednesday OS6

Practical Analyses Over Complex Modeling to Better Support Grassroots Movement

Elizabeth Friedman[1,2], Brian Lee[1], David Rahn[3], Atenas Mena[4], Beto Lugo Martinez[4]
[1]Children's Mercy, Kansas City, Kansas City, USA. [2]University of Missouri - Kansas City, Kansas City, USA. [3]University of Kansas, Lawrence, USA. [4]CleanAirNow, Kansas City, USA

Abstract

Grassroots environmental justice organization, CleanAirNow in Kansas City, has been directing the science to examine the disproportionate exposure to air pollution experienced by residents living fenceline to the largest classification railyard in the US. We assessed geographic asthma disparities, using data from Children's Mercy Kansas City, Census and EPA air monitoring data Prior analyses showed limited increased risk for asthma exacerbation for asthma patients living closer to TRI facilities and railyards. To further explore community-level disparities we conducted a similar study using census tracts.

Patients with 2+ asthma encounters during the EPA study timeframe were identified. Patient addresses were geocoded to census tracts. Community-level asthma rates, standardized by Census population estimates, were calculated for all asthma encounters and acute asthma encounters (UC, ED, inpatient admission). Distances from census-tract centroids to nearest TRI facilities, railyards and highways were calculated. The association between asthma rates and distances were examined using Kendall's tau and multivariable poisson regression models.

Residential distance from railyards exhibited a significant negative correlation with overall (-0.36 [CI: -0.41, -0.32]) and acute (-0.27 [CI: -0.32, -0.22]) asthma rates. Asthma rates were elevated among tracts north of the closest railyard (incident rate ratio [IRR]: 1.38; CI: 1.35-1.41) when compared with southern directionality. Increasing the distance from a railyard by 3 km decreased overall asthma rates by 26%.

Significant negative associations between proximity to all pollution source types and asthma were observed. This community-level research has served as a tool for community engagement and will be used to support proposed local policy. Environmental justice work addresses local concerns involving small, limited datasets, if the data exists at all. The academic epidemiologic platform may reconsider acceptable approaches to small population research in order to better serve communities with the most need.

Wednesday OS7

Associations Between Prenatal Blood Metals and Cord Blood Hormone and Protein Concentrations

Anna R. Smith[1], Pi-I D. Lin[2], Sheryl L. Rifas-Shiman[2], Karen M. Switkowski[2], Abby F. Fleisch[3,4], Robert O. Wright[5], Brent Coull[6], Emily Oken[2], Marie-France Hivert[2,7], Andres Cardenas[1]
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Abstract

Background and Aims: Heavy metals have endocrine disrupting properties and interfere with cellular processes by generating reactive oxygen species and depleting antioxidants. Essential metals and vitamins at physiological levels could mitigate the effect of heavy metals by acting as antioxidants. Little is known if mixtures of prenatal metals and vitamins are associated with metabolic-related hormones and proteins in cord blood.

Methods: We measured six nonessential (arsenic, barium, cadmium, cesium, lead, mercury) and four essential (magnesium, manganese, selenium, zinc) metals and trace elements, and two vitamins (B12 and folate) in first trimester red blood cells from pregnant participants in the longitudinal Project Viva cohort. We measured adiponectin, C-peptide, insulin-like growth factor (IGF)-1, IGF-2, IGF binding protein (BP)-3, leptin, and insulin in cord blood (~N=695). We used covariate-adjusted quantile g-computation and linear regression models to estimate associations between mixtures and individual metal and vitamin concentrations and cord blood hormone levels.

Results: As hypothesized, the essential metal mixture was associated with higher IGF-1 (β=3.20 ng/ml per quartile, 95% CI: 0.39, 6.01), IGF-2 (β=10.93 ng/ml, 95% CI: 0.08, 21.79), and leptin (β=1.03 ng/ml, 95% CI: 0.25, 1.80). As hypothesized, B12 was associated with lower cord blood adiponectin, cadmium was associated with lower IGF-2, cesium was associated with higher C-peptide, and magnesium was associated with higher leptin. Unexpectedly, B12 was associated with higher C-peptide and lower IGF-2 and leptin. Cadmium and lead were associated with lower C-peptide, while barium was associated with higher IGF-1.

Conclusions: Our findings suggest that some prenatal metals and vitamins are associated with cord blood hormones, which may influence growth and development. Future research will evaluate if the hormones mediate associations between prenatal metals and childhood adiposity.

Wednesday OS7

An Industry-Relevant Metal Mixture, Neurodevelopment, and Mediation by Iron Status in Italian Adolescents

Samantha Schildroth[1], Linda Valeri[2], Baoyi Shi[2], Alexa Friedman[3], Roberta F. White[1], Katarzyna Kordas[4], Donatella Placidi[5], Robert O. Wright[6], Donald Smith[7], Roberto G. Lucchini[8], Megan Horton[6], Birgit Claus Henn[1]

[1]Boston University, Boston, USA. [2]Columbia University, New York, USA. [3]National Institute of Environmental Health Sciences, Durham, USA. [4]University at Buffalo, Buffalo, USA. [5]University at Brescia, Brescia, Italy. [6]Icahn School of Medicine at Mount Sinai, New York, USA. [7]University of California Santa Cruz, Santa Cruz, USA. [8]Florida International University, Miami, USA

Abstract

Background: Exposure to metals is associated with decrements in learning and memory function in children. Recent evidence indicates that the associations of multiple metals with neurodevelopment may be mediated by iron (Fe). However, no study to date has investigated Fe status as a possible mediator of a metal mixture and neurodevelopment.

Methods: We used cross-sectional data from 383 adolescents (10-14 years) in the Public Health Impact of Metals Exposure Study. Manganese (Mn), chromium (Cr), and copper (Cu) were quantified in hair; lead (Pb) was quantified in whole blood using ICP-MS. Ferritin, a marker of Fe status, was quantified in serum using immunoassays. The California Verbal Learning Test for Children (CVLT-C) was administered to assess verbal learning and memory. We used Bayesian Kernel Machine Regression Causal Mediation Analysis (BKMR-CMA) to estimate natural direct effects (NDEs) and natural indirect effects (NIEs), adjusting for a priori selected confounders. Betas (β) and 95% credible intervals (CIs) were estimated.

Results: Median biomarker concentrations for Mn, Cr, Cu, Pb and ferritin were 0.07 µg/g, 0.04 µg/g, 9.4 µg/g, 1.3 µg/dL and 32.0 ng/mL, respectively. The NDE, reflecting the direct association not mediated through Fe status for an increase in the overall mixture from its 25th to 75th percentiles, was positive for the recall trials (e.g., trial 5: β=0.12, 95% CI=-0.09, 0.34), suggesting better cognitive performance. These associations were driven primarily by copper. Conversely, the overall mixture, driven by Pb, was adversely associated perseverations (i.e., more words repeated) for the NDE (β=0.13, 95% CI=-0.08, 0.37). There was no evidence of mediation by Fe status, where the NIEs for all CVLT-C outcomes were null.

Conclusion: The direct association of the mixture was associated with aspects of learning and memory. However, there was no evidence of mediation by Fe status among this Fe-replete population.

Wednesday OS7

Mixture of cadmium, magnesium, and calcium and incident acute myocardial infarction (AMI)

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Abstract

Abstract

Background

The dietary minerals of calcium (Ca) and magnesium (Mg) can play important roles in protecting against cardiovascular disease while cadmium (Cd) may exacerbate cardiovascular disease risk. Few studies have examined the joint effects of simultaneous exposure to Cd, Mg, and Ca.

Methods

We conducted a case-cohort study within a non-smoking subgroup of the Danish Diet, Cancer and Health cohort, a prospective study of 50–64 year olds recruited between 1993-1997. We identified 769 cases of acute myocardial infarction (AMI) through 2015 and randomly selected a subcohort of 1135 members. We assessed Ca and Mg dietary intakes (mg/d) from food frequency questionnaires. We quantified Cd (µg/g creatinine) in baseline urine. We used probit Bayesian kernel machine regression (BKMR) to evaluate the joint and interactive effects of Ca, Mg, and Cd on AMI while adjusting for confounders.

Results

Overall joint associations of the mixture with incident AMI were null when all elements were fixed at the 25th [difference in the probit of incident AMI=0.01, 95% credible interval: (-0.03, 0.05)] or 75th [0.01 (-0.04, 0.06)] percentiles, compared to when all elements were fixed at the 50th percentile. Modest evidence of interaction between Ca and Mg was identified in association with AMI, where the protective effects of higher concentrations of Mg were weaker at higher percentiles of Ca (e.g., 75th and 90th percentiles of Ca compared to 50th percentile of Ca). There was no evidence of interaction with Cd.

Conclusions

Our findings suggest that, in this non-smoking population with relatively low Cd levels, there was no joint effect of the mixture of essential elements and Cd on AMI. However, we found that higher Ca intake may reduce the potential protective effects of Mg on AMI. Cd did not appear to modify associations between Ca or Mg and AMI.

Wednesday OS7

Tampons as a Source of Exposure to Metal(loid)s

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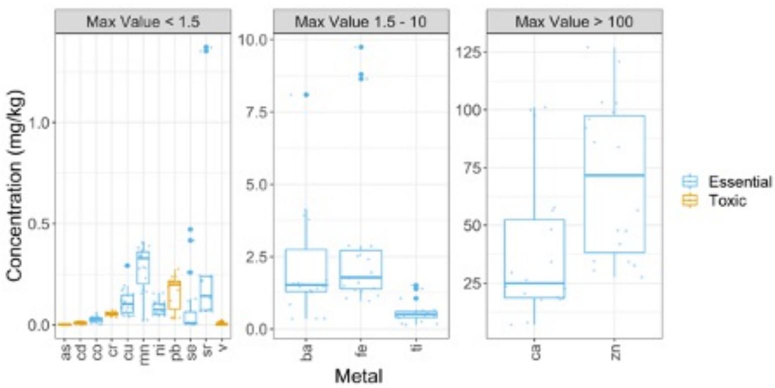
Abstract

Background/Aims: Tampons are cotton and rayon ‘plugs’ inserted vaginally to absorb menstrual blood. They are used by 50-86% of US women and could be contaminated with environmental chemicals, including metals. Adulteration with metals may occur through several processes, including bioaccumulation, deposition, or addition during manufacturing. To our knowledge, metal levels in tampons have not been measured. We evaluated the concentrations of 16 metal(loid)s in several tampon products.

Methods: We took a 200 - 300 mg subsample from each tampon, including both the absorbent material and the netting that helps the tampon keep its shape. We conducted acid microwave digestion followed by inductively coupled plasma mass spectrometry (ICP-MS) to determine concentrations of As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Sr, Ti, V, Zn.

Results: In a pilot of 19 tampons, all metals assessed were present in measurable amounts. Concentrations of Zn and Ca were elevated, with geometric means of 70.3 mg/kg (standard deviation [SD]: 33.1 mg/kg) and 38.5 mg/kg (SD: 30.5 mg/kg), respectively. Three of five toxic metals (As, Cd, V) had geometric mean concentrations of 0.01 mg/kg or lower, while Cr was 0.06 mg/kg (SD: 0.01 mg/kg) and Pb was 0.17 mg/kg (SD: 0.08 mg/kg).

Conclusion: Exposure to metals through tampon use has been severely understudied, despite increased vaginal absorption and extensive potential public health impacts. We found concentrations of Zn and Pb greater than those in a previous study of clothing. Future research is needed to determine (1) concentrations of metals that leach out of tampons into menstrual blood to become bioavailable, and (2) other chemicals (pesticides, plasticizers, fragrances) present in tampons. This is especially important considering that we found measurable quantities of lead, a toxic metal with no known “safe” exposure level.



Wednesday OS7

Application of *AclustsCCA*, a novel mixture method for regional epigenome-wide studies: Mixtures of prenatal metals and methyl donors

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Abstract

Background: DNA methylation (DNAm) may be involved in pathways linking prenatal metals and nutrients to infant and child health. We previously identified associations between individual prenatal metals and differentially methylated regions (DMRs) in cord blood. Using the novel method A-clustering sparse canonical correlation analysis (*AclustsCCA*), we evaluated associations between a mixture of essential and non-essential metals in addition to one-carbon metabolism nutrients measured in maternal blood and DMRs in offspring cord blood in Project Viva pre-birth cohort.

Methods: We measured concentrations of metals (As, Ba, Cd, Cr, Cs, Cu, Hg, Mg, Mn, Pb, Se, Zn) in erythrocytes and folate and B12 in plasma of mothers during the first trimester, and DNAm in cord blood (Illumina HumanMethylation450 BeadChip, N=351). We identified 7,532 genomic regions of correlated DNAm in cord blood. We used canonical variables representing regions and exposure mixtures to test for associations, and computed permutation p-values adjusting for covariates.

Results: Using *AclustsCCA*, 2 DMRs were associated with single metals (As and Hg); 3 were associated with mixtures of metals, and 5 were associated with mixtures of metals and folate ($FDR<0.05$). Seven of these DMRs were located in the HLA region of chr6: *C6orf25* (associated with As, Ba, Mn, and folate; see **Figure**); *C6orf27* (Ba, Cd, Cr, and Hg); *TNXB* (As); *PPT2*, *PRRT1* (Ba, Cd, Cr, Mn); *VARS2*, *GTF2H4* (Ba, Cr, Cs, Hg, folate); *PFDN6*, *WDR46* (As, Ba, Cr, Hg, folate); and intergenic (As, Cd, Cr, Hg, folate).

Conclusion: Applying *AclustsCCA*, a novel method to evaluate associations between multiple exposures and regional DNAm, we identified cord blood DMRs associated with prenatal metal and nutrient mixtures. Results included DMRs previously identified in single-metal analyses (*TNXB*, *VARS2*, *GTF2H4*) and annotated to genes involved in neurodevelopment and immune function. *AclustsCCA* may reflect the reality of multiple exposures and improve biological interpretation of epigenetic variability.

Uncaptioned visual

Wednesday OS7

Early-life critical windows of metal exposure associated with internalizing symptoms in young adolescents

Elza Rechtman[1], Christine Austin[1], Paul Curtin[1], Libni A. Torres-Olascoaga[2], Luis Bautista[2], Sandra Martínez-Medina[3], Erika Proal[2], Viviana Villicana[2], Martha M Téllez-Rojo[2], Robert Wright[1], Manish Arora[1], Megan Horton[1]

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Abstract

Introduction and Aim: Internalizing disorders, such as anxiety and depression, affect 10 – 20% of children and increase risk for later-life psychopathology. The neural circuitry subserving internalizing phenotypes begins developing in utero and is vulnerable to early-life environmental exposures. Although early-life exposure to metals can adversely impact children's neurodevelopment and have lifelong impacts on mental health, little is known about critical windows to metal exposures and adolescent internalizing disorders. In this study, we hypothesized that early-life exposure to a mixture of metals is associated with increased internalizing problems in early adolescence.

Methods: Among 431 (8-12 years; 216 females) pre-adolescents enrolled the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) longitudinal birth cohort study in Mexico City, we estimated weekly concentrations of 10 metals in naturally shed deciduous teeth using laser ablation-inductively coupled plasma-mass spectrometry (i.e., As, Ba, Cu, Li, Mg, Mn, Pb, Sn, Sr, and Zn) from the 14th gestation week through one year of age). Internalizing problems were assessed using the Behavior Assessment System for Children, 2nd edition (BASC-2). We used lagged weighted quantile sum (lWQS) regression to estimate a time-varying mixture effect of multiple metals on internalizing problems. Models were adjusted for age and sex.

Results: A higher metal mixture index in the 22nd-42rd postnatal weeks was associated with increased internalizing problems (maximum $\beta = 0.13$ [95% CI 0.06, 0.23]), driven mainly by Mn, Pb, and As.

Conclusions: This study supports the hypothesis that mixed metal exposure during specific critical windows in early life may associate with mental health disorders in childhood and adolescence. Our lWQS modeling approach and results may inform the role of exposure timing in driving neurodevelopmental outcomes, thereby pointing to future optimal, efficient, and properly timed public health interventions.

Wednesday OS8

Joint effects of prenatal exposure to indoor air pollutants and psychosocial factors on psychopathology at school-age in a South African birth cohort

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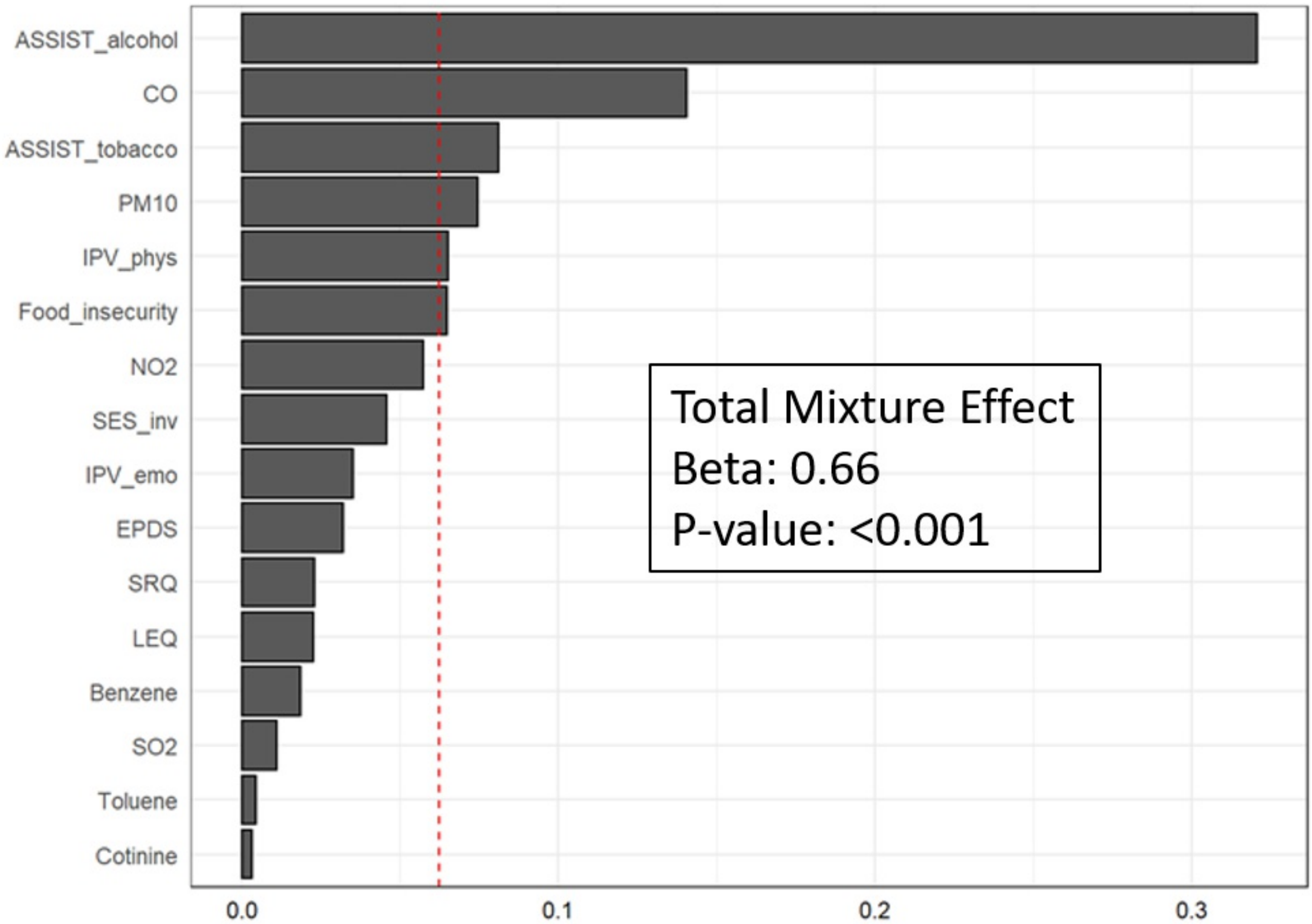
Abstract

Background/aims: Identifying modifiable risk factors for childhood psychopathology can increase quality of life for children and prevent adult psychopathology. Previous studies have shown that indoor air pollution (IAP) and psychosocial factors (PF) during pregnancy separately influence psychopathology, but their joint effects are not well understood. Here, we use environmental mixture methodology to estimate joint effects of IAP and PF during pregnancy on childhood psychopathology at 6.5 years old.

Methods: We used data from the Drakenstein Child Health Study (N=599), a South African birth cohort. Exposure to IAP and PF was measured during the second trimester of pregnancy. The Childhood Behavior Checklist (CBCL) was administered at 6.5 years old to assess child psychopathology. Joint effects of IAP and PF were summarized using self-organizing maps (SOM) and weighted quantile sum regression (WQS). Individual effects of IAP and PF and their joint effects were estimated using linear regression models, adjusted for maternal age, ancestry, and maternal HIV status.

Results: WQS showed adverse associations between the total IAP/PF mixture (beta: 0.37; p-value: <0.001) and CBCL score. SOM clusters showed that these effects were mainly driven by exposure profiles dominated by combined maternal tobacco and alcohol use (Beta [95% CI]; 0.34 [0.10, 0.58]), and other PFs including intimate partner violence and depression (0.31 [0.07, 0.55]). In individual effects models we observed similar adverse associations indicated by the mixture methods. IAPs (e.g., PM10; 0.13 [0.05, 0.22]) and PF (e.g., maternal alcohol use; 0.11 [0.03, 0.19]) were significantly associated with CBCL score and were identified as bad actors in WQS analysis.

Conclusions: Exposure to IAP and PF during pregnancy was associated with CBCL total problems score indicating increased risk for psychopathology. Estimating joint effects of IAP and PF is important to identify vulnerable subgroups for intervention to prevent childhood psychopathology.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CO
ASSIST_tobacco
PM10
IPV_phys
Food_insecurity
NO2
SES_inv
IPV_emo
EPDS
SRQ
LEQ
Benzene
SO2
Toluene
Cotinine
0.0
0.1
0.2
0.3
Total Mixture Effect
Beta: 0.66
P-value: <0.001

Wednesday OS8

Risk of Dementia Due to Joint Air Pollutants and Effect Modification by Social Deprivation

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Abstract

Background: Associations between air pollution and cognitive decline in older adults may vary by neighborhood disadvantage (ND). One measure of cognitive decline lacking evidence is dementia. We test effect modification of air pollutants on dementia risk using both census-based ND and self-rated social cohesion and physical disorder.

Methods: Using a sample of adults age ≥65 years (n=5,555) from the National Health and Aging Trends Study (NHATS-2011), we tested effect modification of twelve air pollutants on dementia incidence by ND, social cohesion, and physical disorder. Baseline interquartile range-standardized annual average air pollutant concentrations were assigned at the census tract level using the Community Multiscale Air Quality Modeling System (CMAQ). ND was measured using tract Social Deprivation Index (SDI). Participants self-rated neighborhood physical disorder on graffiti, litter, and vacant housing; social cohesion on neighbors knowing each other, being helpful, and trustworthiness. Dementia was determined through self- or proxy-reported diagnosis and scores indicative of "probable dementia" on the NHATS A8 dementia screening interview. Least Absolute Shrinkage and Selection Operator (LASSO) selected pollutants associated with dementia incidence. Selected pollutants were included in quantile-based G-computation survival analysis stratified across tertiles of SDI, median physical disorder, and social cohesion.

Results: Higher quartiles of LASSO-selected joint air pollutant concentrations (CO, PM10, O3, SO2, total nitrate, NH4, SO4, and black carbon) increased dementia risk among participants at low (aHR=1.37, 95% CI=0.98-1.93), but not medium level (aHR=1.04, 95% CI=0.65-1.68) or high (aHR=0.85, 95% CI=0.76-0.95) SDI. Higher quartiles of joint air pollutant concentrations also increased dementia risk at high (aHR=1.21, 95% CI=1.0-1.46), but not low social cohesion (aHR=1.03, 95% CI=0.90-1.18).

Conclusion: Dementia risk due to air pollution was elevated only among low SDI census tracts or when social cohesion was high. Associations between air pollution and dementia risk may be attenuated when baseline social deprivation is elevated.

Wednesday OS8

Prenatal exposure to toxic air contaminants and risk of cerebral palsy

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Abstract

Cerebral palsy (CP) is the most common neuromotor disorder that permanently affects children's physical mobility, while the etiology remains unexplained. Increasing research evidence suggests that in-utero exposure to toxic air contaminants (TACs) affects fetal neurodevelopment, we conducted a California statewide study to investigate whether prenatal exposure to TACs is associated with childhood CP.

We analyzed a case-cohort study sample of live births in California (2005-2015) with geocoded maternal residential address within the 5-mile buffer around California TACs monitors. We identified 799 CP cases using the California Department of Developmental Services records and randomly selected 20% birth records as the controls (N=147,820). We selected 33 TACs (22 volatile organic compounds (VOCs) and 11 metals) with potential developmental and neurological toxicity as our primary focus. We estimated the association between pregnancy- and trimester-averaged exposures to individual TAC and CP risk using logistic regression. We also utilized the quantile-based g-computation method to estimate the joint effect of prenatal exposure to mixtures of VOCs or metals on CP. Potential confounders we adjusted include maternal age at delivery, race/ethnicity, education, insurance type, and prenatal care.

Per interquartile-range increase of maternal pregnancy level to 8 individual VOCs (acetaldehyde, acetone, benzene, methyl ethyl ketone, perchloroethylene, styrene, toluene, trichloroethylene) and 6 metals (antimony, iron, lead, manganese, nickel, vanadium) were associated with 7-20% higher odds for CP in the offspring (e.g., acetone: OR=1.19, 95% CI: 1.09-1.30, antimony: OR=1.20, 95% CI: 1.01-1.25). Trimester-specific exposures analyses suggest elevated odds in the first and the second trimesters. The estimated joint effects for exposure to the VOCs mixtures were 1.20 (95% CI: 1.10-1.32) and metals were 1.32 (95% CI:1.14-1.51).

This is the first report that suggests prenatal exposures to ambient air toxic chemicals, specifically VOCs and metals from urban traffic and industry emissions, may increase the risk for CP in children.

Wednesday OS8

Functional changes in neural mechanisms underlying post-traumatic stress disorders in World Trade Center responders

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Abstract

World Trade Center (WTC) responders have high prevalence (23%) of persistent, clinically significant WTC-related post-traumatic stress disorder (PTSD). Recent structural magnetic resonance imaging (MRI) studies demonstrate anatomical differences between WTC responders with and without PTSD. We used resting state functional (rs-fMRI) to investigate neural mechanisms underlying WTC-PTSD and identify changes in local brain areas associated with WTC exposure. Using graph theory analysis of rs-fMRI data, we calculated eigenvector centrality (EC) to measure connectivity in 111 brain areas in WTC responders with PTSD (WTC-PTSD, n = 45) and matched responders without PTSD (non-PTSD, n = 51). Permutation statistics quantified EC differences; partial least squares discriminant analysis (PLS-DA) modeled the divergence in EC values between groups. Associations between WTC-exposure duration (months on site) and EC in identified brain areas were examined using general linear model (GLM) regression, adjusting for medication usage and comorbid depression. Generalized weighted quantile sum (WQS) regression was used to examine associations between an index of PTSD symptoms and EC values. PLS-DA analysis of EC values enabled effective discrimination (auc: 0.749 (0.651-0.847)) of WTC-PTSD from non-PTSD; EC in nine brain regions (right/left anterior inferior temporal gyrus, right superior parietal lobule, right anterior parahippocampal gyrus (PHG), right anterior/posterior temporal fusiform cortex, right caudate nucleus, left amygdala (AMG) and brainstem) differed significantly and contributed the most to differentiate functional neuro-profiles between groups. The association between exposure duration and EC differed significantly between WTC-PTSD and non-PTSD in PHG and AMG (p= 0.010, 0.005, respectively). Within WTC-PTSD, the index of PTSD symptoms was positively associated with EC values in PHG and brainstem. Our results confirm hypotheses about key brain areas associated with PTSD and extend our understanding of neural mechanisms linking WTC exposure with PTSD. Better understanding of neural mechanisms leading to WTC-PTSD would help guide intervention and treatment.

Wednesday OS8

World Trade Center Exposome: A Novel, Data-Driven Approach to Modeling Risk and Protective Factors for adverse mental and physical health outcomes among WTC Responders

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Abstract

Background and Aim: Responders involved in rescue and recovery efforts following the 9/11 World Trade Center (WTC) attacks were exposed to hazardous working conditions and toxic agents. Previous studies associating WTC exposure with adverse health outcomes focus on a small number of risk factors selected a priori. We proposed a data-driven, exposomic approach to investigate the mixture of risk and protective factors experienced by WTC responders (i.e., 'WTC exposome') and its relation to responder health.

Methods: We included 34,096 responders from the WTC Health Program (WTC-HP) with a physical and mental health evaluation and exposure assessment at first (post 9/11/01) visit. We used generalized weighted quantile sum (gWQS) regression to examine positive (i.e., risk) and negative (i.e., protective) associations between the "WTC Exposome" index containing 84 factors (i.e., dust and traumatic exposures, baseline health information, social support) and five WTC-related health outcomes as dichotomous (ever/never): post-traumatic stress disorder (PTSD), gastroesophageal reflux disease (GERD), respiratory problems, diabetes, and headaches. All models were adjusted for age, race, ethnicity, and gender.

Results: The WTC exposome was associated with all five health outcomes (PTSD βrisk = 6.4, βprotective = 0.1; GERD βrisk = 4.4, βprotective= 0.5; respiratory problems βrisk = 3.9, βprotective = 0.6; diabetes βrisk = 1.6, βprotective = 0.7; headaches βrisk = 5.6, βprotective = 0.3; $p<0.0001$ for all models). The WTC exposomic profile (i.e., the mix of risk and protective factors) differed by health outcome. For example, working in an enclosed area contaminated with dust contributed most to PTSD risk while full-time employment post 9/11 appeared protective against PTSD.

Conclusion: Understanding WTC-related risk and protective factors enable us to better identify responders vulnerable to adverse outcomes and identify factors that may protect against the development or progression of disease. This approach has potential for to future disaster response studies.

Wednesday OS8

Metabolomic Associations with an Exposure Mixture of Per- and Polyfluoroalkyl Substances in Pregnant African Americans

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Abstract

Background. Prenatal exposures to per- and polyfluoroalkyl substances (PFAS) are associated with metabolic perturbations and adverse pregnancy and birth outcomes. Despite out knowledge that individuals are exposed to multiple PFAS, the joint effects of PFAS on the human metabolome remains largely unknown. Here, we leveraged high-resolution metabolomics (HRM) data to identify the metabolic pathways and markers perturbed by exposure to a PFAS mixture during pregnancy.

Methods. Targeted measurements on perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorooctane sulfonic acid (PFOS), and perfluorohexane sulfonic acid (PFHxS), along with untargeted high-resolution metabolomics profiling were conducted on non-fasting serum samples collected from 286 pregnant African American people at 8–14 weeks gestation. We estimated the overall mixture effect using quantile g-computation models adjusted for maternal age, education, parity, body mass index, history of addictive substance use, and gestational weeks at serum sample collection.

Results. Our study population was comprised of a socioeconomically diverse group with the majority receiving public health insurance. Relative to individual PFAS exposures (1,498 features $p<0.05$), we observed more significant metabolic features associated with the PFAS mixture (1,651 features $p<0.05$). There were consistent patterns of metabolic perturbations involving systemic inflammation and oxidative stress, including pathways for lysine, leukotriene, alanine, linoleic acid, and vitamin E metabolism. Twelve metabolites associated with the PFAS mixture were confirmed with level-1 evidence, including linoleic acid, carnitine, valine, leucine, tyrosine, and uracil.

Conclusion. In the first study of its kind, we demonstrate the feasibility and utility of using environmental chemical mixture methods together with HRM to assess the synergistic effects of multiple PFAS exposures on the maternal metabolome. We found that a simultaneous exposure to multiple PFAS during early pregnancy was associated with inflammatory and prooxidative pathways and metabolites. Future research is warranted to investigate the interrelationships of PFAS mixtures, maternal metabolomics, and adverse pregnancy and birth outcomes.

Wednesday OS9

Exposure to PM2.5 during pre-conception, pregnancy, and 1-year after parturition in relation to later cardiometabolic alterations in Mexican women.

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Abstract

Background/Aim

Pregnancy is a critical window for long-term programming of the effects of airborne particulate matter ≤2.5μm (PM2.5) exposure. Yet, very little is known about the long-term effects in mothers. This study aims to assess the association of potential critical windows of PM2.5 exposure during and around pregnancy with later-life differences in markers for cardiometabolic health.

Methods

The study population included ~300 pregnant women (mean age ±standard deviation (SD): 29 ±5.6 years) in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) study, a prospective Mexican cohort with cardiometabolic outcomes measured at 48, 72, and 96 months after delivery. Monthly PM2.5 exposure was estimated at each participant's address using a validated satellite-based spatiotemporal model from 2 months prior to conception to 1-year after delivery. To examine potential critical windows of PM2.5 exposure on cardiometabolic endpoints (body mass index (BMI), cholesterol, triglycerides, glucose, glycated hemoglobin (HbA1c), blood pressure, and waist circumference) at each follow-up visit, we used distributed lag models (DLMs) controlling for age, pre-pregnancy BMI, socio-economic status, smoking during pregnancy, marital status, parity, meteorological season, cardiometabolic medications, and alcohol intake.

Results

Women were exposed to an overall average (SD) PM2.5 concentration of 22.7 (1.4) μg/m3 and had a mean (SD) pre-pregnancy BMI of 26.7 (4.4) kg/m2. DLMs revealed potential adverse effects of PM2.5 due to mid-pregnancy exposure for several lipids measured at 48-72 months, including triglycerides and high-density lipoprotein. However, PM2.5 effects peaked around conception exposures for glucose measured 48 months after delivery. We also observed that PM2.5 exposure during the 2nd and 3rd trimesters of pregnancy and post-partum was particularly associated with higher maternal BMI from 24 to 72 months after delivery.

Conclusion

In women of childbearing age, pregnancy may be a susceptible window to PM2.5 exposure for altered cardiometabolic health later in life.

Wednesday OS9

Associations of PM2.5 with incident cardiovascular disease; comparing models using zip code-level and individual-level PM2.5 and confounders

Jochem Klompmaker[1,2], Jaime Hart[1,2], Francesca Dominici[1], Peter James[1,3], Charlie Roscoe[1,2], Francine Laden[1,2]

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Abstract

Background/Aims: Cohort studies nested in large registries/administrative databases have shown that PM2.5 is positively associated with cardiovascular disease (CVD) incidence/mortality. These studies may have improved generalizability and power relative to individual cohort-based analyses. However, they tend to lack information about individual-level socio-economic status, lifestyle factors and residential addresses, and therefore use area-level exposures and confounders. We aimed to evaluate PM2.5-CVD incidence associations in a cohort comparing models using zip code-level and individual/residential-level PM2.5 and confounders.

Methods: We followed 101,870 participants from the US-based Nurses' Health Study from 2000 to 2016. We linked zip code-level PM2.5 and confounders, previously used in Medicare cohort studies, and residential-level PM2.5 and individual-level covariates. We used time-varying Cox proportional hazards models to calculate hazard ratios (HRs) and 95% confidence intervals (95%CI). We specified a basic model (adjusted for individual-level age and race), an individual-level model (basic model + individual-level confounders, e.g. smoking, BMI), and a zip code-level model (basic model + zip code-level confounders, e.g. median household income, median home value).

Results: Residential- and zip code-level PM2.5 were strongly correlated (Pearson r = 0.88). In basic models, we observed a HR (95%CI) of 1.06 (1.01, 1.12) per 5 µg/m3 for residential-level PM2.5 and a HR of 1.04 (0.99, 1.09) per 5 µg/m3 for zip code-level PM2.5. In the individual-level model, the HR for residential-level PM2.5 was 1.05 (0.99, 1.10) per 5 µg/m3. In the zip code-level model, the HR for zip code-level PM2.5 was 1.03 (0.98, 1.08) per 5 µg/m3. In subgroup analyses with PM2.5 exposures >10 µg/m3, associations of residential- and zip code-level PM2.5 were stronger than in the full cohort and similar in the individual- and zip code-level model.

Conclusion: The use of area-level PM2.5 and confounders may result in slightly weaker PM2.5-CVD incidence associations than individual-level PM2.5 and confounders.

Wednesday OS9

Modification of Step-Up Therapy in Black Adults with Poorly Controlled Asthma by $PM_{2.5}$ and NO_2.

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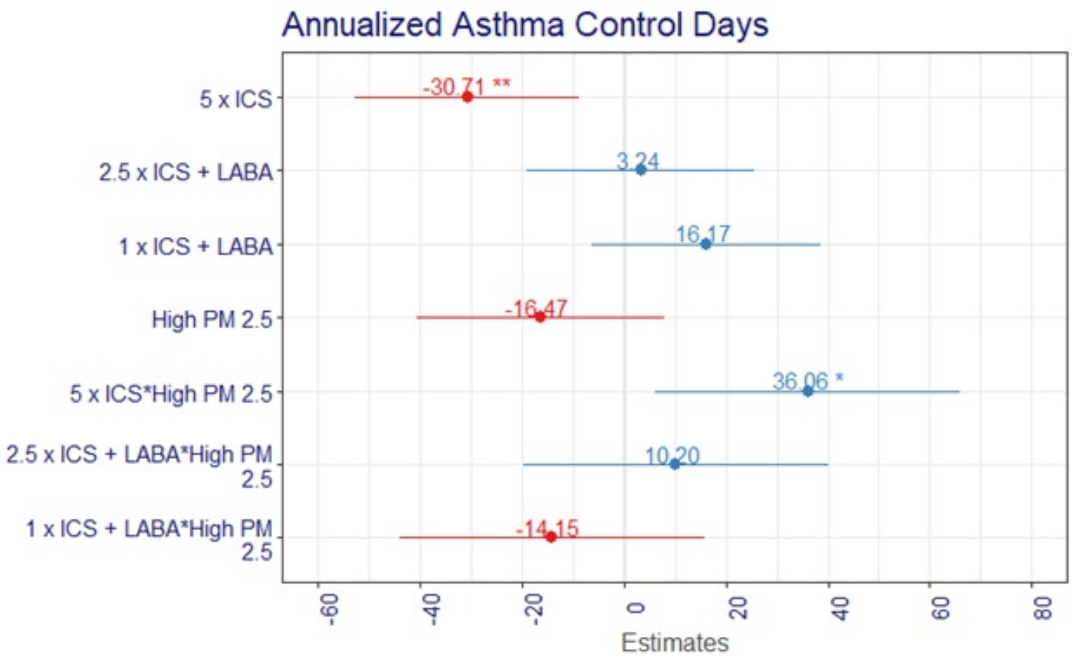
Abstract



Background: Asthma morbidity disproportionately affects Black individuals, though they are often underrepresented in asthma clinical trials. Further, RCTs rarely consider variation in environmental and social conditions – such as ambient air pollutant exposures – on treatment efficacy. These factors are highly relevant for asthma, as air pollution overburdens racial and ethnic minorities. Here we re-analyzed data from AsthmaNet's BARD trial. We investigated whether $PM_{2.5}$ and NO_2 alter the efficacy of adding long-acting beta-agonist (LABA) to inhaled glucocorticoids to treat asthma among Black adults.

Methods: We reassessed data from 294 adults randomized to a sequence of adding LABA to baseline ICS (1xICS+LABA), double-ICS with LABA (2xICS+LABA), quintuple-ICS (5xICS), and double-ICS (2xICS). Treatment preference was determined by the yearly rate of asthma control days (AACD) and forced expiratory volume (%PFEV1) during each treatment period. We geocoded participants' addresses, estimated treatment-period-specific $PM_{2.5}$, and NO_2 mean exposures using validated national spatiotemporal models, and estimated associations with AACD and %PFEV1 using mixed models with random effects for individual and site.

Results: $PM_{2.5}$ and NO_2 exposures varied [2.3-12.5 µg/m3 and 2.6-23.7 ppb, respectively], and above-median $PM_{2.5}$ exposure was associated with 16.5 fewer ACD per year, on average (p =0.2). As hypothesized, treatment efficacy (effect of 5xICS dose on AACD) significantly differed by $PM_{2.5}$ exposures; among those with below-median $PM_{2.5}$, 5xICS conferred a loss of 30.7 ACD annually, but among those with above-median PM2.5, 5xICS conferred a benefit of 36.1 additional ACD each year (p

for interaction = 0.012). Treatment effects were not significantly modified by NO_2 exposures in our sample (p for interaction = 0.07).

Conclusions: Contrary to our prior findings among children, we found that, only among those with above-median $PM_{2.5}$, treatment with 5xICS may confer better asthma control, as indicated by AACD. Richer consideration of participants' environmental context can help improve RCT treatment recommendations.

Wednesday OS9

The Role of Vascular Conditions in the Associations between $PM_{2.5}$ and Incident Dementia

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Abstract

Background

Although particulate matter ($PM_{2.5}$) may increase dementia risk, the exact mechanisms that underlie these associations are still unclear. Given that $PM_{2.5}$ has been consistently linked to cardiovascular disease, a risk factor for dementia, vascular dysfunction might mediate the relationship between $PM_{2.5}$ and dementia. In this study, we investigated hypertension and stroke as mediators and modifiers of associations of $PM_{2.5}$ with dementia.

Methods

We used biennial data between 1998 and 2016 from the Health and Retirement Study with participants older than 50 years. Incident dementia was identified using a validated algorithm based on cognitive testing and informant information. We assessed $PM_{2.5}$ concentrations for 10 years preceding each person's baseline exam based on residential histories using spatiotemporal models. Next, we applied four-way decomposition causal mediation analysis method to quantify the degree to which hypertension and stroke mediated or modified the associations of $PM_{2.5}$ with incident dementia after adjustment for individual and area-level covariates.

Uncaptioned visual

Results

Among 27,857 participants, 4,105 (15%) developed dementia during the follow-up (10.2±5.6 years). In fully adjusted models, we found a hazard ratio (HR) of 1.040 (95%CI: 0.976, 1.109) per interquartile range higher $PM_{2.5}$ concentrations. While strong positive associations of prevalent stroke and hypertension were also found with incident dementia, we found only weak evidence of an association between $PM_{2.5}$ and stroke (OR: 1.08, 95%CI: 0.91, 1.29) and no association with hypertension (OR: 0.99, 95% CI: 0.92, 1.07). Concordantly, we found no evidence that hypertension or stroke acted as mediators.

We found an indication that about half of the excess relative risks were due to interaction with hypertension. However, this evidence was imprecise and consistent with null.

Conclusion

Our results suggest that $PM_{2.5}$ may increase the risk of dementia through pathways other than hypertension or stroke though hypertension may enhance the susceptibility of individuals to air pollution.

Wednesday OS9

Residence-based agricultural pesticide exposure and cardiometabolic risk factors in a cohort of adult Latina women in California's Salinas Valley

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Abstract

Cardiometabolic disease is a leading cause of death worldwide. While animal evidence suggests exposure to agricultural pesticides may worsen metabolic and cardiovascular health, studies examining these relationships in humans have yielded mixed results. We aim to examine the association between exposure to agricultural pesticides and cardiometabolic risk factors in a cohort of adult women living in an agricultural region.

Participants included Latina women (n = 513) enrolled in the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS) study, a longitudinal cohort in the agricultural Salinas Valley of California. Outcomes assessment was completed between 2010 and 2013. Using participant residential addresses and California's Pesticide Use Reporting data, we estimated agricultural pesticide use within one km of residences during the 2-year period preceding cardiometabolic outcome assessment. We used ordinary least-squares regression models to evaluate associations between use of 13 agricultural pesticides and continuous measures of waist circumference, body mass index, and blood pressure, and binary measures of obesity, hypertension, and self-reported diabetes (n = 456-508, varies by outcome).

We observed mixed associations between residential proximity to pesticide use and cardiometabolic outcomes. Permethrin use was associated with increased waist circumference, pulse pressure, and odds of diabetes. Glyphosate use was associated with increased systolic blood pressure. Of the organophosphate pesticides examined, naled use was associated with increased pulse pressure and use of bensulide was associated with increased odds of obesity. However, other organophosphates, as well as methomyl, imidacloprid, maneb and mancozeb, were associated with protective effects.

Our findings suggest that recent exposure to select agricultural pesticides is associated with poor cardiometabolic health outcomes. Associations with some pesticides were in the opposite direction from hypothesized. Future analyses will evaluate the impacts of pesticide mixtures using Bayesian Hierarchical Models and potential drivers of unanticipated protective associations (e.g. selection bias, underlying heterogeneity).

Uncaptioned visual

Wednesday OS9

Ambient particulate matter levels and children's blood pressure in rural California

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Abstract

Background

Elevated blood pressure (BP) in children is a risk factor for adult hypertension and is increasing globally. While there is considerable evidence that very high levels of ambient particulate matter (PM) are linked to increased BP in children, data from less-polluted, rural regions are sparse.

Methods

Over 700 predominantly Hispanic low-income elementary school students in rural California were enrolled in the Children's Assessing Imperial Valley Respiratory Health and the Environment (AIRE) cohort at ages 6-8 years in 2017-2019 and followed until Spring 2022. Systolic and diastolic BP, height, and weight were measured during semi-annual school visits. BP measures were standardized using national age-, sex-, and height-specific percentiles; values ≥90th percentile were considered elevated. Children's residential addresses were spatially linked to the nearest regulatory PM monitor to determine exposure to fine ($PM_{2.5}$) and coarse (PM_{10}) PM. We used generalized estimating equations, specifying identity link and Gaussian distribution, to evaluate associations between seasonal (90-day) PM_{10} and $PM_{2.5}$ levels and elevated BP.

Results

BP was measured in 600 children up to 5 times during the study period; 20% of children (n=147) had at least one elevated BP. In adjusted models, each additional 10 $\mu g/m^3$ increase in average 90-day PM_{10} was associated with a 1.3 percentage point increase in the risk of any elevated BP (95% CI 0.7%, 2.0%). Children exposed to the highest quartile of average 90-day $PM_{2.5}$ levels and PM_{10} levels had a 5.6 percentage point (95% CI 0.8%, 10.3%) and 3.8 percentage point (95% CI 0.4%, 7.3%) increase in risk of any elevated BP, respectively, compared to children in the lowest quartiles of exposure.

Conclusion

We linked low to moderate levels of PM to risk of elevated BP in children. Further research is warranted to understand how components of PM in Imperial Valley impact children's health.

Wednesday OS10

Prevalence of mental health outcomes associated with increasing residential hurricane and flooding risk in the US Gulf Coast

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Abstract

Background: Natural hazards are increasing in frequency and severity. Adverse mental health outcomes (MH) are frequently observed following disasters. However, little is known about the MH of persons living in communities prone to frequent natural hazards.

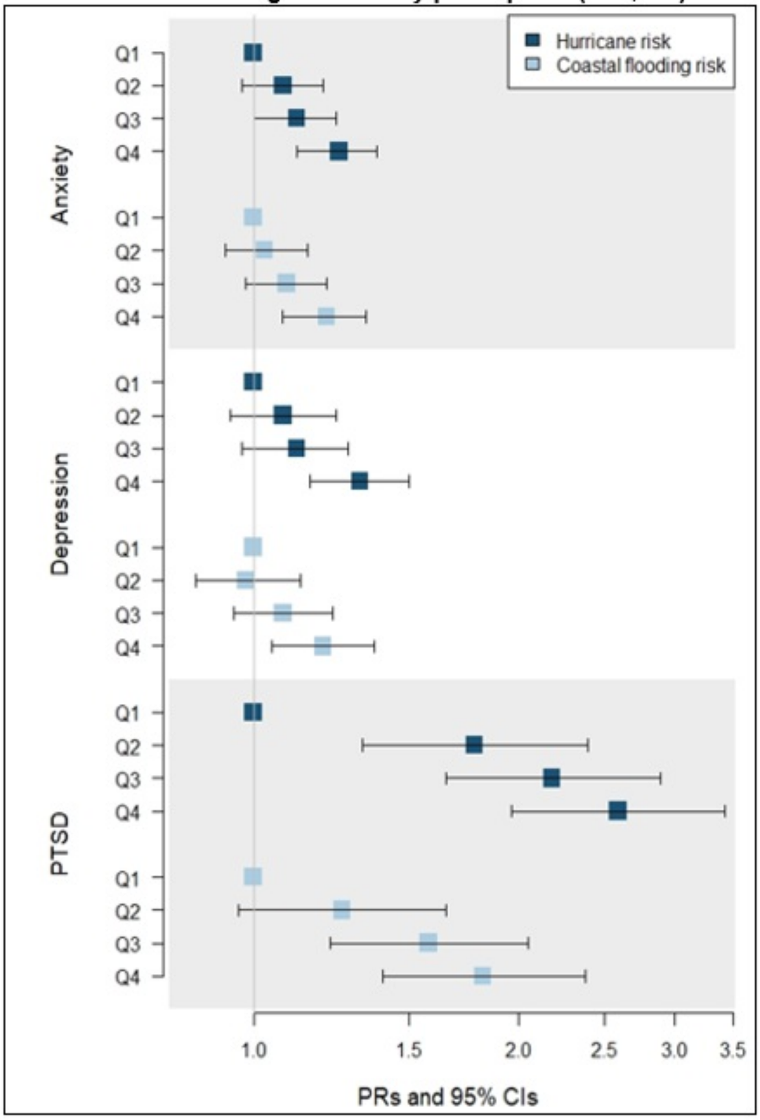
Objective: To evaluate the prevalence of adverse MH associated with natural hazard risk among US Gulf coast residents participating in the Gulf Long-term Follow-up Study, a longitudinal study of health risks following the 2010 *Deepwater Horizon* disaster.

Methods: Participants living in five Gulf states completed a home visit (N=11,193) that included interviewer-administered and standardized mental health questionnaires: Patient Health Questionnaire-9 (depression=score ≥10), Generalized Anxiety Disorder Questionnaire-7 (anxiety=score ≥10), and Primary Care PTSD Screen (PTSD=score≥ 3). Analysis was restricted to participants with complete exposure and covariate information (N=9,850). Geocoded residential addresses were linked at the census-tract level to the National Risk Index, a community-level measure of natural hazard risk. We considered risk scores (quartiles) for overall risk and natural hazards relevant to coastal residents (heatwaves, coastal flooding, and hurricanes). Log binomial regression estimated prevalence ratios (PR) and 95% confidence intervals (CI) for associations of risk scores and MH outcomes adjusting for sociodemographic and lifestyle factors.

Results: Overall natural hazard risk was not associated with MH outcomes. The highest vs. lowest quartile of heatwave risk was associated with anxiety (PR (95%CI): 1.16(1.04, 1.28)) but not depression or PTSD. Coastal flooding and hurricane risk were associated with all MH outcomes, with the strongest associations for the highest vs. lowest quartile of risk and PTSD ($PR_{CoastalFlooding}$: 1.82(1.40, 2.38); $PR_{Hurricanes}$: 2.59(1.96, 3.42)).

Conclusions: Poor MH was more prevalent among individuals with higher natural hazard risk. Associations differed by event type and MH condition. Policies targeting impacts of hazards should be hazard-specific and consider a range of MH conditions.

Figure 1. Hurricane and Coastal Flooding Risks with mental health outcomes among GuLF Study participants (N=9,850).



Wednesday OS10

Wildfire smoke exposure and Emergency Department Visits in Washington State

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Abstract

Background: Wildfires are increasing in prevalence in western North America due to changing climate conditions. A growing number of studies examine the impact of wildfire smoke on morbidity; however, few evaluate these impacts in Washington.

Methods: We use syndromic surveillance data to explore the overall and cumulative effect of wildfire smoke exposure on all-cause respiratory and cardiovascular emergency department visits in Washington state.

Results: Using a time-stratified case crossover design, we observed an increased odds of asthma visits immediately after and in all five days following exposure (lag 0 OR: 1.13; 95% CI: 1.10, 1.17; lag 1-5 ORs all 1.05 or greater with a lower CI of 1.02 or higher), and an increased odds of respiratory visits in all five days following exposure (lag 1 OR: 1.02; 95% CI: 1.00, 1.03; lag 2-5 ORs and lower CIs were all at least as large) comparing wildfire smoke to non-wildfire smoke days. We observed mixed results for cardiovascular visits, with evidence of increased odds emerging only several days following exposure. We also found increased cumulative odds across all visit categories for a 10 µg/m3 increase in smoke-impacted PM2.5 over 6-8 days following exposure. In stratified analyses, we observed elevated odds for respiratory visits among ages 19-64, for asthma visits among ages 5-64, and mixed risk estimates for cardiovascular visits by age group.

Conclusion: This study provides evidence of an increased risk of respiratory ED visits immediately following wildfire smoke exposure, and increased risk of cardiovascular ED visits several days following exposure. These increased risks are seen particularly among children and younger to middle-aged adults.

Wednesday OS10

Drought, Desiccation, Dust, and Wind in the American West: The Connections to Children’s Health

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Abstract

Background and Aim: Although the link between heat and children’s health is well-established in the climate change context, the role drought, desiccation, dust, and wind may play has received less attention. With lack of precipitation, drought and aridity become more frequent in the American West, leading to excessive amounts of dust in the air. In a narrative review, we examined these exposures and looked at their association with coccidioidomycosis (Valley fever), respiratory effects, Kawasaki disease (KD), and motor vehicle accidents among children in the American West.

METHODS: Using PubMed, we searched for terms such as “climate change”, “climate exposures,” “drought,” “dust,” “dust storm,” “aridity,” and “desiccation” along with “health” and “children’s health.” We also limited the search to the western United States.

RESULTS: Among the number of outcomes, we found desiccation of water bodies (Salton Sea) and asthma among children, drought and Valley fever cases among older children and pregnant people, climatic factors and wind and KD cases, and dust storms and motor vehicles as some of the more emerging topics that would likely benefit from further research. Rural children and children from some race/ethnic minority groups appear to be at increased risk, including Black and Filipino-American children for Valley fever, Asian-American children for KD, and Native American and Native Alaskan children for motor vehicle accidents.

CONCLUSIONS: Climate change may herald more dust inducing events in the American West. Climatic factors that exacerbate dust, including drought, desiccation, and wind, can be especially harmful to children but have received less research. More studies covering these exposures and children’s health could inform more well-rounded and inclusive policy decisions regarding community resiliency and outreach efforts pertaining to climate change

KEYWORDS: drought, dust, Salton Sea, Valley fever, Kawasaki disease, car accidents

Wednesday OS10

Synergistic Health Risks Associated with Wildfire Smoke and Extreme Heat in California

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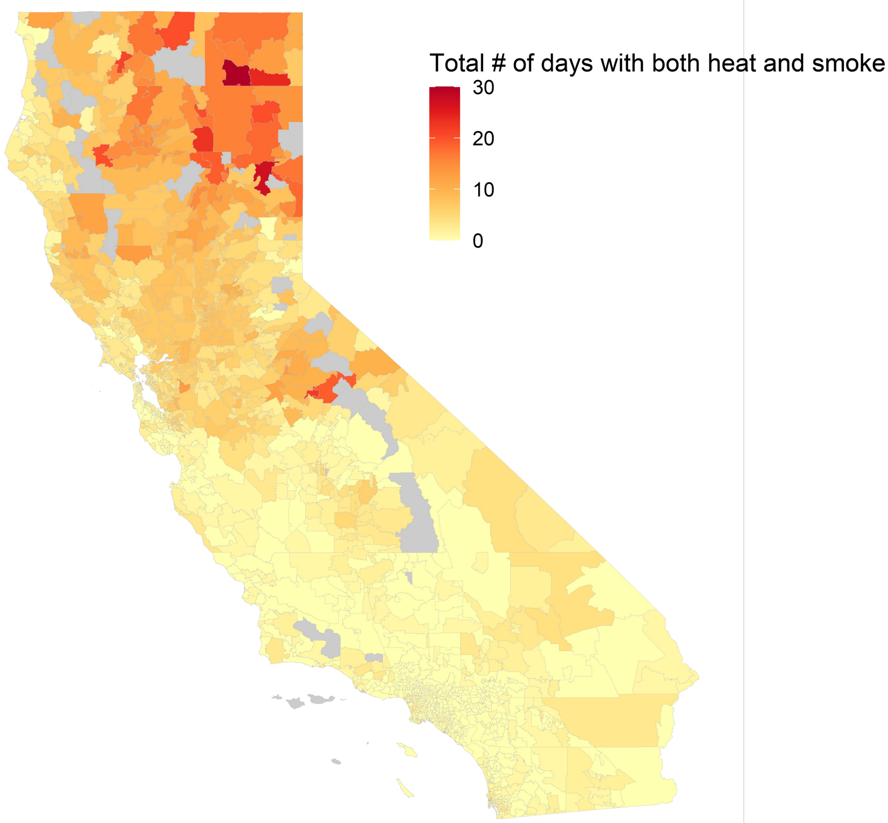
Abstract



Introduction

Climate-related hazards like wildfire smoke and extreme heat are increasingly co-occurring and could individually aggravate oxidative stress and inflammation. Exposure to both hazards simultaneously could lead to synergistic health effects. In this study, we quantified compound exposures to extreme heat and wildfire smoke and evaluated whether synergistic effects exist in California.

Method

Using existing exposure surfaces of wildfire-specific fine particulate matter ($PM_{2.5}$) concentrations and GRIDMET reanalysis product, we identified days with wildfire smoke (>0 wildfire $PM_{2.5}$) or extreme heat (> 85th percentile of historical daily maximum temperature in summer) separately in each Californian zipcode tabulation area (ZCTA) between 2006 and 2019. We obtained daily ZCTA-specific cardiorespiratory hospitalization counts from the Department of Health Care Access and Information. Using a case-crossover design, we estimated state-wise individual and joint effects of these hazards on

cardiorespiratory hospitalizations with a conditional logistic regression model including an interaction term between indicators of hazards, and calculated additive and multiplicative synergistic effects. We explored varying definitions for wildfire smoke and extreme heat in sensitivity analyses.

Results

Extreme heat and wildfire alone are positively associated with increased risk of cardiorespiratory hospitalization at the state level, with odds ratios of 1.01 (95% CI: 1.00, 1.01) and 1.04 (95% CI: 1.03, 1.05), respectively. Having both hazards co-occur is associated with an odds ratio of 1.06 (95% CI: 1.04, 1.09) for hospitalization, corresponding to a 1% (95% CI: -1%, 4%) relative excess risk due to interaction (additive interaction), and a 1.01 (95% CI: 0.99, 1.04) ratio of odds ratios (multiplicative interaction). Stricter definitions of hazards led to estimates of the same direction but less precision.

Conclusion

We found evidence that wildfire smoke and extreme heat co-occurring could cause a higher health risk than the total risk of them occurring separately. Climate change adaptation strategies could benefit from considering such synergistic effects.

Wednesday OS10

Disparities in Preterm Birth Following the July 1995 Chicago Heat Wave

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Abstract

Purpose: To evaluate whether the 1995 Chicago heat wave—among the most severe in the US during the 20th Century—increased the risk of preterm birth (PTB, < 37 weeks completed gestation) and whether the association differed by race/ethnicity.

Methods: We used birth data from January 1990 to December 1996 from the National Vital Statistics File to calculate the mean monthly PTB incidence in Cook County, Illinois, which includes Chicago. We stratified by non-Hispanic (NH) Black and NH white birthing people and used integrated synthetic control and time-series methods to minimize confounding.

Results: From 1990-1996 in Cook County, the mean monthly PTB incidence among NH Black birthing people was 18.6% compared to 7.8% among NH white birthing people. The heat wave hit during July 1995. From August 1995-January 1996, the mean monthly PTB incidence among NH Black birthing people was 16.7% higher than expected (3 additional PTBs per 100 live births per month [95% CI: 1, 5]). We found a similar increase among NH Black individuals with less than a high school education. No increase appeared among NH white individuals.

Conclusions: Severe heat waves may increase the incidence of PTB, especially among vulnerable subgroups such as NH Black birthing people.

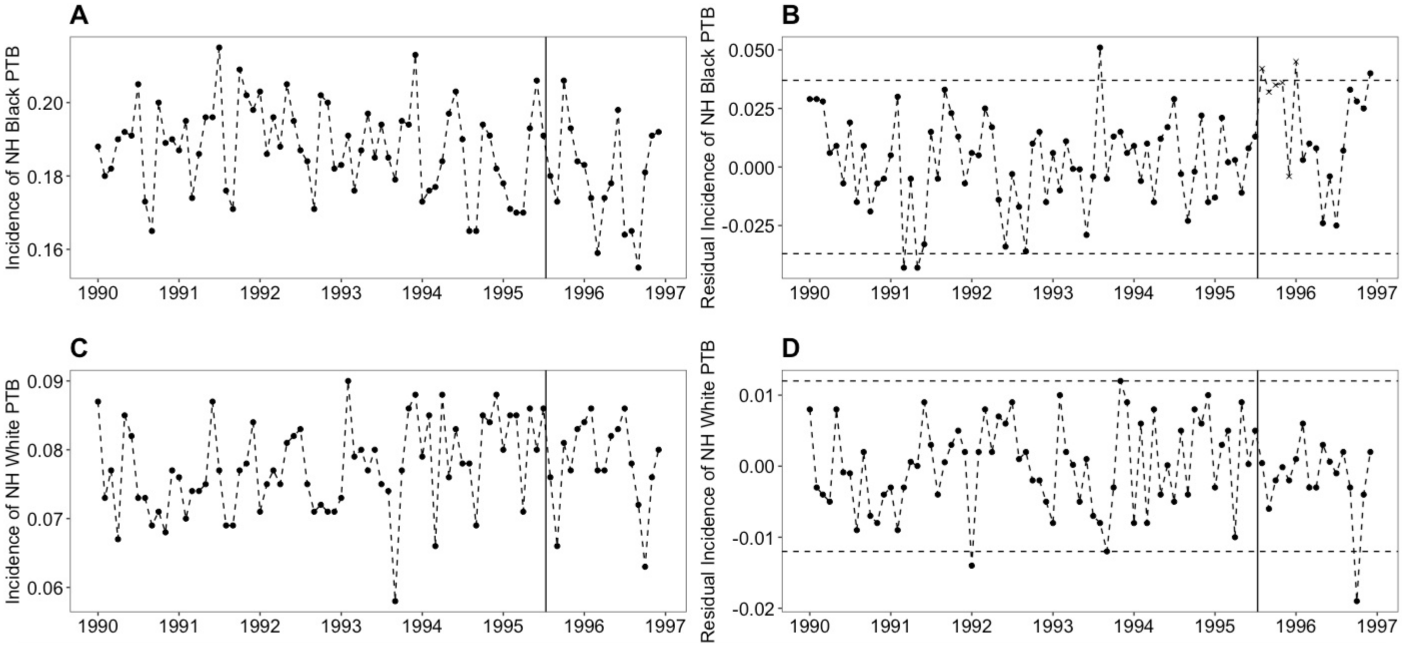

Figure 1: PTB incidence (per 100 live births) among NH Black and NH white birthing people over 84 months in Cook County, IL. Panels A and C plot the observed NH Black and NH white incidence of PTB, respectively; Panels B and D plot the residual incidence of NH Black and NH white PTB, respectively, with mean=0, after inclusion of a synthetic control series to remove autocorrelation. July 1995, the month of the heat wave, is indicated with a black vertical line in each panel. Panel B shows a positive outlying

sequence with "X's" in the 6 months post-heat wave.

Wednesday OS10

Excess Contaminant Releases During Hurricane Harvey: Implications of Natech Disasters for Climate Justice

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Abstract

Background/Aims

The increased severity and frequency of hurricane and flood events are increasing the risk of natural technological (‘natech’) disasters resulting in releases of hazardous substances from industrial sites. Because people of color and low socioeconomic status are more likely to live near industrial sites, they face higher risks for natech-related exposures. We assessed excess contaminant releases during Hurricane Harvey and characterized disparities in residential proximity to releases.

Methods

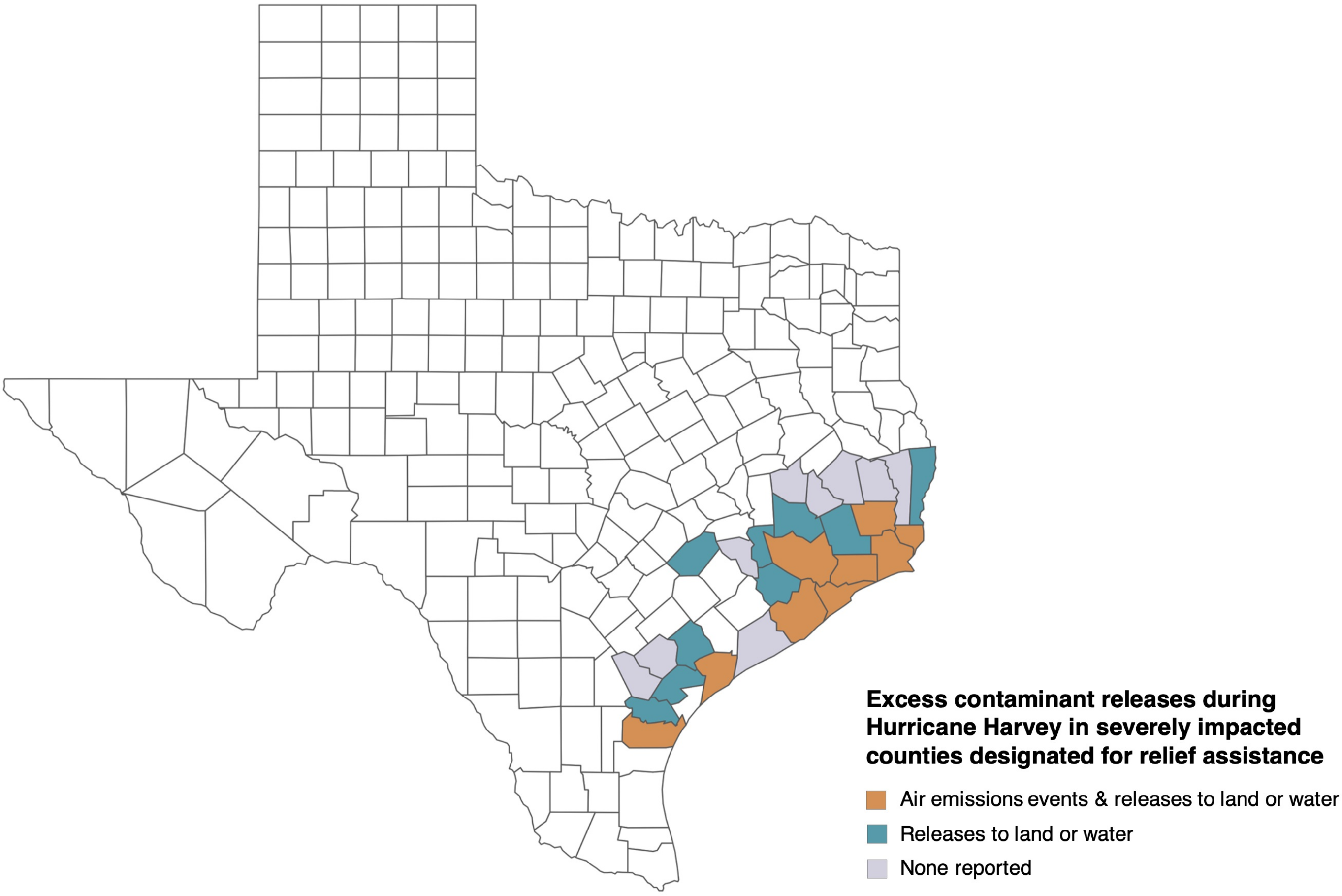
We considered contaminant releases to air and water or land reported to the Texas Commission on Environmental Quality and National Response Center during a 2.5-week period surrounding the hurricane and classified census block groups based on proximity to release events (<2km vs. 2-10km). We considered 27 counties that experienced severe rainfall, flooding, and wind during Harvey and were designated for relief assistance. Sociodemographics were characterized using data from the 2015-2019 American Community Survey. We used multivariate regression to estimate associations between racial/ethnic composition and the likelihood of experiencing a hazardous release event, controlling for poverty, housing tenure, vehicle ownership, linguistic isolation, and flood depth.

Results

Petrochemical and gas manufacturing facilities were responsible for the greatest quantity of excess air emissions. A standard deviation unit increase in the proportion of Latinx residents was associated with a 40% increase in the risk of an air emissions event within 2km (prevalence ratio [95% confidence interval] = 1.40 [1.13, 1.72]). The proportion of people of color was associated with a reduced risk of a release to land or water within 2km; however, a standard deviation unit increase in the poverty rate was associated with 38% increase in risk (PR [95% CI] = 1.38 [1.25, 1.53]).

Conclusion

Excess air contaminant releases during Harvey disproportionately affected Latinx populations, and spills disproportionately affected poor communities, providing further evidence of the inequitable impacts of extreme weather events.



Excess contaminant releases during Hurricane Harvey in severely impacted counties designated for relief assistance

Air emissions events & releases to land or water

Releases to land or water

None reported

Wednesday OS11

Pregnancy-related Hemodynamic Biomarkers in Relation to Trimester-specific Maternal Per- and Polyfluoroalkyl Substances Exposures and Adverse Birth Outcomes

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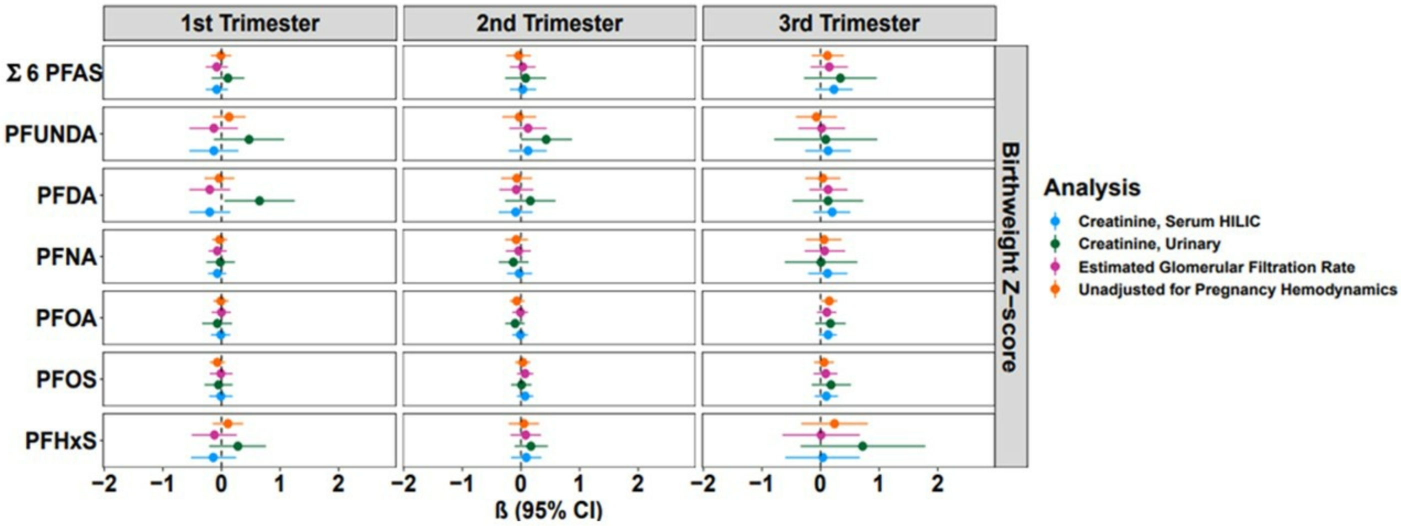
Abstract

The fate of environmental chemicals in maternal and fetal tissues might be affected by pregnancy-related hemodynamic changes that occur across gestation. Specifically, hemodilution and renal function are hypothesized to confound associations between per- and polyfluoroalkyl substances (PFAS) exposure measures in late pregnancy with gestational length and fetal growth. Our aim was to analyze two pregnancy-related hemodynamic biomarkers, creatinine and estimated glomerular filtration rate (eGFR), as confounders of the trimester-specific relationships between maternal serum PFAS concentrations and adverse birth outcomes.

Participants were enrolled in the Atlanta African American Maternal-Child Cohort between 2014 – 2020. Biospecimens were collected at up to two timepoints, which were categorized into the 1st trimester (N=278; 11 mean weeks gestation), 2nd trimester (N=162; 24 mean weeks gestation), and 3rd trimester (N=110; 29 mean weeks gestation). We quantified six PFAS in serum, creatinine in serum and urine, and eGFR using the Cockroft-Gault equation. Multivariable regression models estimated the associations between single PFAS and their sum with gestational age at delivery (weeks), preterm birth (PTB, <37 gestational weeks), birthweight z-scores, and small for gestational age (SGA). Primary models were adjusted for sociodemographics. We additionally adjusted for serum creatinine, urinary creatinine, or eGFR in the confounding assessments.

An interquartile range increase in perfluorooctanoic acid (PFOA) produced a non-significant reduction in birthweight z-score during the 1st and 2nd trimesters (β=-0.01 grams [95% CI=-0.14, 0.12] and β=-0.07 grams [95% CI=-0.19, 0.06], respectively) whereas the relationship was significant and positive during the 3rd trimester (β=0.15 grams; 95% CI=0.01, 0.29). Trimester-specific effects were similar for the other PFAS and adverse birth outcomes, which persisted after adjusting for creatinine or eGFR.

Associations between prenatal PFAS exposure and adverse birth outcomes were not strongly confounded by renal function or hemodilution. However, 3rd trimester samples consistently exhibited different effects than those collected during the 1st and 2nd trimesters.



1st Trimester
2nd Trimester
3rd Trimester
Σ 6 PFAS
PFUNDA
PFDA
PFNA
PFOA
PFOS
PFHxS
Birthweight Z−score
−2
−1
0
1
2
ß (95% CI)
Analysis
Creatinine, Serum HILIC
Creatinine, Urinary
Estimated Glomerular Filtration Rate
Unadjusted for Pregnancy Hemodynamics

Wednesday OS11

Associations of pregnancy and postpartum personal care product use with postpartum glycemic measures − results from the ERGO Study

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Abstract

Background: Personal care products often contain endocrine disrupting chemicals (EDCs), such as parabens and phthalates. EDC exposure and personal care product use are associated with altered glucose homeostasis in pregnancy; data on associations between product use and postpartum glycemic outcomes are lacking.

Methods: The study population included 175 participants from the Environmental Reproductive and Glucose Outcomes (ERGO) Study, a Boston, MA based pregnancy cohort (enrollment: 2016-2020). Participants self-reported personal care product use at ≤ 4 pregnancy visits (median: 11, 19, 26, 36 weeks) and one postpartum visit (median: 7 weeks). At the postpartum visit, we measured hemoglobin A1c (HbA1c), fasting blood glucose (FBG), and 2-hour postprandial glucose via 75-g oral glucose tolerance tests. We estimated visit-specific associations of product use with continuous glycemic measures using multivariable linear regression, adjusting for sociodemographic factors.

Results: Mean (standard deviation) postpartum HbA1c, FBG, and 2-hour glucose levels were 5.2% (0.3), 82 mg/dL (8), and 88 mg/dL (21), respectively. Associations with glycemic outcome measures varied across products and visits. Pregnancy and postpartum hair oil users (visits: 1, 3, 4, postpartum) had lower mean HbA1c levels compared to non-users (e.g., Postpartum: -0.13%; 95%CI: -0.29, 0.03). Conversely, visit 1 hair gel/spray users had a 0.12% (95%CI: 0.01, 0.23) higher mean HbA1c. Visit 2 shaving cream users had a 10.3 mg/dL (95%CI: 1.2, 19.3) higher mean 2-hour glucose level compared to non-users. Postpartum users of certain products (conditioner, hair gel/spray, hair oil, shaving cream) had higher mean FBG levels compared to non-users (e.g., hair oil: 3.6 mg/dL; 95%CI: -0.1, 7.3).

Conclusion: Use of certain personal care products during pregnancy and postpartum was associated with levels of postpartum glycemic measures. Pregnancy and postpartum personal care product use may represent potentially modifiable risk factors for altered glycemic measures, with potential impacts on long-term cardiometabolic health.

Wednesday OS11

Prenatal cadmium exposure and maternal sex steroid hormones across pregnancy

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Abstract

Background/Aims Exposure to the heavy metal cadmium (Cd) occurs through consumption of contaminated food and water, tobacco smoke, and industrial applications. Prenatal Cd exposure has been associated with adverse birth and child outcomes. One possible mechanism is endocrine disruption. Studies of non-pregnant adults suggest Cd impacts androgen concentrations; to date, few studies have examined associations in pregnancy.

Methods Pregnant women from the Understanding Pregnancy Signals and Infant Development (UPSIDE) cohort provided biospecimens and questionnaire data in each trimester (n=272). Urinary Cd was analyzed using ICP-MS, serum total testosterone [TT], estrone, estradiol, and estriol were analyzed using LC/MS-MS, and serum free testosterone [fT] was analyzed using equilibrium dialysis. In adjusted longitudinal models, we examined sex steroid concentrations across pregnancy in relation to specific gravity-adjusted, ln-transformed Cd concentrations Additionally, we fit linear regression models examining trimester-specific associations. In secondary models, we stratified by fetal sex and restricted models to non-smokers (n=254). Results are presented as percent change (%Δ) in hormone concentrations.

Results Median specific gravity-adjusted Cd concentrations were 0.23, 0.15, and 0.17μg/L in trimesters 1, 2, and 3, respectively. In preliminary longitudinal models, higher Cd concentrations were associated with lower fT across pregnancy (%Δ=-5, 95%CI:-8, -2), with no differences in other hormones observed. Results did not differ by fetal sex. In trimester-specific models, higher Cd concentrations were associated with lower TT in trimester 2 (%Δ=-16, 95%CI:-25, -4) and fT in trimester 3 (%Δ=-14, 95%CI:-20, -8). Associations with TT were stronger in women carrying female fetuses, whereas associations with fT were similar across both fetal sexes. Results were similar after the exclusion of smokers.

Conclusion Our preliminary analyses suggest maternal Cd exposure may be associated with reduced testosterone in pregnancy. Additional work is necessary to understand how alterations in gestational testosterone activity may impact pregnancy and child health.

Wednesday OS11

Organophosphate esters and fetal growth in the LIFECODES Fetal Growth Study

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Abstract

Background and Aims: Organophosphate esters (OPEs), including those used as flame retardants, represent emerging exposures of concern and have been associated with adverse birth outcomes, including changes in fetal growth. Previous studies have been inconsistent with respect to the direction and magnitude of associations between OPEs and fetal growth outcomes. However, this literature has been limited by small sample sizes. We estimated associations between OPEs and size-for-gestational age using the LIFECODES Fetal Growth Study.

Methods: This study uses data from participants in the LIFECODES Fetal Growth Study, a case-cohort of 249 small-for-gestational age (SGA), 411 appropriate-for-gestational age (AGA) and 241 large-for-gestational age (LGA) births, which includes pregnancies occurring between 2008 – 2018. We measured concentrations of 8 OPE metabolites at three timepoints and used their geometric mean to estimate average exposures during pregnancy. We used multinomial logistic regression models to estimate the odds ratio (OR) and 95% confidence interval (CI) of an SGA or LGA birth associated with an interquartile-range increase in each metabolite.

Results: Of the metabolites quantified, we detected 5 frequently (> 60% of participants). The metabolites were weakly correlated with one another ($-0.13 < \rho < 0.27$) and we identified temporal trends in their concentrations across the study period. For example, concentrations of bis(2-chloroethyl) phosphate (BCEtP) and di-n-butyl phosphate (DBuP) declined, while concentrations of bis(1-chloro-2-propyl) phosphate (BCPP) increased across the study period. After adjusting for potential confounders, both bis(1,3-dichloro-2-propyl) phosphate (BDCIPP; OR: 1.30, 95% CI: 1.00, 1.68) and BCEtP (OR: 1.25, 95% CI: 0.99, 1.57) were associated with higher odds of an LGA birth. Associations with SGA births were null.

Conclusions: Metabolites of several OPEs were associated with higher odds of an LGA birth. Though the literature is inconsistent, these findings align with previous studies reporting that BDCIPP and BCEtP are associated with higher birthweights.

Wednesday OS11

Per- and polyfluoroalkyl substances are associated with maternal mid-pregnancy sex-steroid hormone concentrations

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Abstract

Background/Aims: Pregnant women are exposed to persistent environmental contaminants, including per- and polyfluoroalkyl substances (PFAS) that may disrupt thyroid function. However, it is unclear if PFAS are also associated with altered maternal sex-steroid hormone levels, which support pregnancy health and fetal development.

Methods: In Illinois women (n=457) with high socioeconomic status, we quantified perfluorononanoic (PFNA), perfluorooctane sulfonic (PFOS), perfluorooctanoic (PFOA), methyl-perfluorooctane sulfonamide acetic, perfluorohexanesulphonic (PFHxS), perfluorodecanoic (PFDeA), and perfluoroundecanoic (PFUdA) acid concentrations in fasting serum samples at median 17 weeks gestation, along with plasma progesterone, testosterone, and estradiol. PFAS and hormones were ln-transformed. We evaluated covariate-adjusted associations of hormones with each PFAS individually using linear regression and with PFAS as a mixture using quantile-based g-computation.

Results: Individually, each interquartile range (IQR) increase in PFOS was associated with 2.8% (95%CI: -0.8, 6.4) higher progesterone and 7.5% (95%CI: 1.6, 13.8) higher estradiol. PFHxS was positively (%Δ: 10.0%; 95%CI: 3.8, 16.6), but PFDeA and PFUdA were negatively (%Δ: -4.9%; 95%CI: -9.4, -0.2, %Δ: -3.5%; 95%CI: -7.0, 0.3, respectively) associated with testosterone. The PFAS mixture was not associated with progesterone (%Δ: 1.0; 95%CI: -6.5, 8.6) due to similar positive (%Δ: 10.0; driven by PFOS & PFNA) and negative (%Δ: -9.0; driven by PFOA) associations with progesterone. However, each IQR mixture increase was marginally associated with 8.0% (95%CI: -4.0, 20.0) higher estradiol due to stronger positive (%Δ: 24.5; driven by PFOS & PFUdA) than negative (%Δ: -16.5; driven by PFOA) associations with estradiol. Finally, the mixture was imprecisely positively associated with testosterone (%Δ: 5.5; 95%CI: -9.0, 19.5), with slightly stronger positive (%Δ: 21.5; driven by PFHxS) than negative (%Δ: -16.0; driven by PFDeA & PFUdA) associations with testosterone.

Conclusion: PFAS mixtures were not associated with maternal sex-steroid hormones due to opposing effects of some individual PFAS. Additional prospective studies are needed to corroborate these findings.

Wednesday OS11

Gestational exposure to the mycoestrogen zearalenone and associations with serum estrogen concentrations

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Abstract

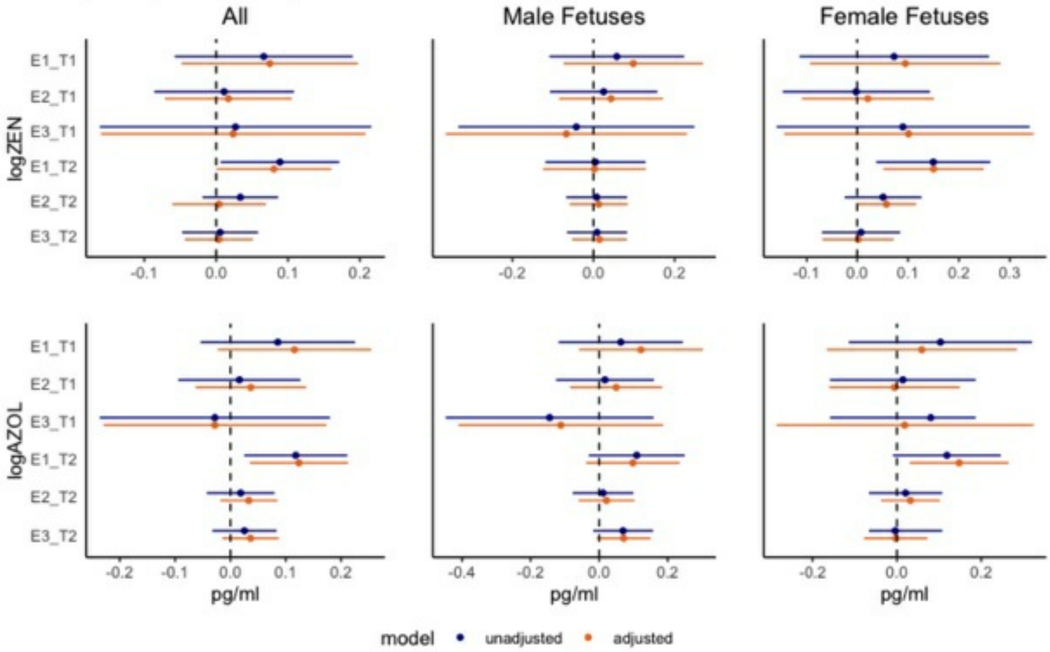
Background/Aims: Zearalenone (ZEN) is a fungal-derived toxin found in global food supplies including cereal grains and processed foods. In the U.S., zeranol, a synthetic derivative of ZEN, is administered to livestock as a growth promoter. Because the chemical structure of ZEN, zeranol, and metabolites closely resembles 17β-estradiol (E2), they interact with estrogen receptors α (ER-α) and β (ER-β) resulting in their designation as 'mycoestrogens'. In animal models, gestational exposure disrupts estrogen activity and impairs fetal growth. In the current study, we evaluated the relationship between mycoestrogen exposure and circulating estrogens in healthy pregnant women.

Methods: Serum and urine samples were collected in each trimester from pregnant participants in the UPSIDE study (Rochester, NY, n=208). We used high performance liquid chromatography and high-resolution tandem mass spectrometry to measure total urinary mycoestrogens (ng/ml) and serum estrogens (pg/ml) (estrone (E1), estradiol (E2), estriol (E3)). Multivariable linear models were fitted for each timepoint (1st and 2nd trimesters) using specific gravity adjusted, log-transformed mycoestrogen concentrations in relation to log-transformed estrogens, adjusting for covariates. We additionally considered effect modification by fetal sex.

Results: ZEN and α-zearalenol (α-ZOL) were detected in >93% and >72% of 1st and 2nd trimester urine samples (ZEN median: 1st 0.098 ng/ml, 2nd 0.114 ng/ml; and α-ZOL median: 1st 0.104 ng/ml, 2nd 0.143 ng/ml). No significant associations between 1st trimester mycoestrogens and estrogens were observed. In the second trimester, ZEN and α-ZOL were positively associated with E1 (ZEN β:0.0803, 95%CI: 0.0004, 0.1602, α-ZOL β:0.1239, 95%CI: 0.0351, 0.2128), with stronger associations observed in pregnancies with female fetuses.

Conclusion: Preliminary results indicate that mid-pregnancy mycoestrogen concentrations are associated with higher serum E1 concentrations. The next steps in this analysis include evaluation of 3rd trimester associations, longitudinal models, and evaluation of birth outcomes.

Figure 1. Multivariable linear models† of associations between urinary mycoestrogens (ng/ml) and estrone (E1), estradiol (E2), estriol (E3) (pg/ml) in the first (T1) and second (T2) trimester among UPSIDE participants (n=208).



Abbr: aZOL: alpha-zearalenol, ZEN: zearalenone.
† Models adjusted for maternal race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Other), education (less than high school, more than high school), infant sex (male =1), smoking during pregnancy (any/none), season of urine collection (1=March, April, May; 2=June, July, Aug; 3=Sept, Oct, Nov; 4=Dec, Jan, Feb), serum collection gestational age (weeks), pre-pregnancy BMI, and parity (nulliparous, parous).

Wednesday OS12

Associations of a Metal Mixture from Ferroalloy Industry with Reported Attention-related Behaviors are not Modified by Iron Status in Italian Adolescents

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Abstract

Background: Exposure to environmental metals has been consistently associated with decrements in attention in children. These associations may be modified by co-exposure to other metals or iron (Fe) deficiency. However, few studies have investigated these relationships, particularly with respect to attention-related behaviors.

Methods: We utilized cross-sectional data from the Public Health Impact of Metals Exposure (PHIME) study that included 707 Italian adolescents (10 – 14 years). Manganese, chromium, and copper were quantified in hair samples and lead was quantified in whole blood using ICP-MS. Concentrations of three markers of Fe status (ferritin, hemoglobin, transferrin) were quantified using immunoassays or luminescence assays. Attention was assessed using the Conners Rating Scales (CRS) Self-Report Scale-Long Form (CASS: L), Parent Rating Scales Revised-Short Form (CPRS-R: S) and Teacher Rating Scales Revised-Short Form (CTRS-R: S). We employed Bayesian Kernel Machine Regression (BKMR) to examine covariate-adjusted associations of the metal mixture with these outcomes, and to evaluate Fe status as a potential modifier.

Results: Concurrent increases in concentrations of all metals were associated with worse self-reported attentional behaviors: metals set to their 90th percentiles were associated with 0.04 (95% credible interval [CI]= 0.00, 0.08), 0.04 (95% CI= 0.00, 0.08) and 0.03 (95% CI= -0.01, 0.06) point increases in ln-transformed T-scores for self-reported inattention, hyperactivity and ADHD index, respectively, compared to when metals were set to their 50th percentiles. These associations were driven by hair manganese, which exhibited nonlinear associations with all self-reported scales. There was no evidence that Fe status modified the neurotoxicity of the metal mixture. The metal mixture was not materially associated with any parent-reported or teacher-reported scale.

Conclusions: The overall metal mixture, driven by manganese, was weakly associated with worse self-reported attention. These findings suggest that concurrent exposure to environmental metals impacts adolescent neurodevelopment, which has significant public health implications.

Wednesday OS12

Acculturation as Predictors for Toxic Metal Exposures among Hispanic Americans in Starr County, Texas

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Abstract

Background: Arsenic, cadmium, and lead are toxic elements that widely contaminate our environment. These toxicants are associated with both acute and chronic health problems, and evidence suggests that minority communities, particularly Hispanic Americans, are disproportionately exposed.

Objective: We sought to evaluate measures of acculturation as predictors of urinary toxic metal concentrations among Mexican American adults living in Starr County, Texas.

Methods: As part of an ongoing longitudinal study, 520 adults, aged 35 to 69 years, underwent baseline interview, physical examination, and urine sample collection in 2018. Self-reported acculturation was assessed across various domains, including language, food, and social preferences as well as nativity using the Short Acculturation Scale for Hispanics (SASH). Multivariable adjusted linear regression was used to assess associations between acculturation measures and creatinine-adjusted urinary concentrations of arsenic, cadmium, and lead. Multivariable adjusted logistic regression was utilized to assess associations between each acculturation measure and a multiple metal index. Lastly, best subset selection with 10-fold cross validation was used to generate a prediction model for each toxic metal with a combination of the acculturation predictors. All models were adjusted for age, sex, education, employment status, and income.

Results: After adjustment, birth in Mexico was associated with higher urinary cadmium and lead; age at immigration was associated with higher urinary arsenic and lead; and the number of parents living in Mexico was associated with increased urinary lead. English language and American food preferences were associated with reduced urinary lead. Birth in Mexico, age at immigration, and number of parents in Mexico were all positively associated with the toxic mixture, while English language and American food preferences were negatively associated with the mixture. These results were further supported by the generated prediction model.

Conclusion: Several measures of acculturation predict toxic metal exposures among Mexican Americans living in Starr County, Texas.

Wednesday OS12

A Novel Approach to Assessing the Joint Effects of Mercury and Fish Consumption on Neurodevelopment in the New Bedford Cohort Study

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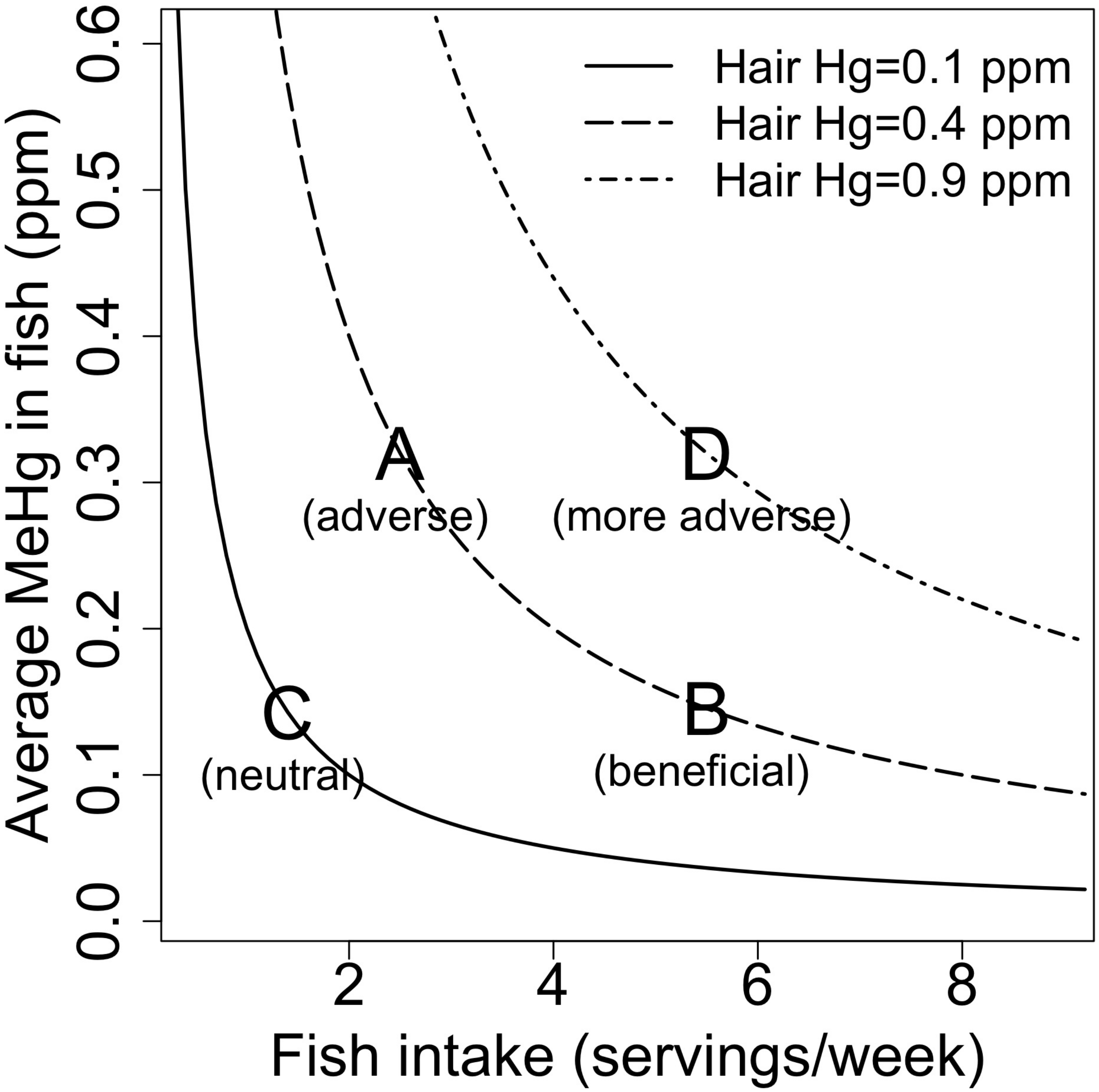
Abstract



Background: Understanding health risks from methylmercury (MeHg) is complicated by its link to fish

consumption which may confound or modify toxicities. One solution includes hair MeHg and fish in the same model. However, when controlling for fish, increasing hair MeHg can only occur by eating higher MeHg fish (Figure 1, subjects B and D); conversely, when controlling for hair MeHg, increasing fish intake can only occur when average fish MeHg decreases (Figure 1, subjects A and B). These scenarios misclassify risks or are unrealistic comparisons. In fish-eating populations, this dilemma can be addressed by separating MeHg exposure into fish intake and average fish MeHg content, and allowing associations of fish intake to vary by average fish MeHg.

Methods: We assessed the joint association of prenatal MeHg and fish intake with neurodevelopment in 361 eight-year-olds from the New Bedford Cohort, a study of children born in 1993-1998 and residing near a PCB-contaminated site in Massachusetts. Neurodevelopmental assessments used standardized tests of IQ, language, memory, and attention. Our primary estimate of average fish MeHg was maternal peripartum hair total Hg (approximating MeHg) divided by fish servings/week during pregnancy. Covariate-adjusted linear regression assessed the association of fish consumption – stratified by tertiles of average fish MeHg – with neurodevelopment.

Results: In the lowest fish MeHg tertile, associations between fish intake and neurodevelopment were generally positive. However, in the highest fish MeHg tertile, associations were negative, most strongly for the Boston Naming Test (no cues) where each serving of fish was associated with 1.3 fewer correct responses (95% CI: -2.2, -0.4). Using standard analyses, outcomes were not significantly associated with hair Hg or fish intake.

Conclusions: Our alternative modeling approach allows assessment of the joint impact of MeHg and fish intake on neurodevelopment, thereby addressing previous limitations and establishing a robust approach for future studies.

Wednesday OS12

Residential proximity to toxic metal-emitting industrial sites and toenail metal concentrations in a United States-wide prospective cohort

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Abstract

Background/Aim: Industrial sites in the United States (U.S.) emit millions of tons of hazardous air pollutants annually, including toxic metals. Whether residential proximity to metal emissions increases the body burden of toxic metals within nearby residents is unclear. We aimed to evaluate the association between air releases of metals from industrial facilities and toenail metal concentrations.

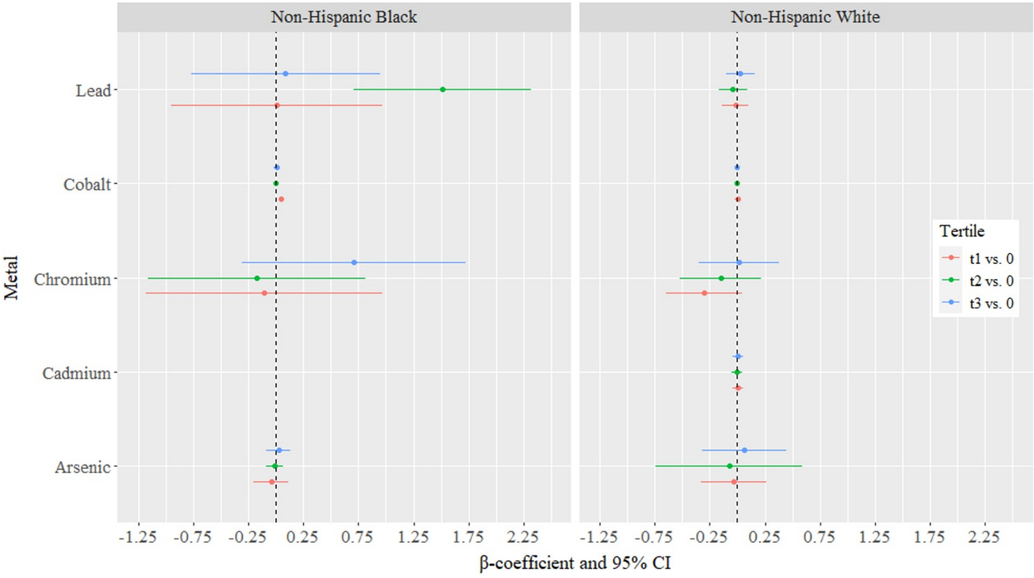
Methods: Arsenic, cadmium, chromium, cobalt, and lead concentrations (µg/g) were measured in toenail samples collected in 2003-2009 from 2,998 women in the Sister Study cohort. Using the U.S. Environmental Protection Agency's Toxics Release Inventory, we estimated the 10-year average air releases of metals (pounds) within 3, 5, and 10 kilometers (km) of participants' baseline residences. We used linear regression to estimate β-coefficients and 95% confidence intervals (CI) for the association between estimated residential metal emissions levels (zero emissions, 1st, 2nd, and 3rd tertiles) and toenail metal concentrations overall and stratified by race.

Results: The prevalence of metal-emitting facilities within 3km of participants' residences ranged from 0.3% (cadmium) to 15.5% (lead). We observed evidence of a positive but non-monotonic association between lead emissions and toenail lead concentrations overall (e.g., 3km: $\beta_{t2vs.0}$= 0.49, 95% CI= 0.24–0.74; 5km: $\beta_{t3vs.0}$= 0.26, 95% CI= 0.08–0.45), with associations evident among non-Hispanic Black (3km: $\beta_{t2vs.0}$= 1.51, 95% CI= 0.71–2.31; 5km: $\beta_{t3vs.0}$= 0.77, 95% CI= 0.15–1.39) but not non-Hispanic White women (3km: $\beta t_{2vs.0}$= -0.04, 95% CI= -0.17–0.09; 5km: $\beta_{t3vs.0}$= 0.03, 95% CI= -0.07–0.12; p-heterogeneity <0.01). Associations for other metals were largely null.

Conclusions: Preliminary results show that higher estimated residential lead emissions levels were associated with higher toenail lead concentrations among non-Hispanic Black women. Ongoing work will explore possible co-occurring exposures that may be contributing to the observed racial disparity.

Keywords: industrial emissions; chemical exposures; heavy metals

Figure 1. Forest plot of β-coefficients and 95% confidence intervals (CIs) for the association between estimated residential metal emissions levels and toenail metal concentrations among Non-Hispanic Black and White women living within 3km of toxic metal-emitting facilities.



Metal	*p-heterogeneity*	*Median toenail concentration (µg/g) (25% quantile – 75% quantile)*
Lead	<0.01	0.13 (0.07 – 0.26)
Cobalt	0.02	0.010 (0.004 – 0.013)
Chromium	0.19	0.51 (0.28 – 0.95)
Cadmium	N/A	0.01 (0.006 – 0.02)
Arsenic	0.99	0.06 (0.042 – 0.086)

Note: No non-Hispanic Black women were observed to be living within 3km of cadmium-emitting facilities, thus cadmium effect estimates are not presented for this group.

Wednesday OS12

A Longitudinal Investigation of Dietary Fluoride Exposures and Cardiometabolic Outcomes in Mexican Children from Ages 4 to 8 Years

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Abstract

Background/Aim

Fluoride intake is ubiquitous and constitutes a long-term exposure during childhood. Experimental research suggests lipid disturbances from fluoride exposure that affect cardiometabolic health; however, epidemiological studies have been scarce and mostly cross-sectional. We evaluated the associations between repeated dietary fluoride exposure and cardiometabolic outcomes in Mexican children.

Methods

Dietary-derived fluoride measurements from food frequency questionnaires were obtained at ages 4, 6 and 8 years for ~500 children recruited in the Programming Research in Obesity, Growth, Environment and Social Stressors (PROGRESS) cohort. Using covariate-adjusted linear mixed effects and linear regression models, we assessed the associations of fluoride exposure (log2 and tertiles) on cardiometabolic risk components measured at ages 4, 6 and/or 8, including lipids (high-density lipoprotein [HDL in mg/dL] and log-transformed triglycerides), glucose, and age- and sex-adjusted z-scores of body mass index (BMI), waist circumference (WC), and blood pressure (BP). We also calculated a cardiometabolic risk score at age 8 using the z-score sum of WC, BP, glucose, and triglycerides-to-HDL ratio.

Results

A doubling of fluoride intake at age 4 was associated with an annual increase in triglycerides [β=0.84 (95% CI: 0.00, 1.69)] and HDL [β=0.23 (95% CI: 0.04, 0.42)] between ages 4-8 years. At age 6, fluoride intake was also associated with higher HDL [β per fluoride doubling=4.27 (95% CI: 1.58, 6.95)]. Cross-sectional analyses at age 8 indicated that higher tertiles of fluoride exposure were associated with higher levels of multiple cardiometabolic outcomes, including z-BMI (p-trend=0.023), triglycerides (p-trend=0.012), glucose (p-trend=0.037), and cardiometabolic risk score (p-trend=0.044).

Conclusion

We found that dietary fluoride exposure may be associated with adverse cardiometabolic outcomes, particularly around age 8, as well as with increases in triglycerides and HDL levels at younger ages. Further longitudinal studies are needed to elucidate potential adverse metabolic effects of fluoride exposure in childhood and later ages.

Wednesday OS13

Burden of Disease from Contaminated Drinking Water in Countries with High Access to Safely Managed Water

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Abstract

Background/Aims

Most residents of high-income countries (≥90%) reportedly have high access to safely managed drinking water. Owing perhaps to the perception of near universal access to high-quality water services in these countries, the burden of waterborne disease in these contexts is understudied. This systematic review aimed to: identify population-scale estimates of waterborne disease in countries with high access to safely managed drinking water, compare methods to quantify disease burden, and identify gaps in available burden estimates.

Methods

We conducted a systematic review of population-scale disease burden estimates attributed to drinking water in countries where ≥90% of the population has access to safely managed drinking water per United Nations monitoring.

Results

We identified 24 studies reporting estimates for disease burden attributable to microbial contaminants. Across these studies, the population-weighted average burden of gastrointestinal illness risks attributed to drinking water was ~3,529 annual cases per 100,000 people. Beyond exposure to infectious agents, we identified 10 studies reporting disease burden associated with chemical contaminants. Across these studies, the pooled population-weighted average of excess cancer cases attributable to drinking water was 1.8 annual cancer cases per 100,000 people.

Conclusions

These estimates exceed WHO-recommended targets for disease burden attributable to drinking water and highlight that preventable disease burden remains in these contexts. However, available literature was scant and limited in geographic scope, disease outcomes, range of microbial and chemical contaminants, and inclusion of subpopulations (rural, low-income communities; Indigenous or Aboriginal peoples; populations marginalized due to discrimination by race, ethnicity, or socioeconomic status) that could most benefit from water infrastructure investments. Currently, available evidence is insufficient to support rational decision-making and to prioritize public investment to protect marginalized communities. Studies quantifying drinking water-associated disease burden in countries with reportedly high access to safe drinking water, focusing on specific subpopulations and promoting environmental justice, are needed.

Wednesday OS13

Public water contaminant estimates for birth cohorts in the Environmental Influences on Child Health Outcomes (ECHO) consortium

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Abstract

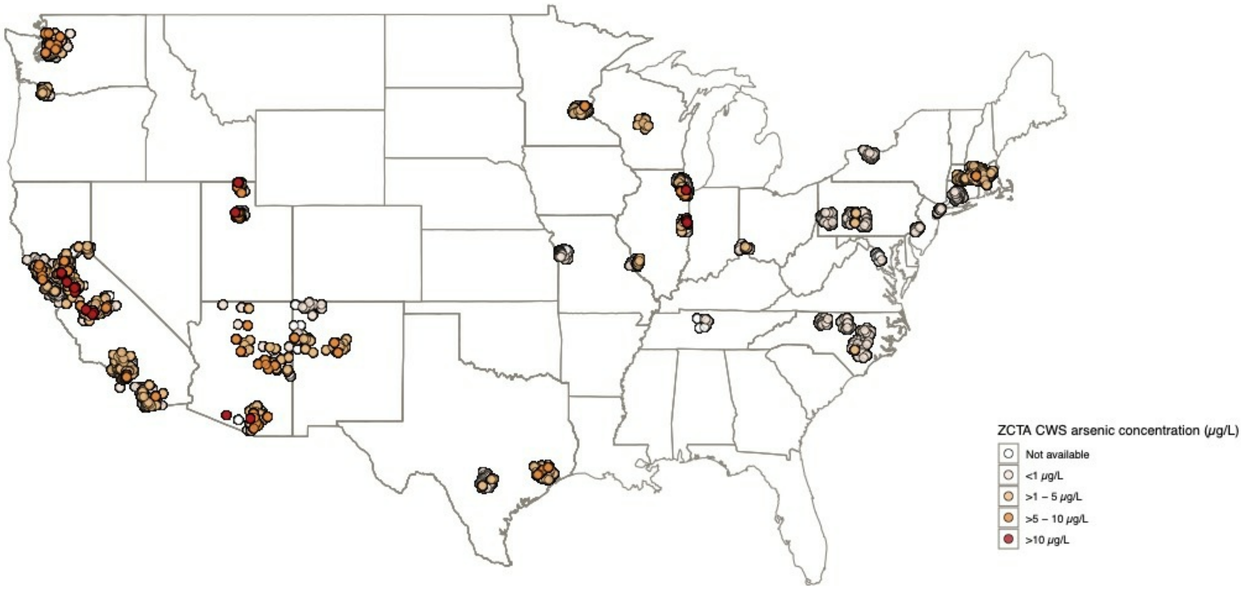
Background: The United States Environmental Protection Agency (USEPA) regulates over 80 contaminants in US community water systems (CWSs), including arsenic, nitrate, and disinfection byproducts that are associated with adverse birth outcomes. The epidemiologic association between CWS contaminant exposures and associated adverse birth outcomes has not been evaluated in nationwide cohort studies because contaminant assignments are not readily available. Our objective was to develop Zip Code Tabulation Area (ZCTA)-level CWS contaminant concentrations for 21 population-based birth cohorts participating in the Environmental Influences on Child Health Outcomes (ECHO) consortium.

Methods: We developed population-weighted, average estimates of inorganics (arsenic, uranium, chromium, selenium, barium, nitrate, fluoride) and disinfectant byproducts (total trihalomethanes, total haloacetic acids) for N=2,568 ZCTAs relevant for ECHO cohorts. We used previously developed, six-year average, CWS-level contaminant concentrations from routine compliance monitoring records in the USEPA's Six Year Review database (2006-2011). Population-weighted averages were developed by intersecting ZCTA boundaries with publicly available CWS distribution boundaries (N=14 states) and by manual assignment (N=10 states/tribal areas). Across states, we compared average contaminant concentrations and the N(%) exceeding each USEPA maximum contaminant level (MCL).

Results: The number of ZCTAs exceeding the MCL was 18 (arsenic), 4 (uranium), 0 (nitrate), 9 (trihalomethanes), and 31 (haloacetic acids). Average concentrations were highest for arsenic in Arizona (3.69 µg/L, 22.4% exceed ½ MCL), uranium in Arizona (5.28 µg/L, 1.18% above ½ MCL), nitrate in California (1,665 µg/L, 8.47% above ½ MCL), trihalomethanes in Pennsylvania (43.8 µg/L, 54.4% above ½ MCL) and haloacetic acid in New York (34.9 µg/L, 82.5% above ½ MCL).

Conclusions: Significant variability in CWS contaminant concentrations exist at the ZCTA-level across population-based ECHO birth cohorts. ECHO-relevant ZCTAs were most likely to exceed the haloacetic acids MCL compared to other contaminants. Future studies can leverage these CWS exposure assignments in epidemiologic studies in ECHO.

Population–weighted, average community water system (CWS) arsenic concentrations (2006–2011) at the zip code tabulation area (ZCTA)–level, N=2,463 ZCTAs relevant for N=21 population–based birth cohorts in the Environmental influence on Child Health Outcomes (ECHO) consortium



Wednesday OS13

Association Between Low Birth Weight Infants and Exposure from PFOS and PFOA Contaminated Drinking Water in Southern California

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Abstract

Low birth weight (LBW) infants have an increased risk of chronic health conditions which increases their sensitivity to environmental exposures at birth. Studies have shown decreases in birth weight associated with perfluoroalkyl substance (PFAS) exposure. We assessed the association between LBW and perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) concentrations from the Third Unregulated Contaminant Monitoring Rule (UCMR3) data. LBW was calculated from California birth records between 2009 and 2015 as the percent of live, singleton births weighing < 2500 grams. We calculated the average PFOS and PFOA value for census tracts in Los Angeles, Orange, and Riverside counties (n=3280) from concentrations reported in UCMR3 for each water district. PFAS concentrations were categorized into binary exposed and unexposed variables. Covariates reported in the CalEnviroScreen 4.0 included socioeconomic factors and other environmental exposures. We fit separate crude and adjusted linear models of LBW and PFOS or PFOA after considering univariate associations with covariates. LBW ranged from 0% to 12.73% in our study area. PFOS and PFOA exposures in public drinking water ranged from non-detect (ND) to 0.0815 µg/L and ND to 0.0485 µg/L, respectively. In a univariate analysis of LBW and poverty, the highest tertile of poverty was strongly associated with increased % LBW (1.34, $p < 0.001$). In unadjusted models, PFOA exposure (-0.34, $p < 0.001$) and PFOS exposure (-0.11, $p = 0.188$) decreased % LBW. The direction of association of PFOA (-0.23, $p < 0.001$) and PFOS (-0.14, $p =0.08$) with % LBW did not change with adjustment. Exposure to PFOS and PFOA was weakly associated with LBW infants in three counties in California. Other covariates may explain differences in LBW rates throughout Southern California. Differences in LBW due to PFAS exposure may be evident if individual level data were available.

Wednesday OS13

Environmental Injustice in Exposure to Feces-Contaminated Water and Resulting Illnesses at New England Beaches

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Abstract

Swimming at the beach is a highly valued recreational activity in New England, but fecal contamination in these waters can endanger public health. Swimming beaches with poorer water quality tend to be nearer to low-income, non-white communities, indicating a potential environmental injustice in access to swimming beaches with clean water. However, the demographics of actual beach visitors at different beaches, as well as the number of people made sick by pathogens at these beaches, are unknown. To estimate these outcomes, we used commercial cell phone location data to model the number of visitors to New England beaches from 2018-2019 and those visitors' home census tracts. We link these visitations to water quality measurements from U.S. EPA's Beach Advisory and Closing Online Notification (BEACON) system. We applied an existing epidemiologic model to estimate gastrointestinal illness resulting from exposure to pathogens while swimming at these beaches. This analysis will allow us to determine if disproportionately more visitors from non-white and lower income communities visit beaches with worse water quality measurements and are consequently more likely to contract gastrointestinal illness from use of the recreational waters, revealing an environmental injustice. As EPA works to refine beach monitoring and closure guidelines and advance environmental justice, this work can help inform policies that promote public health and health equity.

Wednesday OS13

Association Between Occurrence of Per- and Polyfluoroalkyl Substances in Public Water Systems and Socioeconomic Status of Neighborhoods in North Carolina

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Abstract

Background: Exposure to per- and polyfluoroalkyl substances (PFAS) is associated with health risks. However, the joint spatial distribution of PFAS and socioeconomic status (SES) is not known. This study examines the joint distribution of PFAS and SES in North Carolina.

Methods: Hierarchical clustering was used to cluster 2010 census block groups based on features including urbanicity, education, income, housing, poverty, unemployment, and occupation. Seven resulting SES “clusters” were ranked from highest to lowest SES based on the input variables with Social Vulnerability Index used to validate rankings. Clusters were linked to public water systems (PWS) based on the PWS serving a zip code intersecting that cluster. PFAS occurrence data was obtained from the Third Unregulated Contaminant Rule which tested all large PWS and a representative sample of small and medium PWS. Percent of zip codes served by a PWS testing positive for PFAS are reported.

Results: Clusters were further grouped into 3 SES categories (high, medium, and low) to facilitate comparisons. As compared to the low SES clusters, high SES clusters were more urban, had lower unemployment, and greater percentage of White residents, even though race was not included in the clustering. PFAS were observed 2.00 times more frequently in high SES clusters as compared to low (29.9% vs 14.9%) and 1.47 times more frequently as compared to medium SES (29.9% vs 21.9%). All differences were highly significant using chi-squared tests, and robust to requiring 50% of a block group to be in a PWS zip code for assignment.

Conclusion: Based on PWS testing, PFAS occurred most in higher SES areas. This analysis did not account for homes on well water which might be more common in rural, lower SES areas. The drivers of this relationship and its relevance for understanding PFAS and environmental justice remain to be fully explored.

Wednesday OS13

Associations between PFAS Contamination of US Community Water Systems and COVID-19 Mortality

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Abstract

Epidemiologic studies have documented associations between PFAS exposure and harmful effects on the immune system, with confirmation from animal studies. PFAS have also been identified as potential environmental risk factors for COVID-19 outcomes at the individual and ecological levels, but empirical evidence is limited. We combine data on PFAS concentrations in community water systems (CWS) with county-level COVID-19 case records to investigate the relationships between PFAS drinking water contamination and COVID-19 mortality in the U.S. Our analyses use two datasets separately: one at the subnational level (including 5,023 CWS serving 472 counties) and one at the national level (including 4,798 CWS serving 1,186 counties). We use quasi-Poisson regression to investigate the associations between county-level measures of PFAS contamination in drinking water and COVID-19 mortality occurring in 2020. Our adjusted estimates highlight a positive association between county-level COVID-19 mortality and PFAS drinking water contamination. In the subnational dataset, a one-standard-deviation increase in the proportion of CWS with concentrations of at least one PFAS over 5 ng/L (equivalent to a 36 percentage-point increase) was associated with a 7.3% increase [empirical 95% CI: 0.9, 12.3] in COVID-19 mortality. In the national dataset, a one-standard-deviation increase in the proportion of CWS with PFAS concentrations above the reporting limits (equivalent to a 12.5 percentage-point increase) was associated with a 2.3% increase [95% CI: 0, 5] in COVID-19 mortality. Our findings indicate that several PFAS may be important environmental risk factors for COVID-19 outcomes and should be systematically measured as part of water system monitoring efforts. Given that our study is susceptible to ecological bias, we propose that a combination of individual-level analyses and ecological inference using individual-level outcomes are needed in order to more precisely identify the mechanisms that link elevated PFAS exposures to COVID-19 outcomes.

Uncaptioned visual

Wednesday PD1

The Association Between Fine Particulate Matter and Allostatic Load in Children

Rosemarie de la Rosa[1,2], Austin Le[1], Stephanie Holm[2,3], Morgan Ye[2], Nicole Bush[4], Danielle Hessler[5], Dayna Long[6], Neeta Thakur[2]
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Abstract

BACKGROUND: Early-life exposure to fine particulate matter ($PM_{2.5}$) is associated with adverse respiratory health outcomes, increased obesity, and impaired neurodevelopment among children. However, the biological mechanisms of $PM_{2.5}$ exposure contributing to disease pathogenesis are poorly understood. Here, we investigated the effect of $PM_{2.5}$ on allostatic load (AL), a cumulative measure of "wear and tear" across biologic systems downstream of the stress-response, in a pediatric population.

METHODS: We conducted a cross-sectional analysis of 312 children enrolled in the Pediatric ACEs Screening and Resiliency Study at Benioff Children's Hospital Oakland, a Federally Qualified Health Center. Monthly average estimates for $PM_{2.5}$ were obtained from the Atmospheric Composition Analysis Group using a model that incorporates satellite data, transport models, and ground-based observations. Ground-level $PM_{2.5}$ estimates were matched to residential locations and averaged for the twelve months prior to biospecimen collection. AL scores were constructed by summing across anthropometric, cardiovascular, metabolic, immune, and neuroendocrine biomarkers, using clinical or empirical cutoff points. High AL was defined as having ≥3 high-risk biomarkers. Multivariable logistic regression was used to examine the association between an IQR increase in $PM_{2.5}$ and high AL, adjusting for child's age, gender, race/ethnicity, and caregiver education.

RESULTS: The population was predominantly non-Hispanic Black (59.6%), 55% male, with mean age of 6.6 years, and most caregivers had completed high school or greater (89.4%). The median annual average $PM_{2.5}$ concentration was 11.5 μg/m3 (IQR: 2.4) and the prevalence of high AL scores was 30%, with a mean score of 1.8. $PM_{2.5}$ was associated with increased odds of having high AL (aOR=1.47 [95% CI= 1.05, 2.11]). Individual AL biomarkers were not associated with $PM_{2.5}$ exposure.

CONCLUSION: We demonstrate that $PM_{2.5}$ exposure during early childhood may increase AL. Future studies should explore the mechanistic pathways between air pollution exposure and systemic stress-related biological responses.

Wednesday PD1

Long-Term Temporal Trend of Mortality Risk from Short-Term Fine Particulate Exposure in North Carolina

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Abstract

BACKGROUND AND AIMS: Fine particulate matter ($PM_{2.5}$) is composed of hundreds of component parts of differing toxicity. Generation of ambient $PM_{2.5}$ changes temporally, which can impact overall $PM_{2.5}$ composition. However, evidence is lacking on whether these potential changes in source generation over time result in temporal variations of $PM_{2.5}$-mortality, particularly between subpopulations within the United States. We investigate whether the risk of mortality from short-term $PM_{2.5}$ exposure varies over time in North Carolina.

METHODS: We conducted a case-crossover analysis using mortality data in North Carolina between 2001-2016 to evaluate any possible temporal variation in the association between short-term $PM_{2.5}$ exposure and mortality. We fitted conditional logistic regression models to estimate the temporal trends of association and investigated possible modification in the temporal association across subpopulations by sex, age, race, and socioeconomic status.

RESULTS: We assessed 1,152,365 deaths in North Carolina between 2001 and 2016. Our preliminary findings show that different subpopulations have differing association between a given short-term $PM_{2.5}$ exposure level and mortality over time. We identified a 0.46% increase in mortality Odds Ratio (OR) for a 10 $\mu g/m^3$ increase in short-term $PM_{2.5}$ exposure in the entire population between the first half (OR: 1.011, 95% CI: 1.006-1.017) and second half (OR: 1.016, 95% CI: 1.008-1.023) of the study period. We also preliminarily observed between-subpopulation variation such as a 0.78% OR increase for non-Hispanic Blacks and a 0.66% OR decrease for non-Hispanic Asians.

CONCLUSIONS: This suggests that the mortality odds associated with ambient $PM_{2.5}$ exposure is changing over time and has increased in recent years for the general population and most subpopulations. Different subpopulations are experiencing temporal variation in $PM_{2.5}$-mortality association at different rates. Our preliminary findings indicate the need to better understand temporal heterogeneity in the $PM_{2.5}$-mortality association across study periods and population characteristics.

Wednesday PD1

Association of ambient temperature and fine particulate matter ($PM_{2.5}$) with urinary kidney injury biomarkers in children

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Abstract

Background: Limited research has examined associations between exposure to ambient temperature and fine particular matter ($PM_{2.5}$) with kidney function. We aimed to assess associations between temperature and $PM_{2.5}$ exposure with preadolescent estimated glomerular filtration rate (eGFR) and urinary kidney injury biomarkers.

Methods: Participants were children (n=437) enrolled in the Programming Research in Obesity, Growth, Environment and Social Stressors birth cohort based in Mexico City. Validated satellite-based ambient temperature and $PM_{2.5}$ models were used to estimate mean daily temperature and $PM_{2.5}$ exposures at each participant's residence during the seven days prior to a study visit at 8-12 years old. eGFR and urinary kidney injury biomarkers were assessed at the study visit. Time-varying associations between daily mean temperature and $PM_{2.5}$ exposure and kidney outcomes were examined using distributed lag nonlinear models, adjusted for age, sex, body mass index, urine specific gravity, socioeconomic status, indoor tobacco smoking report, and seasonality.

Results: Seven-day average temperature and $PM_{2.5}$ were 16.21°C (range 10.75-21.79 °C) and 18.68 $\mu g/m^3$ (range 7.51-55.73 $\mu g/m^3$), respectively. Higher mean daily temperature exposure was associated with a cumulative decrease in urinary cystatin C of -0.56 ng/mL (95% confidence interval (CI): -1.08, -0.04) and in osteopontin of -0.09 ng/mL (95% CI: -0.16, -0.01). $PM_{2.5}$ exposure was associated with a cumulative increase in eGFR of 1.60 mL/min/1.73m^2 (95% CI: 0.36, 2.85) and urinary cystatin C of 0.14 ng/mL (95% CI: 0.03, 0.25).

Conclusions: Increased exposure to ambient temperature and $PM_{2.5}$ may have implications for kidney health in adolescence, and may lead to subclinical glomerular or tubular injury. Further research is required to assess environmental exposure and risk of kidney disease among children, especially throughout the life course.

Wednesday PD1

Assessment of ambient fenceline gas concentrations related to industrial livestock operation (ILO) infrastructure compared to non-ILO waste processing infrastructure

Kathleen Kurowski[1], Kristoffer Spicer[1], Matthew Aubourg[1], Lauren Deanes[1], Nora Pisanic[1], Kate Kruczynski[1], Devon Hall, Jr.[2], Phyla Holmes[2], Pamela Keith[2], Devon Halll, Sr.[2], Ana Rule[1], Christopher Heaney[1]

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Abstract

Hydrogen sulfide (H_2S), methane (CH_4), and ammonia (NH_3) are health- and climate relevant pollutants emitted from industrial livestock operation (ILO) facilities, as well as non-ILO-related infrastructure. In this study, we compare background concentrations and spatio-temporal variability of H_2S, CH_4 and NH_3 at ILO and non-ILO facilities in North Carolina (NC), Delaware (DE), and Maryland (MD). Between August and November 2022, we performed 27 trips in MD (2 drives), DE (8 drives) and NC (17 drives). Driving routes were designed to target swine concentrated animal feeding operations (CAFOs) and related waste infrastructure, such as waste lagoons (capped and uncapped) and biogas storage facilities associated with anaerobic digestion (AD) pipelines. Concentrations of $CH_{4,}$ NH_3 and H_2S were assessed using a car equipped with gas concentration analyzers (G2204 and G2103, Picarro Inc, Santa Clara, CA). To link gas concentrations with geographical locations and time, the Strava running application was used to record geospatial coordinates of the car during the mobile monitoring runs. Preliminary results indicate that average gas concentrations near uncapped swine CAFO lagoons were higher than average background concentrations for CH_4 and H_2S. We recorded the highest value of H_2S (238 ppb) close to a biogas storage facility in North Carolina, although the highest mean value corresponded to the wastewater treatment plant AD facility (9.6 ppb) during a 30-minute interval. In contrast, the highest CH_4 value (32.3 ppb) we observed was near uncapped swing CAFO lagoons. Mobile monitoring approaches to ILO facility emissions have shown elevated gas concentrations near waste storage facilities and anaerobic digestion facilities. The concentrations of these gases are similar and sometimes greater to those emitted by non-ILO waste infrastructure, which is more highly regulated compared to ILO emissions.

Wednesday PD1

Effects of Ambient Air Pollutants on Progression of Cardiac Structure and Function in the Echocardiographic Study of Latinos (ECHO-SOL)

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Abstract

Background

Effects of air pollution preceding clinical diagnosis of heart failure are not understood. We assessed longitudinal associations between fine particulate matter (PM2.5), nitrogen dioxide (NO2) and cardiac structure and function among 1,660 participants in the Echocardiographic Study of Latinos.

Methods

Left ventricular (LV) mass index, relative wall thickness, average global longitudinal strain (GLS), LV ejection fraction, e’, left atrial (LA) volume index, E/e’ ratio, and diastolic function grades were assessed by echocardiogram. Air pollution concentrations were estimated from validated spatio-temporal models at home locations, as mean concentrations of PM2.5 and NO2 for the year prior to clinical visit 1 (V1, 2008-2011) and 2 (V2, 2015-2018). A mixed effects model was used to model relationships between time-varying air pollution and continuous measures of subclinical heart failure, adjusted for baseline physical activity, gender, education, age, BMI, SBP, DBP, statin use, diabetes, and hypertension status and time-varying smoking and alcohol use.

Results

Participants’ mean age was 56.4 years at V1; mean follow-up was 6.52 years. Mean PM2.5 was 10.3 µg/m3 at V1 and 8.8 µg/m3 at V2. Mean NO2 was 17.4 ppb at V1 and 14.3 at V2. Per interquartile range of pollutant, higher PM2.5 and NO2 were associated with a 0.52% (95% CI -0.16, 1.11) and 0.98% (95% CI 0.13, 1.23) increase in GLS, respectively. NO2 was associated with -1.07% (95% CI -2.24, 0.10) decrease in LV ejection fraction. PM2.5 was associated with a 0.75 (95% CI 0.39, 1.12) increase in e’ and a 1.25 (95% -1.95, -0.56) decrease in E/e’ ratio.

Conclusion

These findings suggest that air pollution is associated with longitudinal changes cardiac structure and function in a US Hispanic/Latino cohort, an important understudied population. Air pollution may represent a modifiable risk factor in the development of clinical heart failure.

Wednesday PD1

Perception of Environmental Risk: Comparing Mental Models of Indoor and Outdoor Air Pollution

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Abstract

Americans spend about 90% of their time in indoor environments (EPA, 2021), yet it is not known whether people are aware of the multitude of pollutant sources that are present in their home environment and whether they perceive any risk to their health. The purpose of this study was to understand whether there are differences in perceiving various environmental objects and activities as pollutants, depending on if the source is something that would exist indoors (e.g., candle) vs outdoors (e.g., barbeque). In a reaction time task framework, participants were asked to respond to two prompts: (1) “Is this a pollutant?” by saying yes or no and (2) “Is this risky for your health?” by using a slider that ranged from ‘not at all’ to very. The stimuli were pollutant words, categorized as those that are typically found indoors and outdoors environments. Pseudowords were used as a controlled category. Reaction time and response values were used to assess differences in perceptions of environmental stimuli. Indoor words were slowly identified as a non-pollutant but quickly identified as non-risky compared to outdoor words. Moreover, participants did not rate indoor words to be a source of pollution or risk as often compared to outdoor words. The public should be educated surrounding the potential health impacts related to pollution in indoor environments. Further research is needed to investigate how biases and certain schemas influence people’s perceptions of indoor pollutants. With this knowledge, we may be better positioned to develop educational materials to inform people of ways to mitigate their risk of exposure to pollution (across the exposome).

Wednesday PD1

Traffic-related air pollution and Parkinson’s disease in central California

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Abstract

Background/Aims: Air pollution exposure may increase the risk of Parkinson’s Disease (PD). We assessed associations between long-term traffic-related air pollution exposures and PD in central California.

Methods: We generated air pollution exposures for 688 PD patients and 851 population controls enrolled in the Parkinson’s, Environment and Genes (PEG) studies 1 and 2. First, we estimated annual average carbon monoxide (CO) concentrations between 1981-2016 using the California Line Source Dispersion Model, version 4 (CALINE4) to model local traffic sources and, additionally, fine particulate matter (PM2.5) concentrations between 2000-2016 based on a high-resolution geoscience-derived model. Exposures were assessed as 10-year averaged CO and 5-year averaged PM2.5 prior to a PD diagnosis and a reference date in controls. We used logistic regression models to estimate odds ratios (OR) and 95% confidence intervals (95%CI), adjusting for age, sex, race, education, and study wave.

Results: For CO, each interquartile range (IQR) increase in 10-year average exposure prior to diagnosis was found to be associated with an OR of 1.06 (95% CI=1.01-1.11) for residential and of 1.08 (0.99-1.18) for occupational address-based exposures. A per IQR increase in 5-year average PM2.5 prior to PD also increased the OR for PD at occupational address (OR=1.26; 95% CI=0.96-1.67). Associations were similar for 5- and 15-year exposure averages and were robust to adjustment for smoking or pesticide exposures.

Conclusion: We found consistent evidence for positive associations between PD and long-term exposure to local traffic-related air pollution in central California measured by CO and PM2.5 at home and workplace addresses.

Wednesday PD2

Associations of exposure to parabens during pregnancy with behavior in early childhood

Megan Woodbury[1,2,3,4], Patricia Cintora[4], Sarah Geiger[4,5], Susan Schantz[4,6]
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Abstract

BACKGROUND/AIMS: Parabens have endocrine disrupting activity, are used as preservatives in consumer products and occur naturally in some foods. We examined the relationship between pregnancy exposure and child behavior using the Child Behavior Checklist (CBCL) when children were 2 and 3 years old.

METHODS: Phenols were quantified in a pool of five maternal urine samples collected across pregnancy. CBCL data were available for 254 children (119 males, 135 females) at 2 and 214 children (100 males, 114 females) at 3 years. Associations of butylparaben (BPB), ethylparaben (EPB), methylparaben (MPB), and propylparaben (PPB) with CBCL composite (internalizing and externalizing) and syndrome subscale scores at each age were assessed using generalized linear models adjusted for assessment age, gestational age at birth, and maternal age, parity, and education, with child sex as a potential modifier.

RESULTS: Most mothers were white, non-Hispanic, and college educated with an annual household income ≥$50,000. Greater gestational exposure to BPB, EPB, or MPB was generally associated with higher CBCL scores (more behavior problems), while PPB was associated with lower scores (fewer behavioral problems) at both ages. BPB was associated with increased scores on several subscales, particularly for males, but only other problems was related to BPB at 2 (β=1.46,95%CI:0.30,2.63) and 3 (β=3.68,95%CI:1.67,5.69). EPB and MPB were also associated with increased scores, particularly behaviors categorized as externalizing, but only oppositional defiant behaviors was associated with EPB at 2 (β=0.01,95%CI:0.001,0.02) and 3 (β=0.01,95%CI:0.002,0.03). MPB was associated with increased attention problems and ADHD scores at 2 (β=0.001,95%CI:0.0001,0.002; β=0.001,95%CI:0.0002,0.003) and 3 (β=0.001,95%CI:0.00004,0.002; β=0.002,95%CI:0.0003,0.003). PPB was associated with decreased internalizing scores at 2 (β=-0.02,95%CI:-0.04,0.002).

CONCLUSION: These results suggest that pregnancy exposure to BPB, EPB, and MPB, but not PPB, may be related to behavioral problems in early childhood. These children will be followed to evaluate whether these associations persist at later ages.

Wednesday PD2

Profiles of Prenatal Endocrine Disrupting Chemical Exposures Associate with Adolescent Brain Structure

Jacob Cohen[1], Jaime Benavides[2], Pam Factor-Litvak[2], Jeff Goldsmith[2], Bruce Ramphal[1], David Pagliaccio[1], Marianthi-Anna Kioumourtzoglou[2], Amy Margolis[1]
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Abstract

Background/Aim: Studies have identified associations between prenatal endocrine disrupting chemical (EDC) exposure and brain structure in youth, but none account for mixtures of co-occurring environmental EDCs. We aimed to identify if profiles of prenatal co-exposure to phthalates and bisphenol A (BPA) associate with cortical thickness.

Methods: Using data from the Columbia Center for Children's Environmental Health, we applied principal component pursuit (PCP) to decompose the exposure matrix into low-rank and sparse matrices. We then identified profiles of exposures (N=457) using factor analysis on the low rank matrix. Subcortical volume and cortical thickness were estimated using FreeSurfer. Linear regressions assessed associations between exposure profiles and 8 hypothesized regions of interest (N=161; age 15-19), controlling for age, sex, and intercranial volume.

Results: Two profiles of prenatal EDC exposures emerged. Profile 1 (high concentrations of phthalates and BPA, present in food packaging/personal-care products) was associated with greater thickness in the right middle anterior cingulate cortex (mACC; β=0.17, 95%CI:0.01, 0.34) and left superior occipital gyrus (β=0.2, 95%CI:-0.01,0.32). Profile 2 (high concentrations of di-2-ethylhexyl phthalates, present in household products) was associated with greater thickness in the right mACC (β=0.20, 95%CI:0.03,0.36), bilateral middle posterior cingulate (β =0.24, 95%CI:0.08,0.41), and right superior occipital gyrus (β=0.2, 95%CI=0.07,0.40).

Conclusions: We identified two profiles of EDC exposure, both of which were associated with greater cortical thickness in regions that support visual-spatial skills (superior occipital, parietal, posterior cingulate) and conflict monitoring (anterior cingulate). Given known links between prenatal EDC exposures and neurobehavioral outcomes in youth, these brain regions should inform future etiological work on the neurodevelopmental phenotypes of EDC exposed youth.

Wednesday PD2

Cross-sectional associations of urinary phthalate and serum PFAS biomarkers with serum total 25 hydroxyvitamin D levels in childhood: The HOME Study

Katherine Marquess[1], Taylor Etzel[1], Bruce Lanphear[2], Andrew Hoofnagle[3], Kim Cecil[4], Aimin Chen[5], Yingying Xu[4], Kimberly Yolton[4], Heidi Kalkwarf[4], Joseph Braun[6], Jordan Kuiper[1], Jessie Buckley[1]
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Abstract

Background: Exposure to endocrine disrupting chemicals, such as phthalates and per-/poly-fluoroalkyl substance (PFAS), may disrupt vitamin D metabolism and adversely affect health. These relations have been assessed in adults but not children. We investigated associations of urinary phthalate and serum PFAS concentrations with serum total 25 hydroxyvitamin D [25(OH)D] levels at ages 8 and 12 in the HOME Study.

Methods: We performed a cross-sectional analysis of data on 233 children of women enrolled during pregnancy in a prospective cohort study in Cincinnati, OH (2003-2006). We measured 9 phthalate metabolites in spot urine samples and 4 PFAS and total 25(OH)D in serum samples collected at ages 8 (n=186) and 12 (n=186). We categorized children as vitamin D deficient if total 25(OH)D was <20ng/mL (age 8: 15.6%, age 12: 32.3%). Using generalized estimating equations accounting for repeated measures within-child, we estimated differences in 25(OH)D (linear regression) and odds of vitamin D deficiency (logistic regression) per IQR increase in concurrent log2 biomarker concentrations. We also used quantile-based g-computation to estimate associations of a simultaneous IQR increase for all phthalate and PFAS biomarkers with vitamin D outcomes. We adjusted for covariates including race, sociodemographics, BMI z-score, diet, and season.

Results: Urinary phthalate and serum PFAS concentrations were weakly associated with higher total 25(OH)D and lower odds of vitamin D deficiency though most confidence intervals crossed the null. In mixtures analyses, an IQR increase in all phthalate and PFAS biomarkers was associated with 6.3 ng/mL (95% CI: 2.9, 9.8) higher total 25(OH)D and 0.3 (95% CI: 0.2, 0.8) times the odds of vitamin D deficiency.

Conclusions: Combined phthalate and PFAS exposure was associated with higher total 25(OH)D levels and lower odds of vitamin D deficiency in HOME Study children.

Wednesday PD2

Exposure to triclosan and adolescent hormone concentrations in the Health Outcomes and Measures of the Environment Study

Hannah E. Laue[1], Bruce P. Lanphear[2], Antonia M. Calafat[3], Kim M. Cecil[4], Aimin Chen[5], Yingying Xu[4], Heidi Kalkwarf[4], Amy D. Willis[6], Juliette C. Madan[1,7], Margaret R. Karagas[1], Kimberly Yolton[4], Abby F. Fleisch[8,9], Joseph M. Braun[10]

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Abstract

Background/Aims: Triclosan, an antimicrobial, has been associated with altered pubertal and andrenarcheal hormone concentrations in cross-sectional studies, but the findings are inconsistent. We examined associations of gestational and childhood triclosan exposure with hormone concentrations in adolescence.

Methods: In 157 participants in the Health Outcomes and Measures of the Environment Study, a prospective pregnancy and birth cohort based in Cincinnati, Ohio, we quantified total urinary triclosan concentrations up to twice during pregnancy and up to 8 times between birth and 12 years. We averaged measurement-error-corrected and creatinine-adjusted concentrations across the gestational and childhood periods. At 12 years, we quantified adrenal, pituitary, and gonadal hormones in morning blood [males (n=73) and females (n=84)—dihydroepiandrostendione sulfate (DHEA-S), luteinizing hormone (LH), follicle stimulating hormone (FSH); males—testosterone; females—estradiol]. We calculated percent change in hormone concentration per doubling of urinary triclosan concentrations in gestation or childhood using generalized linear models adjusting for triclosan concentrations in the other period and sociodemographic and perinatal factors. For DHEA-S, FSH, and LH we examined if child's sex modified associations between urinary triclosan and hormone concentrations.

Results: For females, each doubling of average childhood triclosan was associated with a 15.9% decrease in estradiol concentrations (95% CI: -29.1, -0.1). We found suggestive evidence of sex-specific associations between gestational triclosan exposure and FSH concentrations, where a doubling of triclosan was associated with lower observed FSH concentrations among males [-7.3% (-16.6, 3.1)] and higher observed concentrations among females [5.3% (-4.4, 15.8), pinteraction=0.09]. No strong evidence of associations between triclosan and other hormones was identified.

Conclusion: Gestational and childhood triclosan concentrations were related to some pubertal hormone concentrations in a sex-specific manner. Our findings indicate the need to better elucidate potential actions of triclosan on the pituitary versus the ovary and more precise windows of exposure sensitivity.

Wednesday PD2

Systematic evidence mapping to inform class-based approach to assessing the impact of personal care products on pubertal timing

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Abstract

Personal care products (PCPs) contain many different compounds and are a potential source of exposure to endocrine disrupting chemicals (EDCs), including phthalates and phenols. Early-life exposure to EDCs commonly found in PCPs has been linked to earlier onset of puberty. The objective of this evaluation was to characterize the human and animal evidence on the association between exposures to PCPs and their chemical constituents and outcomes related to pubertal timing, and to inform decision making on a class-based assessment of the relationship between PCP exposure and timing of puberty. We followed the OHAT systematic review framework to develop a systematic evidence map that identifies and categorizes available research on PCPs and puberty-related outcomes. Ninety-eight human studies and 299 animal studies that evaluated a total of 96 different chemicals were identified and categorized by key concepts across puberty-related outcomes. Among these studies, phthalates and phenols were the most well-studied chemical classes. Most human and animal studies of phthalates and phenols examined secondary sex characteristics and changes in testosterone and estradiol levels. This systematic scoping review identified and mapped the published research evaluating the association between exposure to PCPs and their chemical constituents and puberty-related health outcomes. The systematic evidence map aids researchers in making evidence-based decisions on the available research by enabling them to search, sort, and filter the literature base within and across key concepts including chemical class, evidence stream (i.e., human or animal), and health outcome. The map serves as an evidence base to direct a class-based approach to evaluate the evidence on the association between phthalate and phenol exposures and puberty-related health. It will be critical to assess the evidence to determine whether chemicals within these classes are associated with similar health effects based on evidence of shared mechanisms and biological function, not just chemical class or structure.

Wednesday PD2

Associations of Dietary Intake and PFAS Concentrations in Hispanic Young Adults in the MetaAIR Cohort

Hailey Hampson[1], Elizabeth Costello[1], Douglas Walker[2], Hongxu Wang[1], Brittney Baumert[1], Damaskini Valvi[2], Sarah Rock[1], Dean Jones[3], Michael Goran[4], Frank Gilliland[1], David Conti[1], Tanya Alderete[5], Zhanghua Chen[1], Leda Chatzi[1], Jesse Goodrich[1]
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Abstract

Background/Aims

Per- and Polyfluoroalkyl Substances (PFAS) are a group of pollutants that have been linked to adverse health effects, including obesity, high cholesterol, and type 2 diabetes. Diet is an important exposure source of PFAS, but it is unknown how diet impacts PFAS levels in young adults at high risk of metabolic diseases. Thus, we aim to characterize dietary patterns associated with plasma PFAS concentrations in primarily Hispanic young adults.

Methods

124 young adults (age 17-22, 57% Hispanic) were included from the Southern California MetaAIR cohort. Dietary data were collected using two 24-hour dietary recalls to measure consumption of food groups and food items. Seven plasma PFAS were measured using Liquid Chromatography-High Resolution Mass Spectrometry (LC-HRMS). Multivariable linear regression assessed associations of dietary variables with individual PFAS concentrations, adjusting for age, sex, race/ethnicity and parental education. Latent Unknown Clustering with Integrated Data (LUCID) was used to characterize dietary patterns of individuals with high versus low PFAS levels.

Results

Consumption of chocolate candy was most strongly associated with PFOS, where each one-serving increase per day (40g) in chocolate candy was associated with a 1.28 ng/mL increase in PFOS ($p=0.043$). LUCID identified a high-PFAS group of individuals with high levels of all seven PFAS. Individuals with high PFAS levels had a dietary pattern that was high in whole grain snack chips, full fat sauces & condiments, processed meats, refined grain breads, sugar, chocolate candy and sweetened tea and low in starchy vegetables, frozen dairy desserts, reduced fat milk, salad dressing, whole grain bread, nuts and seeds and deep yellow vegetables.

Conclusion

In Hispanic young adults, high PFAS concentrations were characterized by a dietary pattern similar to an unhealthy diet as described by the USDA dietary guidelines.

Uncaptioned visual

Figure. LUCID analysis variable selection and clustering of 161 food items associated with PFAS.

Wednesday PD2

Systematic review of persistent organic pollutants and oxidative stress markers

Jiawen Carmen Chen[1], Brittney O. Baumert[1], Yijie Li[1], Yiping Li[1], Shudi Pan[1], Shante Robinson[2], Bruna Rubbo[1], Elizabeth Costello[1], Jie He[3], Hailey Hampson[1], Emily Beglarian[1], Sarah Rock[1], Jesse Goodrich[1], Sandrah P. Eckel[1], Max T. Aung[1], Rob McConnell[1], David V. Conti[1], Lida Chatzi[1]

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Abstract

Background: Persistent organic pollutants (POPs) are a class of human-made chemicals that are resistant to environmental degradation. Previous in-vitro and in-vivo studies have shown that POPs can induce oxidative stress, which has been linked to diseases including neurodegenerative diseases, cardiovascular diseases, and cancer. However, the findings in epidemiological studies are inconsistent and an evidence synthesis study is lacking to summarize the existing literature and explore research gaps.

Objective: We evaluated the effect of POPs, including per- and polyfluoroalkyl substances (PFAS), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), and polybrominated diphenyl ethers (PBDEs), on oxidative stress biomarkers in epidemiological studies.

Methods: A literature search was conducted in PubMed and Embase to identify all published studies related to POPs and oxidative stress up to 12/07/2022. The oxidative stress biomarkers of interest included pro-oxidant and antioxidant biomarkers that are involved in protein oxidation, nucleic acid damage, lipid peroxidation, and antioxidant defense. We included human observational studies reporting at least one exposure to POPs and an oxidative stress biomarker of interest for data extraction.

Results: A total of 103 epidemiological studies met inclusion criteria – 33 for OCPs, 35 for PCBs, 49 for PFAS, and 12 for PBDEs. We found consistent positive associations of OCPs with several pro-oxidant biomarkers, including protein carbonyls, nitric oxide, and malondialdehyde. PCBs also had consistent positive associations with malondialdehyde. OCPs were negatively associated with several antioxidant biomarkers including total antioxidant capacity, acetylcholine esterase, and paraoxonase-1, but inconsistent associations were found with first line defense antioxidant enzymes including superoxide dismutase, glutathione peroxidase, and catalase.

Conclusions: Higher levels of OCPs were associated with increased oxidative stress level through increased pro-oxidant biomarkers that are involved in protein oxidation, DNA damage, and lipid peroxidation, as well as decreased total antioxidant capacity. These findings have the potential to reveal the underlying mechanisms of POPs toxicity.

Figure 1. Effect direction plot on included studies investigating associations between organochlorine pesticides (OCPs) and oxidative stress biomarkers

References \ Pro-oxidant markers	Protein oxidation				DNA oxidation			Lipid peroxidation					
	PC	Homocysteine	GSSG	GSSG/GSH	8-OHdG	NO	8-oxodG	MDA / TBARS	8-isoPGF2α	Ox-LDL	CD	BCD-LDL	HNE-MA
Low ROB in all domains													
Abbasi-Jorjandi et al. 2020	+					+		+					
Abdollahdokht et al. 2021	+					+		+					
Artacho-Cordon et al. 2016			0	0				+					
Franken et al. 2017					0								
Kumar et al. 2014. Chemosphere		0	0	0						+	0	+	
Yin et al. 2020		+											
High ROB in one domain													
Abolhassani et al. 2019								0					
Ambroz et al. 2022							+/-		-				
Iscan et al. 2002								0					
Ketelslegers et al. 2008					+								
Mangum et al. 2016									0				
Pathak et al. 2010	+							+					
Pathak et al. 2011	+				+			+					
Rafeeinia et al. 2022	+					+		+					
Samareh et al. 2022								+					
High ROB in two domains													
Anand et al. 2015								+					
Koppen et al. 2020							+						
Miao et al. 2021					0				+				+
Yousefi et al. 2022	+					+		+					
High ROB in three domains													
Dwivedi et al. 2022								+					

References \ Antioxidant markers	Enzymatic								Non-enzymatic			
	SOD	GPx	HO-1	CAT	AChE	PON1 activity	GRd	GST	TAC	GSH	TGSH	Albumin
Low ROB in all domains												
Abbasi-Jorjandi et al. 2020	-	-		0	-	-			-			
Abdollahdokht et al. 2021	-	-			-	-			-			
Arrebola et al. 2019												
Artacho-Cordon et al. 2016	+	0	0				0	0		0		
Kumar et al. 2014. Chemosphere									0	0	0	
High ROB in one domain												
Abolhassani et al. 2019					0	0			-			
Iscan et al. 2002	+	+		0			+	+		+		
Khan et al. 2008												0
Lawton et al. 1985												-
Pathak et al. 2010									-	-		
Pathak et al. 2011										-		
Rafeeinia et al. 2022	-	-		+	-	-			-			
Samareh et al. 2022					-	-			-			
High ROB in two domains												
Santillán-Sidón 2020								-				
Yousefi et al. 2022	+	+		+	-	-			-			
High ROB in three domains												
Dwivedi et al. 2022	+/-	+/-		+/-			-					

Notes: +: Statistically significant positive association; -: Statistically significant negative association; 0: No association; +/-: some significant positive and negative associations

Wednesday PD3

Climate and Stillbirth

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Abstract

Background/Aim. The most commonly known causes of stillbirth in the US are complications of the placenta, cord, and membranes, pregnancy complications, birth defects and/or chromosomal abnormalities, and maternal conditions unrelated to pregnancy. Yet, nearly 30% of stillbirths have no known cause, as evaluated by stillbirth workups, indicating the need to explore other causes, such as environmental. The aim of this review is to summarize the relationship between stillbirth and environmental exposures from the literature and identify areas in need of further investigation.

Methods. A literature review will summarize the relationship between stillbirth and the following environmental exposures: ambient air pollution, ambient temperature, and water pollution. Areas in need of further investigation will be identified. Air pollution will be summarized by component (e.g., PM2.5), sources (e.g., traffic), and acute vs long-term exposures. Low and high-temperature exposures will be summarized. Water will be summarized by pollutant.

Results. Multiple climatic and environmental causes are associated with stillbirth. These can be categorized as direct – those factors that affect the mother and fetus, and indirect – those that affect the direct factors, such as ambient temperature and humidity. In this presentation, we will discuss the causes and methods to assimilate their effects on stillbirths.

Conclusion. Environmental factors, such as smoking, indoor air pollution, and extreme heat, increase stillbirth rates. Yet, this is an under-studied area and much is left to be explored about how poor air quality, water pollutants, and temperature extremes impact stillbirths. Additionally, environmental exposures do not occur in a vacuum. Those exposed to the highest levels of pollutants or extreme conditions often simultaneously experience the most severe health inequities (e.g., U.S. Stillbirths impact marginalized groups at significantly greater rates, with Black/African American and Pacific Islander/Hawaiian women experiencing double the rate of stillbirth compared to their non-Hispanic White counterparts)

Wednesday PD3

Effects of a lead hazard control intervention during pregnancy on adolescent height and bone mineral density

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Abstract

Background. Lead is a bone toxicant in laboratory studies, but research on children's bone health is limited.

Aims. To estimate effects of an intervention to prevent children's lead exposure on adolescent height and bone health endpoints using a randomized controlled trial.

Methods. At enrollment (~16 weeks' gestation), we randomly assigned pregnant women and their children to receive an intervention to reduce lead hazards (Lead) or residential injuries (Injury) in the Health Outcomes and Measures of the Environment (HOME) Study (2003-2006). At age 12 years, we measured children's height with a stadiometer and areal bone mineral density (aBMD) at six skeletal sites with dual-energy X-ray absorptiometry. To estimate the effects of Lead assignment on z-scores of height(age-and sex-standardized) and aBMD(age-, sex-, and race-standardized), we conducted intent-to-treat analyses using linear regression. We estimated direct effects of Lead assignment on aBMD and indirect effects through height using mediation analyses. We conducted sensitivity analyses 1) weighted for inverse probability of selection; 2) adjusted for aBMD predictors to improve precision; and 3) restricted to participants who adhered to protocols (per-protocol).

Results. Children assigned to Lead had higher height z-scores (n=87;mean±standard deviation=0.60±0.17) than children assigned to Injury (102;0.27±1.08). Intent-to-treat height z-score difference for Lead vs. Injury was 0.33 [95%CI:0.01,0.65], which was similar when selection-weighted (0.36 [0.04,0.68]) or covariate-adjusted (0.31 [-0.01,0.63]), and in per-protocol (0.31 [-0.01,0.63]). Although we did not observe strong associations between Lead assignment and aBMD, there was evidence of partial mediation through height. For example, children assigned to Lead had 0.11[-0.20,0.42] greater ultradistal forearm aBMD z-score compared to children assigned to Injury (indirect through height:0.09[0.002,0.19]; direct:0.03 [-0.27,0.33]).

Conclusion. At age 12 years, children randomly assigned to lead hazards reduction were taller than children assigned to injury prevention. Height partially mediated weak associations with aBMD.

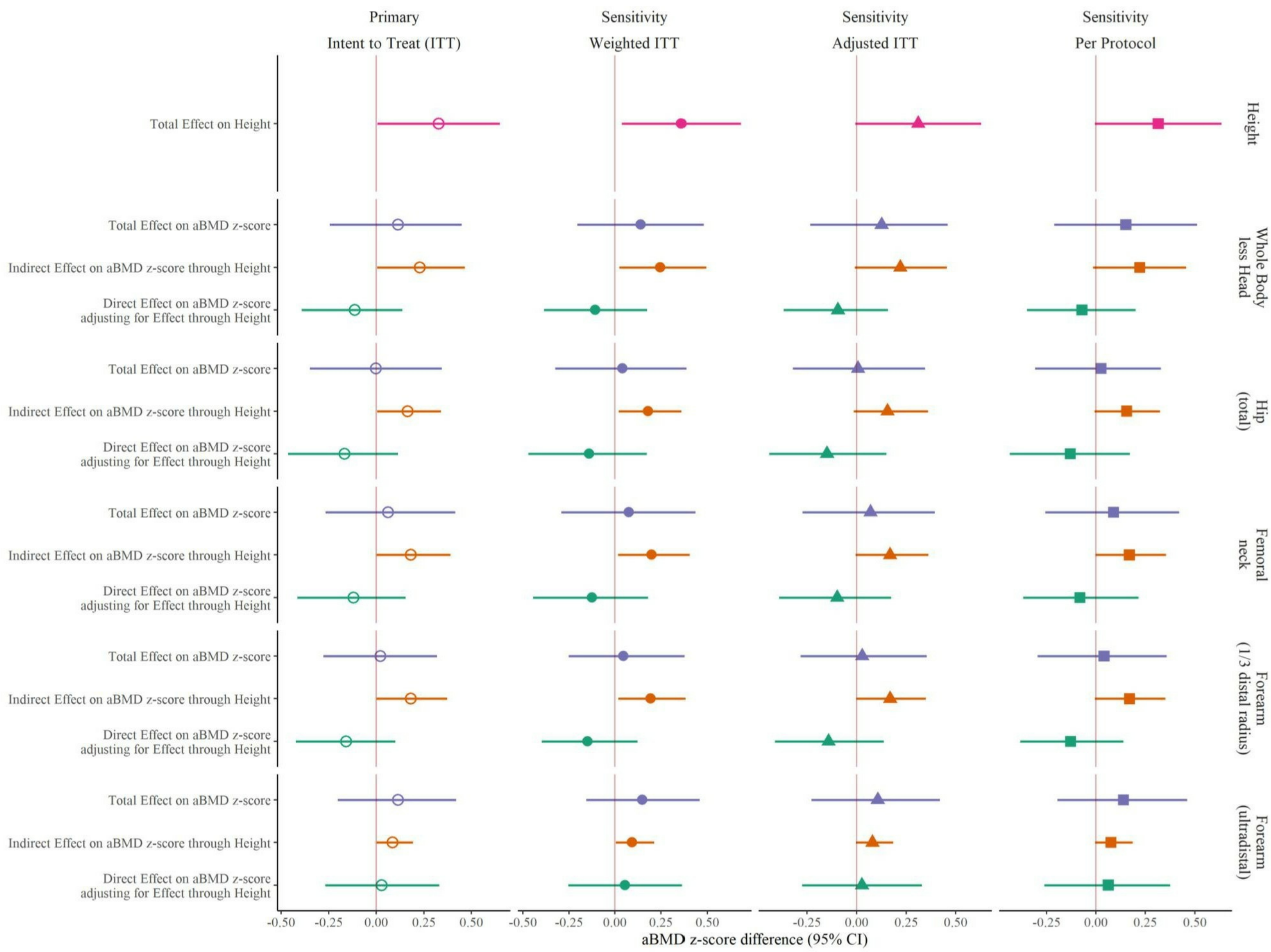

Figure. Effects of lead Intervention assignment on height and aBMD z-scores* at age 12 years, decomposed into direct and indirect effects through height at age 12 years, in intent-to-treat (n=189) and per-protocol (n=186) analyses (hollow symbols: primary analyses; solid symbols: sensitivity analyses**).

Abbreviations: aBMD: areal bone mineral density; ITT: intent-to-treat. *Height z-scores were age- and sex- standardized based on CDC growth charts; aBMD z-scores were age-, sex-, and race-standardized based on the Bone Mineral Density in Childhood Study reference.**Weighted ITT used inverse probability of selection weights estimated using pre-intervention pregnancy blood lead levels, lead intervention assignment, and maternal race; Adjusted ITT and per-protocol analyses were adjusted for maternal race and child's sex assigned at birth, duration of breastfeeding, 12-year physical activity questionnaire for children (PAQ-C) score, calcium, and energy intake.

Wednesday PD3

Associations of maternal prenatal per- and polyfluoroalkyl substance concentrations with menstrual patterns, androgen excess, and polycystic ovary syndrome in Project Viva

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Abstract

Background: Because prenatal exposure to PFAS may impact offspring cycle regularity and androgen excess (AE), this study aimed to evaluate maternal PFAS concentrations during pregnancy and menstrual patterns, AE, or polycystic ovary syndrome (PCOS) in the offspring.

Methods: We studied 350 mother-daughter pairs in Project Viva, a Boston-area longitudinal pre-birth cohort. We examined associations of concentrations of 6 PFAS in maternal prenatal plasma samples (median: 9.6 weeks gestation) with menstrual cycle characteristics (length and regularity), AE features (acne and hirsutism), and PCOS diagnosis as reported by daughters in mid/late adolescence. We used logistic regression to estimate associations of single PFAS separately with each outcome, and weighted quantile sum regression to estimate associations of the PFAS mixture with the outcomes, adjusting for maternal sociodemographic, reproductive, and other lifestyle/health factors.

Results: In this study, 28.6%, 2.6%, and 6.2% of the daughters reported having irregular menstrual cycles, PCOS, and moderate/severe acne, respectively. There was a 1.38-fold higher odds of the daughter having irregular menstrual cycles per doubling of prenatal 2-(N-methyl-perfluorooctane sulfonamide) acetate (MeFOSAA) (95% CI: 1.01-1.90), and a 2.69-fold higher odds of PCOS per doubling of prenatal 2-(N-ethyl-perfluorooctane sulfonamide) acetate (EtFOSAA) (95% CI: 1.05-6.92). When adjusted only for maternal age and race/ethnicity, prenatal perfluorooctane sulfonate (PFOS) and perfluorononanoate (PFNA) were associated with moderate/severe acne [OR for PFOS (95% CI) = 2.06 (1.08-3.95); OR for PFNA (95% CI) = 2.55 (1.30-5.03)], though the CIs included the null after further adjusting for remaining covariates. No associations were found for other outcomes, or between PFAS mixture and any outcome.

Conclusion: Maternal concentrations of certain PFAS are associated with higher risk of menstrual irregularity and PCOS during mid/late adolescence. Future studies of larger size and across the reproductive life-course are needed to replicate these results and understand the mechanism.

Wednesday PD3

Daily PM2.5 During Pregnancy and Adverse Birth Outcomes in Los Angeles County

Sanjali Mitra[1], Karl O'Sharkey[1], Seung-a Paik[1], Qi Meng[1], Jason Su[2], Beate Ritz[1,3]
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Abstract

Background: Preterm birth (PTB) and term low birth weight (TLBW) are associated with higher incidence of infant mortality and adverse neurodevelopment. PM2.5 exposure has been linked to PTB and TLBW. However, there is still a need to determine whether there are specific vulnerable periods in pregnancy or whether certain populations are more vulnerable. This study investigated trimester-specific the effect of PM2.5 on birth outcomes based on a model with high spatial and temporal resolution.

Methods: Birth certificate records for all births in Los Angeles County between January 1st, 2017 and December 31st, 2019 were obtained from the California Department of Public Health (N=334,059). Daily PM2.5 values at 30m spatial resolution developed through a California-wide LUR model and machine learning approaches were used to estimate exposure to PM2.5 for each trimester and the entire duration of pregnancy. Logistic regression analyses were conducted to estimate the odds for PTB and TLBW, adjusting for key covariates stratifying by race/ethnicity.

Results: This study found no association between our modeled prenatal PM2.5 exposure and PTB except for Non-Hispanic Whites for exposures during the entire pregnancy (OR=1.03; 95% CI=0.99, 1.08). However, for TLBW we estimated increased effects for PM2.5 in the 3rd trimester in all women that was strongest among Hispanics (OR = 1.05; 95% CI: 1.00, 1.10), Blacks (1.03; 0.93, 1.15), and Asian and Pacific Islanders (1.05; 0.96, 1.15), consistent with the fastest growth of the fetus happening during the third trimester.

Conclusion: Results indicate that the modeled PM2.5 exposure was not associated with PTB in minorities, but increases in effect were estimated for TLBW among Hispanic, Black, and Asian or Pacific Islander births.

Wednesday PD3

Near-birth diurnal temperature differences and preterm birth in North Carolina 2011-2015

Kristen Cowan[1,2,3], Tom Luben[1], Alison Krajewski[1], Breanna Alman[4], Ambarish Vaidyanathan[5], Kristen Rappazzo[1]
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Abstract

Background: Small differences between daily maximum and minimum temperature are occurring more often during extreme heatwaves and cold waves globally. A growing body of evidence shows that extreme high and low temperatures are associated with poor birth outcomes but associations with daily temperature difference are relatively unexamined. We estimated associations between near-birth daily temperature differences and preterm birth in North Carolina (NC) from 2011-2015.

Methods: Temperatures were estimated at the census tract-level from the North American Land Data Assimilation System (NLDAS-2). The difference between the daily maximum and minimum temperature was calculated for each NC census tract. Our study population included singleton live births occuring at ≥20 weeks gestation with a NC residence at date of birth that could be geocoded and linked to a census tract. Census tract-level temperature differences were averaged over the 5 days leading up to and including the date of birth. Linear binomial regression models were used to estimate risk differences (RDs) per 10,000 births for preterm (<37 weeks) and extremely preterm births (<28 weeks) adjusted for year of birth, season of birth, birthing person education and race/ethnicity.

Results: In this cohort, 46,364 (8.18%) births were preterm and 3,890 (0.69%) were extremely preterm. Temperature differences ranged from daily values of 1.4° to 67.8° Fahrenheit. No evidence of association between daily temperature difference averaged over the 5 days before birth and preterm birth or extremely preterm birth was observed (Figure 1). A 10-degree increase in the average temperature difference 3 days before birth was associated with a 6.73 per 10,000 births increase in preterm birth (RD: 6.73 (95% CI: -2.06, 15.53)) and a 0.08 per 10,000 increase in extremely preterm birth (RD: 0.08 (-2.57, 2.73)).

Conclusion: Further research is needed to identify how various ranges of temperature difference impacts birth outcomes.

Uncaptioned visual

Wednesday PD3

Effect of Psychosocial and Environmental Stressors on Prenatal DNA methylation

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Abstract

Background

Pregnancy is a multifactorial biological process consisting of immune, physiological, and endocrine changes to support the metabolic needs of mother and fetus with potential impacts on their health. Biological changes (e.g., DNA methylation) may interact with environmental and clinical risk factors, perturbing conserved prenatal pathways. This study aimed to identify differential methylation between early and late pregnancy samples among paired whole blood prenatal samples (n=129,N=258) in the MADRES pregnancy cohort, consisting of predominately low-income Hispanic women. Interaction by clinical, environmental, and psychosocial risk factors was assessed.

Methods

Associations with differential methylation across paired samples was estimated using adjusted linear regression. We then evaluated two-way and three-way interactions between gestational age (GA) and the following factors: maternal pre-pregnancy body mass index (BMI), perceived stress using the perceived stress scale (>14), sleep using the Jenkins Sleep Scale (>4), and residential prenatal exposure to particulate matter with aerodynamic diameters <2.5µm (PM2.5). Stress and sleep were categorized into four level (unexposed, first trimester exposed, late trimester exposed, exposed at all timepoints).

Results

4,155 CpGs were associated with differential methylation between early and late pregnancy in paired samples. None of these differential CpGs were modified by BMI, sleep, or stress. There was evidence for three-way modification by stress and BMI, and sleep and BMI with GA. Methylation change was blunted in response to poor sleep quality across all categories among individuals with a higher BMI in the UQCRFS1 gene.

Conclusion

A subset of CpGs were identified that changed over time in pregnancy. These changes in CpG levels were not directly affected by factors like continuous BMI. However, CpGs displayed differential methylation among individuals with higher BMI who also had any evidence of poor sleep quality, and high stress.

Wednesday PD4

Per- and polyfluoroalkyl substances mixtures in pregnancy and breastfeeding duration in Project Viva

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Abstract

Background: Per- and polyfluoroalkyl substances (PFAS) may disrupt mammary gland development and thereby inhibit breastfeeding duration. However, prior studies examining PFAS and time to breastfeeding termination have differing findings, have not consistently adjusted for prior breastfeeding duration, and have not examined the overall effect of PFAS mixtures.

Methods: We studied 1079 lactating women from Project Viva, a longitudinal cohort that enrolled pregnant participants from 1999-2002. We investigated associations of plasma concentrations of 6 PFAS [perfluorooctane sulfonate (PFOS); perfluorooctanoate (PFOA); perfluorohexane sulfonate (PFHxS); perfluorononanoate (PFNA); 2-(N-ethyl-perfluorooctane sulfonamido) acetate (EtFOSAA); 2-(N-methyl-perfluorooctane sulfonamide) acetate (MeFOSAA)] in early pregnancy (mean: 10.1 weeks of gestation) with self-reported breastfeeding termination by 9 months postpartum, after which women rarely cite low milk supply as a reason for terminating. We used Cox regression for single-PFAS models and quantile g-computation for mixture models. We adjusted analyses for sociodemographics, prior breastfeeding duration, and gestational age at the time of blood draw.

Results: We detected all 6 PFAS in over 98% of samples. Sixty percent of women reported terminating breastfeeding by 9 months postpartum. Women with higher plasma concentrations of PFOA, EtFOSAA, and MeFOSAA had a greater risk of terminating breastfeeding before 9 months postpartum [HR (95% CI) per doubling concentration: 1.19 (1.04, 1.37) for PFOA; 1.10 (1.01, 1.20) for EtFOSAA; 1.19 (1.08, 1.30) for MeFOSAA]. In the quantile g-computation model, a simultaneous quartile increase in the PFAS mixture was associated with 1.16 (95% CI: 1.04, 1.30) greater risk of terminating breastfeeding before 9 months postpartum.

Conclusion: Our findings suggest that exposure to certain PFAS, individually and as a mixture, may adversely affect breastfeeding duration and draw further attention to environmental chemicals that possibly dysregulate human lactation.

Uncaptioned visual

Wednesday PD4

Detecting Shape-based Interactions in Environmental Chemical-Mixtures using an Ensemble of Exposure-Mixture Regression and Interpretable Machine-learning Tools

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Abstract

Background

There is growing public health interest in discovering interactions between multiple environmental exposures, which may increase adverse health effects. However, most existing approaches are typically “black boxes” learning interactions that are difficult to translate into testable hypotheses. Further, most algorithms don't consider the “shape-based geometry” of interactions, i.e., the chemical concentration thresholds beyond which there may be a synergistic or antagonistic effect. Therefore, we developed and validated a method to discover shape-based “interaction signatures with thresholds” (termed “insights”) among environmental chemicals.

Methods

We developed the “Multi-ordered explanatory interaction” (Moxie-) algorithm by merging the efficacy of Extreme Gradient Boosting with the inferential power of Weighted Quantile Sum regression to extract synergistic insights associated with the outcome/odds of disease in an adverse direction. We evaluated the insights from Moxie-algorithm’s performance through simulations and compared it with the currently available gold-standard signed-iterative random forest algorithm. To demonstrate its utility, we used a cross-sectional dataset from the Childhood Autism Risks from Genetics and Environment (CHARGE) dataset (n=479 children) to evaluate synergistic interactions among 62 chemicals/metabolites measured in urine (30 Phenols and Parabens, 20 Phthalates, 6 Pesticides, and 6 Trace elements) in association with increasing the odds for autism spectrum disorder (vs. typical development).

Results

In simulations, the Moxie-algorithm was highly sensitive and specific and had low false discovery rates in detecting true synergistic insights (2nd, 3rd, 4th order) through moderate (n=250) to large (n=1000) sample sizes. In CHARGE, we found a two-order synergistic insight between trace-element cadmium and alkyl-phosphate-pesticide Diethyl-phosphate(DEP), which was detected when the urinary concentrations of cadmium and DEP adjusted for specific gravity were above 0.028 ng/ml and 12.582 ng/ml, respectively.

Conclusion

Our findings demonstrate a novel validated approach for detecting shape-based interactions by integrating exposure-mixture regression and machine learning methods in environmental epidemiology studies.

Wednesday PD4

Interpretable and explainable machine learning approach to forecast and predict air pollution: A Systematic review.

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Abstract

Background: Nowadays, several studies are interested in carrying out a predictive model based on machine learning approach to estimate the level of future concentration of atmospheric pollutants. Most Machine learning models aim to improve overall prediction accuracy, yet they may fail to explain the interactions between the various specific factors and their effects on air pollution, i.e. they are uninterpretable models (black box).

Objective: Therefore, this systematic review will focus on reviewing studies that used interpretable machine learning models and methods that interpret and explain the air quality prediction and forecasting.

Methods: The terms "air pollution", "machine learning" and "interpretability" (including synonyms and closely related words), were used as search terms in the titles, abstracts or keywords, to identify relevant studies published between 2011 and 2022, from PubMed, Scopus, Web of Science, Science Direct and JuSER. The quality of the included studies was assessed based on an ecological checklist for maximizing reproducibility of ecological niche models.

Results: Among 3,470 identified studies, only 459 focus on air pollution prediction using machine learning, 70 of these provide an interpretation of the used models. The current study summarizes and discusses different types of interpretable machine learning algorithms as well as the methods used to explain the predictions resulted by machine learning models. The majority of studies considered by this review used linear regression as an interpretable machine learning model for air pollution prediction (30.6% studies), followed by SHapley Additive exPlanations (21.7% studies) and Partial dependence plots (9.6% studies) as model-agnostic methods.

Conclusions: The main objective of this review study is to provide a comprehensive summary of interpretable machine learning models in air quality prediction that may benefit governments to take sound and reliable decisions based on a realistic scientific basis to control air pollution.

Wednesday PD4

Constructing DNA methylation risk scores for mediation analysis

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Abstract

Background: Methylation risk scores (MRS), weighted sums of DNA methylation (DNAm) values of pre-selected DNAm sites, could be used as a mediator in mediation analyses. However, current MRS approaches that capture DNAm signatures related to either exposure or outcome usually do not accurately capture indirect effects.

Methods: We propose a MRS tailored for mediation analyses (MRSmed). MRSmed leverages summary statistics from two external epigenome-wide association studies (EWAS), one for the exposure and one for the outcome. We use the product of the beta estimates from the two EWAS as weights for DNAm sites to reflect the indirect effect through DNAm. Different P-value thresholds are applied and DNAm sites with a P-value below the thresholds in both EWAS are included. Finally, for each P-value threshold, MRS are calculated as weighted sums of DNAm values of the included DNAm sites, and the proportions of association mediated through MRSmed are estimated by a traditional mediation approach. The P-value threshold that produces the highest proportion mediated is selected as the optimal P-value and the corresponding MRS is used for downstream analyses.

Results: We conducted simulation studies based on DNAm data from 2,664 Indian participants and varying scenarios with or without mediation through DNAm. MRSmed achieved a high statistical power (90%-100%) to detect indirect effects with a well-controlled type I error. The feasibility of this approach was further shown in a real data application, where we performed a causal mediation analysis to assess the association between maternal smoking, MRSmed and birth weight in the South African Drakenstein Child Health Study (n=260).

Conclusion: MRSmed is a powerful new approach to detect indirect effects of DNAm in mediation analyses, which could in turn help to elucidate causal mechanisms that underlie the association between environmental exposures and common diseases.

Wednesday PD4

Analyzing Relationships for Long-term Exposure to Air Pollutants and Cause-specific Mortality Using Generalized Additive Models

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Abstract

Long-term exposure to various air pollutants has been demonstrated to associate with the increased cause-specific mortality in recent epidemiological studies. Global exposure-response (ER) relationships have been investigated for long-term fine particulate matter (PM2.5) exposure and deaths caused by cardiovascular diseases, and lung cancer (LC). However, the research on the associations for cause-specific mortality and major components of PM and other gaseous pollutants is insufficient.

In this study, we collected cause-specific mortality data from 522 sub-regions in 45 countries to construct Generalized Additive Models for Exposure-response (GAMER) models. Global-scale ER curves between long-term air pollution exposure and relative risk (RR) of mortality caused by circulatory system diseases (CSD) and LC were established. Positive associations were observed between chronic PM2.5 exposure and both CSD and LC mortality. In addition, increased RR was discovered for LC mortality due to long-term black carbon (BC) and NO2 exposure. In two-pollutant models considering the influence of PM2.5, positive relationships between LC mortality and both O3 and BC exposure remained significant. Global annual PM2.5-attributable CSD and LC mortality were estimated to be 6.70 million (95% CI: 5.79 million - 7.54 million) and 0.31 million (95% CI: 0.18 million - 0.47 million) by our GAMER model.

ER relationships for PM2.5 and CSD and LC mortality observed in our study are in alignment with the results of the well accepted models in previous studies, namely, Integrated Exposure-Response model and Global Exposure Mortality Model. Our GAMER model was the first to build the ER relationships for LC mortality risk and O3 and BC exposure on a global scale.

Wednesday PD4

Quantifying Water Co-benefits of Electricity Savings in the Built Environment for Resilient Climate and Energy Planning

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Abstract

Background/Aims

Population growth has led to expected water shortages in 40 out of 50 U.S. states in the next decade, making water management critical to sustaining health of both the environment and the public. Electric Generating Units (EGUs) are a large competitor for water resources, requiring water for cooling, cleaning, and processing. Not all energy sources are equal in terms of water demand, and energy sources that have low emissions of greenhouse gases (GHGs) and air pollutants, such as nuclear energy, can require 2-3 times as much water as emission-intense sources like coal. Solar technologies can have some of the highest water consumption use per MWh. As a large water consumer, EGUs will compound water scarcity as energy demand increases unless energy plans and policies prioritize water management. There are tools for quantifying emissions of EGUs along with their impacts to air pollution, public health, and climate, but no tool exists for quantifying their water impacts.

Methods

To address this gap, we have developed the Water and Generation Resource Integrated Database (Water GRID–wGRID). wGRID quantifies the water impacts of EGUs, providing the location-specific water footprint of electricity consumption in terms of water consumption and withdrawal.

Results

Our study shows that two comparable buildings with the same energy demand in different parts of the U.S. can have significantly different energy-related water footprints, due to varying mix of generating and cooling technology attributes.

Conclusion

Climate-resilient energy will need to account for both emissions and water impacts of energy specific to a region to prevent unintended energy resiliency consequences due to high water demands in water-scarce regions. wGRID can aid resilient development of the energy sector by informing energy decisions, allowing them to take into account not only climate and public health, but also water impacts.

Wednesday PD4

Heterogeneous Distributed Lag Models to Estimate Personalized Effects of Maternal Exposures to Air Pollution

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Abstract

Background: Children's health studies support an association between maternal environmental exposures and children's birth outcomes. A common goal is to identify critical windows of susceptibility--periods during gestation with increased association between maternal exposures and a future outcome. The timing of the critical windows and magnitude of the associations are likely heterogeneous across different levels of individual, family, and neighborhood characteristics.

Methods: We develop and illustrate a statistical learning method that combines distributed lag models and Bayesian additive regression trees to estimate critical windows at the individual level and identify characteristics that induce heterogeneity from a high-dimensional set of potential modifying factors. Using an administrative Colorado birth cohort we estimate the individualized relationship between weekly exposures to fine particulate matter (PM2.5) during gestation and birth weight.

Results: We find evidence of heterogeneity in the PM2.5–birth weight relationship, with some mother-child dyads showing a 3 times larger decrease in birth weight for an IQR increase in exposure compared to the population average. Specifically, we find increased susceptibility for non-Hispanic mothers who are either younger, have higher body mass index or lower educational attainment.

Conclusions: New statistical methods to estimate individualized critical windows of susceptibility to environmental exposures. These methods allow us to identify both who is most susceptible and when during the life-course they are most susceptible.

Wednesday PD4

Health and Economic Cost Estimates of Short-term Total and Wildfire PM2.5 Exposure on Work Loss

Ying-Ying Meng[1], Yu Yu[1], Diane Garcia-Gonzales[1], Mohammad Al-Hamdan[2], Miriam Marlier[1], Joseph Wilkins[3], Xiao Chen[1], Michael Jerrett[1]

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Abstract

Objectives To help determine the health protectiveness of government regulations and policies for air pollutant control for Americans, our study aimed to investigate the health and economic impacts of work loss due to sickness associated with daily total PM2.5 and wildfire-specific PM2.5 exposures in California.

Methods We linked the 2015-2018 California Health Interview Survey respondents' geocoded home addresses to the air pollution data developed by the National Aeronautics and Space Administration Health and Air Quality Applied Sciences Program and the Community Multiscale Air Quality model and calculated the coefficient for the association between daily total PM2.5 exposure and work loss. Then we applied coefficients derived from our regression analyses to the Environmental Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) platform to calculate the health and economic impacts of PM2.5 exposure on work loss due to sickness.

Results We observed that each 1µg/m3 increase in daily total PM2.5 exposure will lead to more than 1 million days of sick leave per year ranging from 1.1-million to 1.6-million person-days in 2015-2018, and the related economic loss was 235 to 300 million dollars. We also found that the wildfire smoke alone could contribute to 708,206 work loss days in California in 2015 and increase to more than 2.6 million sick days with a related economic loss of more than 500 million dollars per year in 2017 and 2018.

Conclusions Both conventional and wildfire-specific sources of PM2.5 produced substantial work loss and cost in California. Updating the current BenMAP-CE calculations for work loss days will be essential in quantifying the current health impacts of regulations and policies to help inform the full impact of policy decisions to protect public health.

Wednesday PD5

Leveraging Exposomics to Investigate the Pathobiology of Asthma

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Abstract

Background

Asthma develops through repeated cycles of inflammation often triggered by environmental factors, which can lead to progressive obstruction of the airways. Currently, guidance is urgently needed from a preventative environmental health perspective. As such, further studies to explore the unknown environmental exposures related to asthma severity and control, particularly in monitoring exposures at molecular and individual levels, and understanding the underlying biological mechanisms are urgently needed.

Methods

This innovative study utilizes biomonitoring and bioinformatics approaches to identify specific toxic-biologic pathways and validate them in human cellular systems. Pittsburgh and Allegheny County both have high asthma prevalence, as well as indications of more severe disease. The County also has some of the worst air quality in the nation. Here, as a pilot study, external and internal exposome data are collected from fifty asthmatics from the existing Asthma and Environmental Lung Health Institute Asthma Registry at UPMC with differing exposures to potential airborne pollutants to determine whether these pollutants link to the differences in the personal external exposome, the internal fingerprint, and the biologic response signatures.

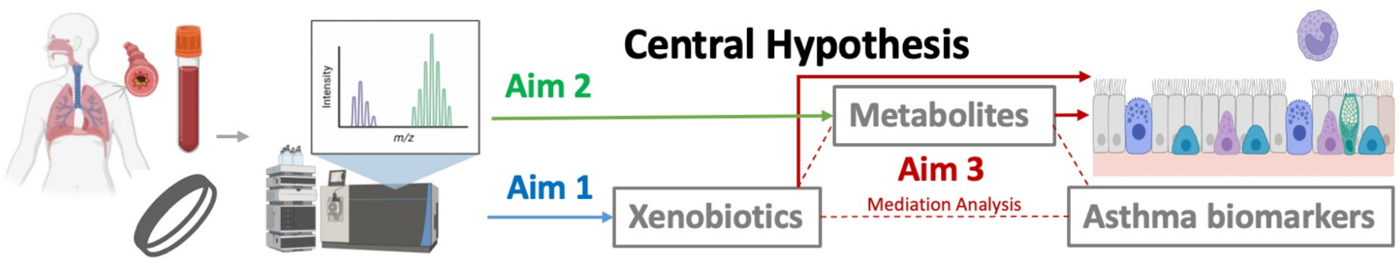
Results

Specifically, the following three specific aims are achieved: Aim 1 - Characterize asthma-related organic contaminants and xenobiotics from the external and internal exposome profiles; Aim 2 - Determine asthma-related internal metabolome and proteome in both cross-sectional blood samples; and Aim 3 - Perform multivariate mediation analysis based on the results of the exposome profiles, internal metabolome and proteome, and asthma biomarkers, then validate the hypothesized xenobiotic-biomolecule-asthma pathways by human cell lines.

Conclusion

Altogether, these studies form a novel exposomics approach by integrating these three aims on environmental monitoring, biomonitoring, molecular epidemiological, statistical inferential, and in vitro experimental approaches. This project generates a better understanding of environmental influences on asthma phenotypes, severity, and control by connecting external exposures with internal biomolecules at both molecular and clinical levels.

Figure



Wednesday PD5

Improving the Prediction of Death from Cardiovascular Causes with Multiple Risk Markers

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Abstract

Background: Traditional risk factors including demographics, blood pressure, cholesterol, and diabetes status are successfully able to predict a proportion of cardiovascular disease (CVD) events. Whether including additional routinely measured factors improves CVD prediction is unclear. To determine whether a comprehensive risk factor list, including clinical blood measures, blood counts, anthropometric measures, and lifestyle factors, improves prediction of CVD deaths beyond traditional factors.

Methods: The analysis comprised of 21,982 participants aged 40 years and older from the National Health and Nutrition Examination Survey 2001-2016 survey cycles. Data were linked with the National Death Index mortality data through 2019 and split into 80:20 training and testing sets. Relative to the traditional risk factors (age, sex, race/ethnicity, smoking status, systolic blood pressure, total and high-density lipoprotein cholesterol, antihypertensive medications, and diabetes), we compared models with an additional 22 clinical blood biomarkers, 20 complete blood counts, 7 anthropometric measures, 51 dietary factors, 13 cardiovascular health-related questions, and all 113 predictors together. To build prediction models for CVD mortality, we performed Cox proportional hazards regression, elastic-net (ENET) penalized Cox regression, and random survival forest, and compared classification using C-index and net reclassification improvement.

Results: During follow-up (median, 9.3 years), 3,075 participants died; 30.9% (1,372/3,075) deaths were from cardiovascular causes. In Cox proportional hazards models with traditional risk factors (C-index=0.850), CVD mortality classification improved with incorporation of clinical blood biomarkers (C-index=0.867), blood counts (C-index=0.861), and all predictors (C-index=0.871). Net CVD mortality reclassification improved 13.2% by adding clinical blood biomarkers and 12.2% by adding all predictors. Results for ENET-penalized Cox regression and random survival forest were similar.

Conclusions: The addition of clinical blood biomarkers and blood counts substantially improves CVD mortality prediction, beyond traditional risk factors. These biomarkers may serve as an important clinical and public health screening tool for the prevention of CVD deaths.

Wednesday PD5

Mixture effects of prenatal exposure to polybrominated diphenyl ethers on urinary oxidative stress biomarkers in the Chemicals in Our Bodies Cohort

Neha Sehgal[1], Rachel Morello-Frosch[2], Amy Padula[3], Erin DeMicco[3], June-Soo Park[4], Sabrina Smith[4], Ginger Milne[5], Tracey Woodruff[3], Stephanie Eick[1]

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Abstract

Uncaptioned visual

Background: Prenatal exposure to polybrominated diphenyl ethers (PBDEs) has been linked to adverse birth outcomes, including preterm birth. However, the mechanism of action remains unclear. Laboratory studies suggest that PBDEs generate reactive oxygen species, leading to elevated oxidative stress, a known contributor to preterm birth in epidemiologic studies. We hypothesized that elevated levels of PBDEs would be associated with an increase in oxidative stress during human pregnancy.

Methods: Participants included in the present analysis were enrolled in the Chemicals In Our Bodies cohort, in San Francisco, CA (N=201). Four PBDEs (BDE-47, -99, -100, and -153) were measured in 2nd trimester serum. Urinary levels of oxidative stress biomarkers (8-iso PGF2α; 2,3-dinor-5,6-dihydro-8-iso-PGF2α; 2,3-dinor-8-iso-PGF2α; and PGF2α) were measured in the second and third trimester. Associations between individual PBDE and oxidative stress biomarkers (averaged and trimester specific) was examined using linear regression. Quantile g-computation and Bayesian kernel machine regression (BKMR) were used to assess the cumulative effect of PBDEs and individual oxidative stress biomarkers. All models were adjusted for parity, maternal age, pre-pregnancy body mass index, maternal education, and hospital.

Results: Our analytic sample included a socioeconomically diverse group of pregnant women, with 53% having a college degree. Using linear regression, a natural-log unit increase in BDE-47 and BDE-99 was positively with elevated levels of averaged 8-iso PGF2α; 2,3-dinor-8-iso-PGF2α; and PGF2α. In quantile g-computation models, a simultaneous one quartile increase in all PBDEs was associated with an increase in levels of 8-iso-PGF2α; 2,3-dinor-8-iso-PGF2α; and PGF2α levels. Associations were greatest in magnitude for second trimester levels of 2,3-dinor-8-iso-PGF2α (mean change per quartile increase=0.25, 95% confidence interval=0.09, 0.41). Associations were similar using BKMR.

Conclusion: Our findings suggest that prenatal exposure to PBDEs is positively associated oxidative stress, as measured by 8-iso-PGF2α and 2,3-dinor-8-iso-PGF2α, highlighting one possible mechanism linking PBDEs to adverse pregnancy outcomes.

Wednesday PD5

A two-step approach to examine the association of the place-based exposome with birth telomere length: a pilot study

Zhongzheng Niu[1], Helen Foley[1], Shohreh Farzan[1], Mao Tian[1], Tingyu Yang[1], Brendan Grubbs[1], Sandrah Eckel[1], Fred Lurmann[2], Nathan Pavlovic[2], Rima Habre[1], Theresa Bastain[1], Carrie Breton[1]
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Abstract

Background: Telomere length (TL), an established biological aging biomarker, is a function of its length at birth and attrition over one's lifetime. However, determinants of birth TL remain unclear. We conducted a pilot study to examine differences in birth TL by place-based exposomes.

Methods: A random subset of cord blood samples (n=53) was selected from the Maternal and Developmental Risks from Environmental and Social Stressors (MADRES) cohort. Residential address histories were assembled for each participant and used to estimate the following place-based exposomic measures: daily ambient particulate matter (PM_{10}; $PM_{2.5}$), nitrogen dioxide, ozone, temperature, and the CalEnviroScreen cumulative scores and components (e.g., pollution measures from the air, soil, and water and neighborhood vulnerability such as poverty and unemployment prevalence). Birth TL was measured from cord blood DNA using qPCR comparing telomere to a reference gene (36B4). Coefficients of variation for telomere and 36B4, measured in triplicate, were 0.6% and 0.3%, respectively. Intraclass correlation coefficient for interplate replicate samples' TL was 0.84 (95% CI: 0.58, 0.94). We used the "rexposome" R package to examine the exposomic association (ExWAS) with TL, followed by exposure-specific approaches (e.g., distributed lag model) as the second step. All analyses were adjusted for technical and demographic factors.

Results: Pregnancy-average levels of ambient PM_{10} and $PM_{2.5}$ were inversely associated with birth TL, while neighborhood poverty and unemployment prevalence were positively associated with birth TL. These associations were not statistically significant after FDR adjustment (Figure 1A). The exposure-specific analysis (Figure 1B) identified a sensitive window of $PM_{2.5}$ exposure between 8 and 22 gestational weeks associated with lower birth TL (average effect for 5 μg/m^3 increase in $PM_{2.5}$: -0.07, 95% CI: -0.13, -0.01).

Conclusion: Ambient $PM_{2.5}$ exposure during early to mid-pregnancy was associated with lower birth TL. Future studies with larger sample sizes are needed to replicate these findings.

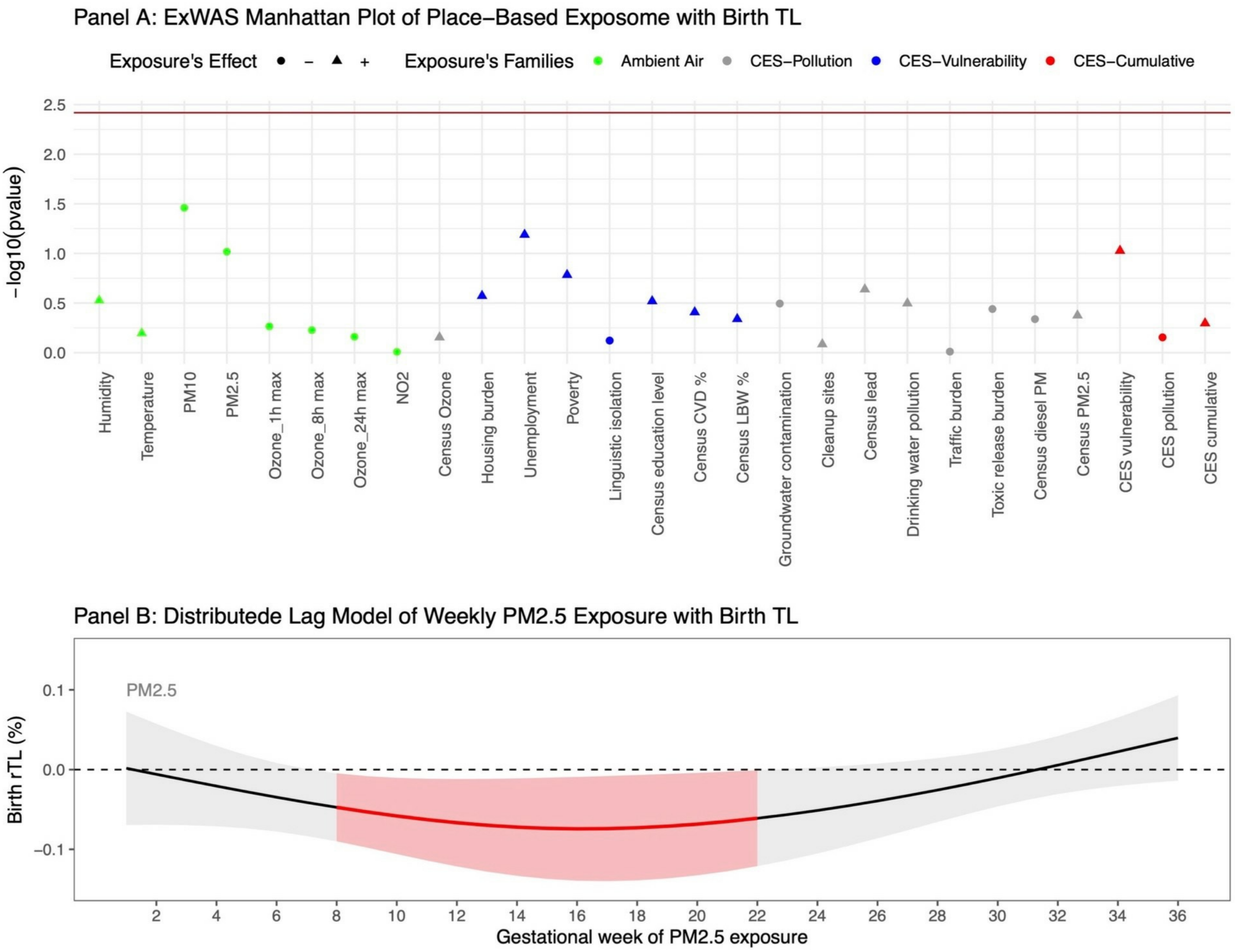

Figure 1. Two-step analyses of place-based exposome with birth telomere length.
Panel A, ExWAS Manhattan plot. Exposure's positive effect is shown in triangle, negative in circle, and colored by exposure's family. **Panel B**, difference in birth TL by gestational weekly $PM_{2.5}$ exposure (5 ug/m^3 increase) from distributed lag model. All analysis were adjusted for assay plate, DNA concentration, maternal age, newborn sex, and gestational duration. Weekly temperature was also adjusted in the distributed lag model. rTL - relative telomere length; CES – CalEnviroScreen score; CVD – cardiovascular disease; LBW – low birth weight

Wednesday PD5

Communicating Environmental Health with Future Medical Professionals

Charlotte Sheridan[1,2], Charlotte Roscoe[3,4]
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Abstract

Background: In recognition of the impact of environmental determinants on health, the American Medical Association and the Association of Medical Education in Europe have both released policy statements in support of education on environmental health exposures within the medical school curricula. Yet, medical education on environmental topics (e.g. climate, air pollution, greenspace) remains lacking as reported by the Planetary Health Report Card, a widely adopted evaluation metric of medical school coursework.

Methods: To address this deficiency and improve communication of environmental epidemiology, we are creating an educational video on the external exposome aimed at medical students and practitioners. We drafted key messages about the embodiment of multiple environmental exposures and partnered with an artist, Enya Lachman-Curl, to visually represent the layering of environmental exposures across space and time, throughout the life course. We will consult with professional science communicators and a focus group of medical students in an iterative process to refine the message and ensure key concepts about the external exposome are conveyed clearly to the target audience.

Results: The exposome and health video will be available for medical students and educators who seek to learn more about the environmental exposome, while serving as a prototype for future engagement by environmental researchers with the medical community through interdisciplinary art and communication teams. The educational video will be shared across social media platforms and public health accounts of partnering institutions to reach the target audience.

Conclusion: Sustained and intentional engagement with medical education is necessary to improve medical practitioners understanding of environmental harms and move medical practice towards prevention, rather than cure, of disease. This video will both improve the understanding by medical practitioners of the environmental exposome and, we hope, encourage other ISEE members to engage with artists, content curators, and/or medical communities to disseminate epidemiological research.

Wednesday PD5

Potential Interactions among Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Psychosocial Stress: A Scoping Review and Implications for Cumulative Risk Assessment

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Abstract

Background: Cumulative risk assessment (CRA), which considers co-exposures to multiple chemical and non-chemical stressors, is key to assessing real-world risks and addressing environmental injustice. Epidemiologic evidence is needed to support and expand quantitative methods for CRA. By reviewing the literature on co-exposures to BTEX and psychosocial stress, we aimed to characterize potential interactions and develop recommendations for CRA and future research.

Methods: We conducted a literature search in PubMed to identify studies on BTEX published after the CDC's 2004 *Interaction Profile for BTEX*. We included studies that assessed an overall mixture effect or interactions between components. We analyzed results to update CDC's classifications of the strength and direction of expected pairwise interactions. In an additional literature search, we identified studies on BTEX and psychosocial stress co-exposures. Drawing upon these findings and the broader literature, we developed an approach to account for potential effect measure modification.

Results: We identified 24 epidemiologic studies on BTEX co-exposures. Newer mixtures methods (e.g., Bayesian kernel machine regression) were only employed in one study. Since few studies provided information on pairwise interactions, we were unable to update CDC's classifications. We identified 3 studies on co-exposures to BTEX and psychosocial stress, which all found worsened health effects compared to BTEX exposure alone. While full quantification of effect measure modification remains elusive, we propose a semi-quantitative approach to incorporate susceptibility into risk-based decision-making.

Conclusion: Evidence on BTEX interactions is limited for updating CDC's 2004 classifications. Standardized methods for operationalizing stress are needed to facilitate development of quantitative approaches. In the interim, risk policy decisions should be implemented to account for the added burden of non-chemical stressors in disadvantaged communities. Enhanced communication between risk assessors and epidemiologists would help ensure research can effectively be used to develop CRA approaches and, in turn, promote environmental justice.

Wednesday PD5

Use of high-resolution metabolomics (HRM) for the Identification of metabolic markers associated with ambient air pollution in two large US cohorts

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Abstract

Background and Objective. A full understanding of the myriad mechanisms underlying ambient air pollution toxicity is essential given the established links between air pollution and numerous adverse health effects. We aim to apply high-resolution metabolomics to study biological perturbations associated with long-term air pollution exposure and health.

Methods. A total of 1,366 male and female participants within the Cancer Prevention Study-II (CPS-II) Nutrition and CPS-3 Cohorts were included in this analysis. All participants were cancer free at the time of blood draw. Metabolic profiling was measured in non-fasting plasma samples using ultrahigh-performance liquid chromatography-tandem mass spectrometry. Exposure assessment to 6 ambient air pollutants, including carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter (PM10), fine particulate matter (PM2.5), sulfur dioxide (SO2), and ozone (O3), was conducted using spatiotemporally-resolved models based on residential address at blood draw. We conducted a metabolome-wide association study using multivariable linear regression models, regressing each pollutant on individual metabolites and adjusting for potential confounders and covariates including age at blood draw, sex, race, body mass index, alcohol consumption, smoking status, passive smoking, vegetable and fruit intake, and educational level. Associations with a false discovery rate <0.2 were considered significant.

Results. 321 unique metabolites were associated with at least one air pollutant, after controlling for covariates and multiple testing comparison. The majority of significant features were associated with PM2.5 and CO. A majority of significant metabolites (>70%) indicated perturbations in lipid, amino acid, xenobiotic, cofactor, and vitamins super pathways. Specifically, fatty acid, tryptophan, purine, androgenic steroids, urea cycle, arginine and proline, and bile acid metabolism were the top sub-pathways consistently associated with various air pollutants.

Conclusion. This is the largest prospective study examining metabolic perturbation associated with air pollution exposure using untargeted metabolomics. Findings from this study will lay the foundation for future studies to develop sensitive biomarkers of air pollution.

Wednesday PD6

Acute effects of ambient air pollution on asthma emergency department visits in 10 U.S. states

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Abstract

Background: Previous studies of short-term ambient air pollution exposure and asthma morbidity in the U.S. have been limited to a small number of cities and/or pollutants, and with limited consideration of effects across ages.

Objectives: To estimate acute age group-specific effects of fine and coarse particulate matter (PM), major PM components, and gaseous pollutants on emergency department (ED) visits for asthma during 2005-2014 across the U.S.

Methods: We acquired ED visit and air quality data in regions surrounding 53 speciation sites in 10 states. We used quasi-Poisson log-linear time-series models with unconstrained distributed exposure lags to estimate site-specific acute effects of air pollution on asthma ED visits, overall and by age group (1-4, 5-17, 18-49, 50-64, and 65+ years), controlling for meteorology, time trends, and influenza activity. We then used a Bayesian hierarchical model to estimate pooled associations from site-specific associations.

Results: With 3.19 million asthma ED visits, we observed positive associations for multi-day cumulative exposures to all air pollutants examined (*e.g.*, 8-day exposures to $PM_{2.5}$: rate ratio [RR] of 1.016 with 95% credible interval of [1.008, 1.025] per 6.3 μg/m^3 increase, $PM_{10-2.5}$: 1.014 [1.007, 1.020] per 9.6 μg/m^3 increase, organic carbon: 1.016 [1.009, 1.024] per 2.8 μg/m^3 increase, and ozone: 1.008 [0.995, 1.022] per 0.02 ppm increase). PM and ozone showed stronger effects at shorter lags, while associations of traffic-related pollutants (*e.g.*, elemental carbon and oxides of nitrogen) were generally stronger at longer lags. Most pollutants had more pronounced associations within children (< 18 years) than adults; $PM_{2.5}$ had strong effects on both children and the elderly (> 64 years); ozone had stronger effects on adults than children.

Conclusions: We reported positive associations between short-term air pollution exposure and increased rates of asthma ED visits. We found that air pollution exposure posed a higher risk for children and older population.

Wednesday PD6

Prenatal Particulate Air Pollution Exposure, Newborn Blood DNA Methylation, and Respiratory Health in School-Aged Children: An Epigenome-Wide Meta-Analysis from the PACE Consortium

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Abstract

Background

Prenatal particulate air pollution exposure has been associated with an increased risk of adverse birth and childhood health outcomes. Epigenetics is a suggested biological mechanism linking environmental exposures and adverse health outcomes. Here, we aim to determine whether *in utero* exposure to particulate matter with a diameter of <2.5 µm ($PM_{2.5}$) or <10 µm (PM_{10}) is associated with differential DNA methylation (DNAm) in newborns, and whether those changes in DNAm are associated with respiratory health at school-age.

Methods

We conducted a meta-analysis of epigenome-wide association studies (EWAS) for the association between prenatal ambient $PM_{2.5}$ (N=3274, 9 cohorts) and PM_{10} (N=3102, 9 cohorts) concentrations and newborn blood DNAm (Illumina 450K or EPIC BeadChips). Annual mean concentration of $PM_{2.5}$ and PM_{10} were estimated at the mother's residential address during pregnancy. EWAS were conducted using robust linear regression, adjusted for child sex, prenatal smoking, socioeconomic status, cell type proportions, batch effects, and genetic ancestry. Causal mediation analyses will be conducted to determine whether the significant CpG sites from the meta-analyses mediate the association between air pollution exposure and lung function, asthma, and wheezing at school-age.

Results

After correcting for multiple testing [Bonferroni threshold=6.2E-08] we identified 3 CpG sites significantly associated with prenatal PM_{10} exposure, and 10 CpG sites significantly associated with prenatal $PM_{2.5}$ exposure. Some of these CpG sites mapped to genes that have been implicated in inflammatory pathways (TMC3-AS1 and VAV2) and differential methylation of TMC3-AS1 has been previously associated with asthma. The mediation analyses are currently ongoing.

Conclusion

These findings suggest that prenatal air pollution exposure is associated with differences in the newborn methylome. Identifying differential DNAm could provide novel insights for early detection of air pollution-related child respiratory health outcomes and promote interventions to reduce air pollution exposure in at-risk populations.

Uncaptioned visual

Meta-analysis of PM2.5 exposure and newborn blood DNAm

Wednesday PD6

The Relationship between Neighborhood Environmental Vulnerability and Pediatric Asthma Health Inequities in Los Angeles County, California; Fulton County, Georgia; and New York City, New York

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Abstract

Background/Aims: Existing literature suggests that demographic, economic, residential, and health-related factors measured on a neighborhood-level influence vulnerability to environmental exposures. Greater vulnerability to environmental exposures contributes to pediatric asthma exacerbations. We developed a neighborhood environmental vulnerability index (NEVI) to identify populations where resources can be allocated to mitigate vulnerability to environmental exposures. We aimed to explore the relationship between NEVI and pediatric asthma ED visits (2014-2019) in three US metropolitan areas: Los Angeles (LA) County, California (CA); Fulton County, Georgia (GA); and New York City (NYC), New York (NY).

Methods: In exploring the relationship between NEVI and pediatric asthma ED visits in LA County, Fulton County, and NYC, we performed separate linear regression analyses examining the association between overall NEVI score and its domain-specific scores (demographic, economic, residential, and health status) with pediatric asthma ED visits (per 10,000) across each metropolitan area.

Results: Linear regression analyses suggested that higher overall and domain-specific NEVI scores were associated with higher pediatric asthma ED visits. Corresponding adjusted R-squared values suggested that the overall NEVI scores explained at least 40% of the variance in pediatric asthma ED visits. Overall NEVI scores explained more of the variance in pediatric asthma ED visits in Fulton County, compared to LA County and NYC. The NEVI scores for the demographic, economic, and health status domains explained more of the variance in pediatric asthma ED visits across LA County, Fulton County, and NYC, compared to the NEVI score for the residential domain (Figure1).

Conclusion: Higher NEVI scores were associated with higher pediatric asthma ED visits in LA County, Fulton County, and NYC. The relationship differed in effect size and variance explained across the areas. Future studies can use NEVI to identify populations in need of greater resources to mitigate the severity of environmentally-related outcomes, such as pediatric asthma.

Uncaptioned visual

Wednesday PD6

Lag exposure to pollen increases respiratory related emergency department visits in older adults in the Midwest Region of the United States: 2006-2013

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Abstract

Introduction: Climate change is increasing the length and intensity of the growing seasons of various species of aeroallergenic pollens. These pollens have been shown to exacerbate respiratory disease symptoms of allergic rhinitis and asthma. However, the extent and nature of how short term lag exposures to pollens impact respiratory health events is not well understood. This research uses a database of respiratory related emergency department (ED) visits in Medicare recipients age 65+ (N= 5.1 million visits) in 30
counties each in Michigan, Ohio and Pennsylvania from 2006-2013 and a prognostic, model based raster of four types of pollens to test and estimate associations of pollen exposure with symptomatic respiratory disease.
Methods: We regressed daily ED visit count by ZIP code on cumulative seasonal pollen concentration counts for each evergreen, deciduous broadleaf, grass and ragweed pollen class including confounders for precipitation and temperature. Models were Poisson regression models with daily population-at-risk offsets and included distributed-lag-non-linear tansformations of temperature and pollen with a 7-lag-day exposure history.
Results: We found that one week cumulative exposure to greater than the 90th percentile of deciduous broadleaf pollens was positively associated with increases in ED visits (RR 1.09 95% CI(1.02, 1.16)). However, we found no association for cumulative exposure to
evergreen (RR 1.00 95% CI(0.95, 1.05)), grass pollens (RR 1.01 95% CI(0.95, 1.05)) or ragweed pollens (RR 1.03 95% CI(.98,1.08))
Conclusions: Cumulative exposure to deciduous broadleaf pollens, which appear in late winter/early wpring may increase risk for serious respiratory symptoms in elderly adults

Wednesday PD6

Personal Care Product Use and Asthma Morbidity Among Children with Asthma Living in Baltimore City

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Abstract

Over 4 million U.S. children <18 years suffer from asthma, a chronic inflammatory condition that affects the airways and leads to breathing difficulty. Emerging evidence indicates that chemicals in personal care products (PCP) may play a role in asthma development and control, but research remains sparse. We evaluated the association between PCP use and asthma morbidity among children. Generalized linear models were used to assess associations between self-reported PCP use and asthma symptoms in the prior two weeks (maximal symptom days, cough without a cold, and exercise-related symptoms) among 110 children 8-17 years with asthma living in Baltimore City. Product use included individual products and the number of products used in the prior 7 days by type of application (i.e., aerosol, wash-off, leave-on hair products, leave-on face and body products). Models were adjusted for age, sex, race, insurance status, season, and having a caregiver who is a current smoker. Participants were majority Black (87%), male (56%), and 8-11 years (66%). In the prior 7 days, participants used an average of 7 PCP (range: 3-23). Use of aerosol products, shampoo, hair sheen, and nail polish were associated with increased odds of maximal symptom days [number of aerosol products (adjusted odds ratio (aOR): 1.36; Confidence Interval (CI): 1.17,1.59), hairspray (aOR: 1.63; CI: 1.14, 2.33), perfume (aOR: 1.40; CI: 1.11,1.77); liquid shampoo (aOR: 1.34; CI: 1.05,1.73), hair sheen (aOR: 1.41; CI: 1.00, 2.00), and nail polish (aOR: 2.42; CI: 1.72, 3.41)]. Hair products were positively associated with exercise-related symptoms [hair coconut oil (aOR: 1.40; CI: 1.01,1.95), hair gel (aOR: 1.85; CI: 1.26, 2.70), hair oil (aOR: 1.17; CI: 0.88,1.55) and hair sheen (aOR: 2.10; CI: 1.44, 3.06)]. Our findings indicate that some PCPs may contribute to asthma morbidity, but larger studies are needed to confirm our findings and to identify chemicals of concerns.

Wednesday PD6

Acute exposure to daily and sub-daily $PM_{2.5}$ concentrations and respiratory mortality in children from the Mexico City Metropolitan Area

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Abstract

Background. Several studies have studied the health impacts from $PM_{2.5}$ on the respiratory health of children from the Mexico City Metropolitan Area (MCMA). However, few studies have evaluated the effects of daily-mean (24-hour average), and sub-daily (maximum one-hour concentration) $PM_{2.5}$ exposure on infant (>28 days-old to 1 year-old) and childhood (2 to 12 years-old) respiratory mortality in this region.

Methods. We used ICD10-coded mortality records (n=48,812) from the Mexican National Institute of Statistics and Geography to identify infant and childhood mortality cases in the MCMA from 2004 to 2019, and our daily satellite-based $PM_{2.5}$ estimates of mean (2004-2019) and one-hour maximum (2011-2019) $PM_{2.5}$ concentrations developed for the MCMA. The time-stratified case-crossover design, and conditional logistic regressions with distributed lags were used to estimate time-varying associations of $PM_{2.5}$ (lags 0-6 days) with non-accidental (A00-R99), and respiratory [all-respiratory (J00-J99), influenza and pneumonia (J09-J18), other acute-lower respiratory infections (J20-J22), and chronic-lower respiratory diseases (J40-J47)] mortality. Our models were adjusted by daily mean-ambient temperature, and included a negative control exposure ($PM_{2.5}$ one day after death) to estimate potential confounding.

Results. A 10μg/m^3 higher same-day exposure (lag_0) to mean-$PM_{2.5}$ was associated with higher all-respiratory [lag_0= 4.62% (95%CI: 1.69%–7.64%)], and influenza and pneumonia [lag_0= 7.41% (95%CI: 3.51%–11.46%)] mortality in infants. Sex-specific associations (lag_0) for all-respiratory mortality in infants were 7.05% (95%CI: 3.08%–11.18%) in males, and 1.62% (95%CI: -2.70%–6.14%) in females. A 10μg/m^3 higher max-$PM_{2.5}$ was associated with all non-accidental [lag_0=1.53% (95%CI: 0.33%–2.75%)], all-respiratory [lag_0= 4.05% (95%CI: 1.75%–6.39%)], and influenza and pneumonia [lag_0= 5.13% (95%CI: 2.19%–8.16%)] mortality in infants. Overall, no associations were found between the negative control exposures and mortality outcomes.

Conclusions. Our study provides further evidence that exposure to mean-$PM_{2.5}$ is associated with infant respiratory mortality, and on the adverse impacts of sub-daily exposures in this age group.

Wednesday PD6

Childhood Cumulative Ambient Air Pollution Exposures and Respiratory Symptoms in Adulthood

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Abstract

Background: Few studies have examined longitudinal effects of childhood air pollution exposure on adult respiratory health, including if effects are independent of childhood respiratory effects. Using Southern California Children’s Health Study data, we evaluated associations between childhood air pollution and adult respiratory symptoms, while considering child respiratory health.

Methods: Childhood residential exposure (birth–age 17 years) was assessed for outdoor nitrogen dioxide (NO_2), ozone (O_3), particulate matter <2.5µm ($PM_{2.5}$) and <10µm (PM_{10}), and respiratory symptoms (bronchitis, cough, phlegm) were ascertained via a questionnaire in adulthood. Logistic regression models were fitted to estimate associations between mean childhood air pollution exposure and adult respiratory symptoms, adjusting for potential confounders. We further adjusted for childhood respiratory symptoms and asthma to understand if observed associations operated through childhood respiratory health. Effect modification was assessed for family history of asthma, childhood asthma, and adult allergies.

Results: The study included 1,365 participants, comprised mostly of non-Hispanic White (57%) or Hispanic (31%) individuals. Mean age at adult assessment was 32.1 years (SD=4.8) with 25% reporting having any respiratory symptoms in the last 12 months. Childhood exposure to NO_2 and PM_{10} were associated with adult respiratory symptoms. The odds ratio associated with a one SD increase in mean childhood exposure was 1.45 (95%CI:1.01,2.09) for NO_2 (SD=11.3ppb) and 1.47 (95%CI:1.02,2.13) for PM_{10} (SD=14.6µg/m3). Results for O_3 and $PM_{2.5}$ were null. Adjusting for childhood respiratory symptoms or asthma did not markedly change NO_2 or PM_{10} results. Effect modification by childhood asthma was observed for PM_{10}, with larger effects among those with asthma.

Conclusion: We observed associations between air pollution exposure during childhood and respiratory symptoms in later adulthood. These associations were not explained by impacts on childhood respiratory health; however, children with asthma diagnosis in childhood did experience stronger effects of childhood air pollution on respiratory symptoms as adults.