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The following abstracts are from the 2nd year Master of Science and Master of Public Health degree students in our Environmental Health, Occupational and Environmental Medicine, Occupational and Environmental Exposure Sciences, Toxicology, and Environmental and Occupational Health programs.
Prevalence of *Salmonella* and *E. coli* on Produce from Seattle Farmers Markets

Amy Leang  
Environmental Health, MS  
Preceptor: John Scott Meschke

This study surveyed the extent of microbial contamination on lettuce and tomatoes purchased from farmers markets, an increasingly popular source of local produce. Foodborne outbreaks in the U.S. have implicated *Salmonella* and *E. coli* as etiologic agents associated with raw produce-related illness; lettuce and tomatoes in particular have been implicated as common vehicles for *Salmonella* and *E. coli*. Over 120 samples of lettuce and tomatoes were collected from five major farmers markets in the Seattle metropolitan area throughout the 2012 summer/fall harvest season. Samples were analyzed for surface contamination of *Salmonella* spp. and generic *E. coli* as an indicator for fecal contamination. Whole tomato and 50 g lettuce samples were enriched or eluted in sterile Whirl-Pak® bags. Surfaces of samples were manually rubbed in liquid media to aid in removal of surface attached particles. Samples were pre-enriched in Universal Pre-enrichment Broth for the detection of *Salmonella* spp., followed by selective enrichment with Tetrathionate (TT) broth and plating onto XLD agar for isolation. Presumptive colonies were confirmed with API and qPCR targeting the *Salmonella invA* gene. Rapid Colilert® tests, paired with Quanti-Tray®/2000 (IDEXX), were adapted for qualitative and quantitative detection of generic *E. coli* on produce. Following elution with phosphate buffered saline (PBS), positive wells were enumerated after 24 hrs and *E. coli* levels expressed as MPN/100 mL. No *Salmonella* was detected; presumptive *Salmonella* isolates were confirmed to be *Citrobacter. E. coli*, indicating fecal contamination, was present on 62% of lettuce and 6.4% of tomatoes samples. No significant differences were found in *E. coli* contamination by temporal variation, between organic and conventional production methods, or between vendors. There were significantly more lettuce samples contaminated with *E. coli* than tomatoes (*p* < .05).
A Novel Method for Rapid Extraction, Purification, and Concentration of Poliovirus RNA

Elizabeth Burton
Environmental Health, MS
Preceptor: John Scott Meschke

Current methods for confirmation of poliovirus (PV) infection in acute flaccid paralysis (AFP) cases may take up to 45 days to confirm due to shipping logistics and requisite tissue culture. A rapid preliminary result indicative of PV infection would facilitate a more rapid outbreak response by national PV eradication programs. Working toward this goal, a novel chromatographic strip has been developed for the rapid extraction, purification, and concentration of PV RNA. Development of the strip involved the construction of 4 mm, 6 mm, and 8 mm wide strips of six types of Millipore® High-Flow Plus nitrocellulose (NC) attached to six different types of Whatman® absorbent pads. These 36 strips were analyzed in terms of migration rates and saturation times using lysis buffer. Optimum performance was observed when 8 mm wide strips of HF 90 NC were attached to Whatman CF6 wicking pad, which allows absorption up to 250 µL in a 15 minute period. Non-specific binding of nucleic acids to the NC strip was assessed using a polyA-FAM fluorescent probe, and showed an 18% loss of sample. However, by testing various pretreatment conditions for the NC, it was found that pre-blocking the strips in a solution of 0.015% casein sodium salt, 0.3% polyvinylpyrrolidone, 0.001% Tween 20, in Tris Buffered Saline, pH 8.6, for five minutes eliminated non-specific binding issues. The strips were next imbedded with 5 µM, 10 µM, and 30 µM polyT30, Locked Nucleic Acid polyT30, and polyT90 capture lines. Lysis buffer spiked with PV1 was absorbed by the strips, and the capture lines were scraped off of the strip and placed in 50 µL RT-qPCR reactions. Reverse transcription was performed at 45C for 20 minutes, followed by 95C for 5 minutes. The NC is then removed from the reaction, and qPCR is performed with 40 cycles of 95oC for 15 seconds followed by 30 seconds at 60oC. The 5 µM T90 consistently showed the best amplification, yielding Ct values within 0.05±0.03 logs to controls seeded with equal amounts of PV1 RNA. This device presents a simple rapid method for extraction, purification, and concentration of polyadenylated RNA that can be performed in the field, is complete within 15 minutes, eliminates cold-chain requirements, and will facilitate rapid response.
Dietary Phthalate Exposure in Pregnant Women

Samantha Serrano
Environmental Health, MS
Preceptor: Sheela Sathyanarayana

Background: Phthalates are a family of synthetic chemicals with widespread use in industrial and consumer products. Due to their ubiquity in the environment, the general population experiences nearly daily exposures to these compounds. Animal studies have shown that phthalates disrupt normal male reproductive tract development during gestation. Because of possible human toxicity, assessing phthalate exposures is important. Food is considered the greatest source of some phthalates, however, few U.S. studies have investigated diet’s contribution to overall body burden and none have assessed exposures specifically in pregnant women.

Methods: We used multivariate regression analysis to examine the association between reported dietary intake of various food groups (beef, seafood, poultry, oils, butter, lard, shortening, spices, soy and dairy products, and fast-food) and first trimester urinary phthalate metabolite levels in a multicenter cohort of 283 pregnant women from Minnesota, New York, Washington, and California participating in The Infant Development Environmental Study (TIDES). Additionally, we examined whether reported use of environmentally friendly products and consumption of chemical free diets was associated with reduced urinary phthalate concentrations compared with not following these practices. We adjusted all analyses for maternal age, BMI, race, education, and study center.

Results: Soy intake was found to be associated with increased levels of log monobutyl phthalate (MBP) (β=0.05; 0.01, 0.08), the sum of log dibutyl phthalate (DBP) metabolites (β = 0.05; 0.01, 0.09) and the sum of log benzylbutyl phthalate (BzBP) metabolites (β = 0.04; 0.01, 0.07). Consumption of dairy was associated with decreased levels of the sum of log di-2-ethylhexyl phthalate (DEHP) metabolites (β = -0.018; -0.032, -0.004). No statistically significant associations were found between environmentally-friendly consumption practices and reduced urinary phthalate metabolite concentrations.

Conclusions: These results suggest that soy products may be a significant dietary source of some phthalates. It is possible that dairy was associated with decreased levels of phthalate metabolites in this study population because we were unable to differentiate between women consuming dairy products containing low concentrations of DEHP phthalates (yogurt, skim milk) versus higher concentrations of DEHP phthalates (cream, cheese, whole milk).
Characterization of Traffic-Related Air Pollutants Near a Major Roadway in Albuquerque Using a Mobile Monitoring Approach

Lyndsey Banks
Occupational and Environmental Exposure Sciences, MS
Preceptor: Christopher Simpson

Objectives: This particular study is a sub-component of a larger Center for Clean Air Research (CCAR) exposure mapping project with an overreaching aim of characterizing gases and particles near roadways, in multiple cities, for future exposure assessment in health effect studies. The overall objective of this specific study is, therefore, to characterize the spatial gradients of ‘non-reactive’ and ‘reactive’ vehicle emitted pollutant species near major roadways through the use of mobile monitoring techniques.

Methods: In order to assess the characteristics of air pollutants in proximity to roadways, a mobile monitoring campaign took place using an instrument platform designed to measure concentrations of particles and gases while continuously on the move. The platform followed a predetermined route in Albuquerque, New Mexico, over seven sequential days in April, 2012 during the evening commute timeframe. A series of roads, parallel to each other and Interstate 40, and beginning approximately 5-10m from the interstate, were traversed at least two times per observation day in an effort to tease-out the aging phenomenon. Metrics obtained during the monitoring campaign include: light scattering coefficients, light absorption coefficients, particle-bound polycyclic aromatic hydrocarbons (PAHs), particle optical diameters, particle number concentrations, ozone (O3), nitrous oxide (NO), oxides of nitrogen (NOx), carbon monoxide (CO), carbon dioxide (CO2), integrated volatile organic compounds (VOCs) and location.

Results: Spatially resolved measurements were obtained for several reactive gaseous species as well as non-reactive tracers of vehicle exhaust. CO2 and NOx show an expected decline with distance from roadway, indicative of the dispersion process, whilst O3/NOx ratio show an increase as a function of distance from roadway.

Conclusions: The innovative use of mobile monitoring allows for improved estimates of near-roadway gradients in air pollution, when compared with traditional stationary site sampling. Spatially resolved measurements allow for additional insight into the traffic-related pollutant aging phenomena in the vicinity of major roadways.
Validation of Training Concepts for Effective Ventilation Control for Welding Fumes in Confined Spaces

Lea Duffin
Occupational and Environmental Exposure Sciences, MS
Preceptor: Noah Seixas

Over 13,000 shipyard welders in the United States are subjected to hazardous welding fumes in confined spaces with inadequate or no ventilation. The purpose of this study was to validate a training provided to shipyard workers on overall ventilation effectiveness, particularly in the dynamic shipyard environment. Training was developed using general ventilation concepts and adapting them to be used in the shipyard. Training concepts included proximity of the exhaust ventilation to the welder, creating crossdrafts, and providing mixing in the space. Testing of ventilation in dynamic work environments (such as shipyard confined spaces) is difficult and rarely conducted. However, this study tested the training concepts in the field by taking particulate concentration measurements before and after ventilation was introduced into the space. We found that adding an exhaust or supply blower resulted in a decrease in particulate concentration in the space and breathing zone, but providing a crossdraft at the welder’s breathing zone did not produce a decrease in particulate concentration. The training concepts developed for shipyard welders do provide control and protection from welding fumes in the shipyard confined spaces.
Evaluation of Anti-Vibration Gloves in a Manufacturing Setting

Andrew Forbes
Occupational and Environmental Exposure Sciences, MS
Preceptor: Peter Johnson

While anti-vibration gloves are widespread as a form of reducing employee exposure to hand-arm vibration (HAV) there is concern about how effective they actually are in a real manufacturing environment with specific tools. Currently ISO 10819 is used to certify gloves as “anti-vibration”; however, the standard only tests a static position and force which may not accurately represent a glove's ability to reduce vibration exposure during specific tasks. The aims of this study are to examine 4 different types of gloves and see how effective they are at reducing vibration exposure in employees doing a specific workplace task. A jitterbug style sander was mounted with a tri-axial accelerometer while the subject had another tri-axial accelerometer attached to the back of their hand and both were connected to the same data logger so that simultaneous measurements could be taken. In a randomly assigned order the subject used each of the gloves to take one minute samples from sanding both a vertical and a horizontal surface. The same was done for a barehanded measurement where the subject used no glove, also randomly assigned in the order. A ratio from the tool and hand samples was found for each glove to find the transmissibility factor. The glove transmissibility factors were then compared to that subject’s bare hand sample to find the overall effectiveness of the glove. This method may allow for a better evaluation of whether anti-vibration gloves are an effective means of reducing exposure for specific tasks.
Evaluating Whole Body Vibration and Standing Balance In Truck Drivers

Molly Halverson
Occupational and Environmental Exposure Sciences, MS
Preceptor: Peter Johnson

Background: Exposure to occupational whole body vibration (WBV) has been shown to negatively affect balance and may contribute to falls. Over 60% of fatal fall-related occupational injuries occur in the long haul freight trucking industry. Fall-related injuries are eight times more likely to occur upon descending the vehicle than ascending. We hypothesize that WBV has a detrimental effect on postural stability upon truck egress and may be a contributing factor to falls when truck drivers egress their truck.

Methodology: A three-dimensional vibrating platform (hexapod system) will be used to expose eighteen truck drivers to two hours of simulated driving with exposure to field-collected WBV from the floor of a truck cab. The hexapod system will provide an accurate and systematic method to simulate these vibrational exposures for the purpose of investigating balance changes with prolonged exposure to WBV.

Using a repeated measures design, the truck drivers will participate in two exposure conditions: 1) sitting in an active-suspension anti-vibrational seat, and 2) sitting in a standard air-suspension truck seat. Seat order will be randomized and counterbalanced. Immediately before exposure to WBV and after two hours of exposure, participants will be asked to stand on a Wii balance board under two conditions for 15 seconds, with the eyes closed and with the eyes open. During this 15 second period, standing balance center of pressure (COP) deviations will be measured. In addition, the Mini-BEST test, a qualitative clinical balance assessment tool, will be performed to complement the quantitative force plate measurements.

Analysis: The association between exposure to WBV and postural instability will be assessed pre- and post- WBV exposure, and between the two seat conditions. Relative to the air-suspension seat, we anticipate that subjects’ WBV exposure will be roughly 50% lower with the active suspension seat. Postural measurements of interest for the COP deviations will focus on medio-lateral (ML) path length, anterior-posterior (AP) path length, and total path length. Secondary variables include the standard deviation and RMS of the AP and ML components, and sway velocity. The area of the COP will also be fitted to an ellipse to characterize and evaluate major and minor sway axis lengths. Other variables of interest include eyes open/closed to assess the ocular component of vibration-induced imbalance.
PPE Effectiveness in Agricultural Settings

Abigail Sutphen
Occupational and Environmental Exposure Sciences, MS
Preceptor: Michael Yost

Although pesticides are known to be harmful to humans, the use of pesticides in agricultural settings is highly accepted. Personal Protective Equipment (PPE) is usually required, but how effective it actually is against pesticide exposure is unknown. There have been some studies on this in laboratory settings, but no other studies that are in the field, getting a more accurate estimate of whether or not there is pesticide breakthrough and when the breakthrough occurs. Therefore, the current PPE used during the application of pesticides where agricultural workers are concerned will be evaluated. The PPE focused on in this study is OV Respirator cartridges with R95 Pre-filters and 15 mil reusable nitrile gloves.

Specific Aims:

To create sampling trains that can be used to simulate respirator use, and to evaluate a respirator cartridge and filter combination to determine its’ effectiveness.

To determine whether nitrile gloves provided adequate protection against dermal exposure to agricultural oil.

To share the results of this study.

As this is a pilot study, it therefore had some problems out in the field and has a relatively small sample size. However, the methodology is original, and could lead to or be used in future studies.

Respirators

An ambient and a cartridge sampling train were created to test the effectiveness of the respirator cartridges that are worn. Charcoal tubes were used as media for the ambient sampling train and charcoal cloth in 37 mm cassettes was used as media for the cartridge sampling train. Pumps were attached at the end of both sampling trains, which simulated the breathing rate of a tractor driver, which is 8 L/min. The sampling train with the cartridge ran at 8 L/min, and the in order to match the face velocity the ambient sampling train ran at 1.037 L/min. Both sampling trains were fastened to the back of a tractor for an 8 hour shift.

Gloves
Charcoal patches were placed on the inside of reusable nitrile gloves; one on the palm side and one on the back side of the hand. These gloves were worn by tractor drivers for 8 hours to determine if the gloves are thick enough to protect against solvents and oils.
Toxicokinetics of Domoic Acid (DA) in Pregnant and Non-pregnant Mice After Repeated Oral Administrations

Julie Park
Toxicology, MS
Preceptor: Elaine Faustman

Domoic acid (DA), a toxin produced by harmful algal blooms of Pseudo Nitzschia, has been associated with significant neurotoxicity in human, non-human primates, rodents, and marine mammals. Consumption of contaminated seafood is therefore of potential concern. Exposure of pregnant women to DA is of concern as this could affect the neurodevelopment of a developing fetus. Developmental exposures are believed to result in brain alterations and behavioral disturbances that may persist into adulthood. Oral administration was used for this study because it was the most relevant route to human exposures. After repeated oral administrations of DA doses of 1, 3, 5, or 15 mg/kg/day to pregnant and non-pregnant C57BL/6 mice for 8 days (from gestational days 10 to 17), toxicokinetic data was generated. DA concentrations were quantified in plasma and amniotic fluid (limit of quantification (LOQ) of 0.5 ng/mL) and fetal brain (LOQ of 0.25 ng/g tissue equivalents) using LC–MS by multiple reaction monitoring. In non-pregnant mice, 5 and 15 mg/kg DA caused neurotoxicity and mortality. The highest DA plasma concentrations found at 1, 3, 5, and 15 mg/kg treated mice were 6, 19, 34 and 166 ng/mL, respectively. Pregnant mice received daily DA dosages of only 1 or 3 mg/kg, and they showed no clear toxicity-related effects. The plasma concentrations in dams were about 50% higher than those in non-pregnant animals at equivalent dose levels after exposure. DA levels remained highest in maternal plasma; amniotic fluid, fetal plasma, and fetal brain had similar DA levels. Pregnant and non-pregnant animals had a half-life of about 4 hours in plasma. In contrast, DA was retained in the fetal brain. These toxicokinetic data provide informative results in terms of link exposure and health impacts associated with chronic low-level DA exposure during pregnancy.
Longitudinal Approaches for Metagenomic Characterization of the Puget Sound for Environmental Health Surveillance

Jessica Youngblood  
Toxicology, MS  
Preceptors: Elaine Faustman

The marine environment is the largest, most diverse and influential ecosystem on Earth. Still largely unexplored, the foundation for further ocean exploration begins with the most abundant and productive life forms in the ocean, the microbial communities. Microbes are essential to all life and play an intimate role in ecosystem function and environmental health. Microbial diversity and community function are important metrics that can be used to monitor and predict environmental changes. Standard lab techniques used for environmental microbial assessment are limited in scope and high-throughput, comprehensive approaches should be endorsed to appropriately estimate and monitor microbial diversity. Metagenomic profiling offers a sensitive approach to evaluate intact community genomes for the novel detection and characterization of microbial populations. Its gene-based, population level surveillance provides advanced insight into uncultured organisms broadening our understanding of microbial environments, community compositions and functional potential. In addition to ecological relevance, metagenomic surveillance creates translational research opportunities for monitoring environmentally hosted human health determinants. The objective of this study was to further define the Puget Sound metagenome by more effectively addressing coastal areas and their environmental signals of human impact and environmental health relevance. This is the second metagenomic study of the Puget Sound, and includes the addition and characterization of seven metagenomes, comprising a total of 14 samples from 10 different locations including a proximal wastewater treatment plant that discharges effluent into the Puget Sound. This longitudinal study uses 454 next generation sequencing, field metadata, and bioinformatic analysis to profile the surface water bacterial communities of the Puget Sound, both temporally and spatially, to characterize community composition, functional potential, and probable human health determinants. Our results revealed the high reproducibility and discriminatory capabilities of metagenomic profiling. Repeat samples taken approximately a year apart exhibited highly similar composition, while repeat samples taken during different seasons displayed considerable compositional differences suggesting that environmental conditions influence taxonomic relative abundance. Comparative analysis of all metagenomes exposed significant differences in both microbial diversity and human health determinants across a gradient of anthropogenic impact. These results demonstrate our improved characterization of the Puget Sound, as well as the future applications and significance of metagenomic analyses in environmental health monitoring and surveillance.
Evaluating the Duwamish River Cleanup Health Impact Assessment

Jonathan Childers
Environmental and Occupational Health, MPH
Preceptor: William Daniell

Since the 1800s, activities have polluted the Lower Duwamish River, which serves the needs of a mixed industrial and residential area in Seattle and King County, WA. Accordingly, in 2001-2002, the U.S. Environmental Protection Agency (EPA) and Washington’s Department of Ecology listed the Lower Duwamish Waterway as a priority site for cleanup under the federal Superfund law and Washington’s Model Toxics Control Act. In February 2013, the EPA released its Proposed Plan for cleanup of the Duwamish Superfund Site.

The University of Washington, the Duwamish River Cleanup Coalition/Technical Advisory Group, and Just Health Action received a grant from the Health Impact Project (a collaboration of the Pew Charitable Trusts and the Robert Wood Johnson Foundation) to conduct the Duwamish River Cleanup Health Impact Assessment (HIA). Guided by extensive stakeholder involvement, the HIA will address the Cleanup’s unintended and under-studied health effects, and make recommendations to improve outcomes, for four key groups: residential communities; Tribes; non-tribal fishers; and workers in Duwamish Valley industries.

In June 2013, the HIA Final Report will be submitted as an official public comment on the EPA’s Proposed Plan. To understand how the HIA affects the Cleanup plans, the proposed research will evaluate the impact of the HIA as perceived by decision-makers and stakeholders. Semi-structured key informant interviews and focus group discussions will collect perspectival input regarding the process and effect of the HIA. Qualitative analysis of the data will be conducted according to standard practices outlined in the social science literature.
Health Impact of Gentrification Spurred by the Duwamish River Superfund Cleanup

Jonathan Childers
Environmental and Occupational Health, MPH
Preceptor: William Daniell

The Duwamish River serves the needs of a mixed industrial and residential area in Seattle and King County, WA. Past and present activities have contaminated the shoreline, sediments and resident fish and shellfish. Due to health risks from exposure to this contamination, in 2001-2002, the U.S. Environmental Protection Agency (EPA) and the Washington Department of Ecology listed the Lower Duwamish Waterway as a priority site for cleanup under the federal Superfund law and Washington’s Model Toxics Control Act. Given its environmental, social, cultural and economic implications, the Lower Duwamish Superfund Cleanup may result in a variety of unintended health consequences. The University of Washington, in collaboration with the Duwamish River Cleanup Coalition/Technical Advisory Group (DRCC/TAG) and Just Health Action, received funding from the Health Impact Project (a collaboration of The Pew Charitable Trusts and the Robert Wood Johnson Foundation) to conduct a Health Impact Assessment (HIA) of the EPA’s proposed Cleanup plan. One major portion of the HIA examined potential health impacts in two residential communities (Georgetown and South Park) from Cleanup-spurred reinvestment, revitalization, and gentrification. We found that gentrification is already underway in these communities, and the Cleanup could substantially worsen the related health risks for vulnerable populations. In collaboration with community advisors, we identified and prioritized tools for promoting more equitable revitalization and associated recommendations, to be submitted to the EPA and other agencies responsible for the Cleanup and its direct and indirect consequences.
A Community-Based Assessment of Subsistence Fishing in Seattle's Urban Waters

Amber Lenhart
Environmental and Occupational Health, MPH
Preceptor: William Daniell

In February 2013, the Environmental Protection Agency (EPA) released a proposed plan to clean up the Lower Duwamish Waterway (LDW) Superfund Site in Seattle, Washington. To address the potential unintended health impacts of the EPA’s cleanup plan on local residents, affected tribes, subsistence fishers, and workers in local industries, the University of Washington, in partnership with the Duwamish River Cleanup Coalition/Technical Advisory Group and Just Health Action, conducted a Health Impact Assessment. A variety of individuals rely on the LDW for subsistence fishing. Little is currently known about these subsistence fishers, and identifying their potential health impacts would be difficult without a clear picture of the culture, behaviors, and needs of this population. A community-based research project was conducted with local fishing communities to 1) characterize the diverse urban subsistence fishing population potentially affected by the LDW Superfund Site cleanup, and 2) identify alternative culturally-appropriate opportunities to discourage fishing (for resident fish and shellfish) on the Duwamish River while promoting safe and healthful fishing alternatives during and after the cleanup. Demographic surveys, semi-structured key informant interviews, and focus groups provided demographic data and qualitative information about reasons for fishing and reactions to possible alternatives to institutional control fishing advisories. Reasons for fishing and fish consumption identified from the key informant interviews and focus groups included participation in cultural and traditional activities; access to a low-cost source of vitamins and nutrients; and opportunities for recreation and exercise, relaxation and stress-relief, family time, and contact with nature. Reactions to alternatives to institutional controls were mixed, suggesting a need for innovative thinking about potential alternatives. The findings from this research project informed the recommendations of the health impact assessment of the EPA’s cleanup plan.
Many American Indian and Alaska Native communities face disproportionate burdens of health disparities, including increased respiratory and cardiovascular diseases. Indoor woodsmoke exposure from woodstove heating contributes to these disparities. Retrofits and improvements to woodstoves can help decrease potential exposure to these substances, but there are a number of barriers that prevent people from making changes. To assess tribal members’ perceptions of health outcomes associated with woodsmoke, current woodstove use practices, and potential barriers and facilitators to safer woodstove use, a novel woodsmoke health literacy survey was designed in partnership with Tribal Healthy Homes Northwest and the Tulalip Tribes. The survey is expected to be administered in approximately 30 homes in each of four tribal communities. Survey findings will inform a post-survey intervention in Fall 2013.
Implementation and Evaluation of a Polio Eradication Game for Increasing the Public's Interest in Global Health

Toluwalose Okitika
Environmental and Occupational Health, MPH
Preceptor: Judith Wasserheit

Background: Interactive games on global health challenges and solutions are a potential tool for increasing interest in global health. To test this hypothesis, we developed an interactive polio eradication game and evaluated its impact on increasing global health interest compared to providing information through exhibits.

Methods: The Polio Eradication (PE) game is a life-size human board game that simulates polio eradication efforts in Pakistan. Four players; a researcher, transportation expert, local operative, and physician, collaborate in the context of an outbreak to eradicate polio. Participants in the PE group (who played or watched the PE game) and the control group (who did not participate in the game but visited one-way global health educational exhibits) completed a survey on the impact of the intervention (PE game vs. exhibits) on their level of interest in global health activities. We used relative risk regression to examine the association of cofactors on the level of interest in global health.

Results: The PE game had 164 participants compared with 110 individuals in the control group. The game participants were younger (33% ≤19 years) than the control group (11% ≤19 years). Prior to playing the game, 34% of participants reported little or no knowledge about global health and 21% reported high levels of knowledge about global health. Of the game participants, 77% (N=116/164) reported that the game increased their level of interest in global health. Predictors for increased global health interest after game participation were: no previous global health knowledge (RR=1.28; 95% CI: 1.13, 1.45), not currently involved in Global Health (RR=1.41; 95% CI: 1.07, 1.85), and visiting Seattle (RR=1.25; 95% CI: 1.04, 1.51). Gender and age were not associated with a change in global health interest after participation in the PE game. There was a trend towards increased interest in global health among game participants compared to those who only visited other exhibits (RR=1.10; 95% CI: 0.94, 1.28).

Conclusion: The results suggest that a hands-on interactive game on global health challenges can prove effective for increasing the public's interest particularly among those with little previous knowledge of or involvement in global health activities. Such games have the potential to raise awareness about, and change public attitudes towards global health issues. They may also be particularly useful for engaging youths in public health activities.
The University of Washington Superfund Research Program Community Organization Capacity Needs Assessment

Toluwalose Okitika
Environmental and Occupational Health, MPH
Preceptor: Thomas Burbacher

The University of Washington Superfund Research Program (UW-SRP) maintains a continuous relationship with non-profit community organizations that work on environmental health issues in the EPA Region 10 states of Alaska, Idaho, Oregon and Washington. As part of the ongoing support for these organizations, the UW-SRP provided administrative support to help the organizations form the Northwest Toxics Community Coalition (NWTCC) in 2007. The goal of the coalition is to bring together different environmental health community organizations within EPA Region 10 to assist one another by sharing individual experiences, expertise and available resources. During the past year, the UW-SRP has worked with the NWTCC to develop a community organization capacity needs assessment in an attempt to document the individual experiences, expertise and available resources in the various organizations in the region.

Forty-nine community organizations were invited to participate in the capacity needs assessment. We used a structured self-administered online survey and a follow-up phone interview to gather information from the participating organizations. The online survey contained 31 questions related to various activities, approaches and goals that are common among these groups. Participants were asked to rank the 31 questions on a scale of 1-5 based on their importance for successful outcomes (1=waste of time to 5= essential) as well as rank how easy or difficult it is to accomplish (1=nearly impossible to accomplish to 5=easily accomplished). The online survey was followed by a confidential phone interview that used open-ended questions to explore in-depth information about each participating organization.

Preliminary results show that getting access to individuals with technical expertise to interpret scientific data related to environmental health issues of concern; developing a mission statement that reflects the needs of the community and the organization’s goals; and having an impact on agency decisions regarding environmental issues of concern, were ranked as the top three most important aspects of their work by 80%, 70% and 68% of the organizations respectively. However, only 32%, 64% and 8% of respondents thought these were easy or somewhat easy to accomplish. There were minimal variations among participants’ ranking scores across the nine categories suggesting that these organizations have similar experiences, expertise, resources and goals. Analysis of the qualitative data will help us to better investigate these trends. The results of this assessment should be useful both to these organizations and other stakeholders, particularly the agencies responsible for environmental cleanup, to explore avenues for improving agency-community organization relationships.
Spatial Modeling of Diesel Exhaust Markers in South Seattle

Jill Schulte
Environmental and Occupational Health, MPH
Preceptor: Joel Kaufman

Background: South Park and Georgetown, two of Seattle's most diverse and affordable neighborhoods, contain the primary commercial traffic corridors from the Port of Seattle to interstates and state highways. Community members have expressed concern about exposure to diesel exhaust emitted by the large number of commercial trucks that pass through their neighborhoods. The aim of this project was to model the spatial distribution of diesel exhaust markers at a fine scale across these neighborhoods using measurements from a high-density air sampling campaign.

Methods: Two-week average concentrations of 1-nitropyrene, a unique marker of diesel exhaust, were measured in summer and winter at 24 sites. Land-use regression models were built using spatial characteristics of sampling sites, including land use and road density. Mobile source emissions predictions from the CAL3QHCR dispersion model were included in spatial models. Black carbon concentrations measured by a mobile monitoring platform that drove through the neighborhoods were also included as model covariates.

Results: 1-nitropyrene concentrations ranged from 0.211 pg/m3 to 3.03 pg/m3 in summer and 0.861 pg/m3 to 5.71 pg/m3 in winter. The spatial model of log10 summer 1-nitropyrene concentrations had a cross-validated R2 of 0.730 and a cross-validated RMSE of 0.123 log10 pg/m3. No suitable spatial model of winter 1-nitropyrene was found due to low variability in measurement results.

Conclusions: A clear gradient of summer diesel exhaust concentrations was identified at a fine scale within the neighborhoods of South Park and Georgetown. Spatial features that can predict summer diesel exhaust concentrations include distance to railroad tracks, land use, dispersion model predictions and mobile monitoring results. The existence of this gradient suggests that in stagnant periods, the health and environmental impacts of diesel traffic are not evenly distributed across these neighborhoods. Residents hope to use these results to advocate for improved air quality in their communities.
Traffic Density and Environmental Equity in Housing: A Geographic Analysis in King County

Jill Schulte
Environmental and Occupational Health, MPH
Preceptor: Joel Kaufman

Background: A central goal of the King County Equity and Social Justice Initiative is to ensure environmental equity in housing conditions. Traffic density is a primary concern of this group, as the noise and ambient air pollution that accompany high traffic volumes are associated with adverse respiratory and cardiovascular health impacts. Previous research suggests that King County neighborhoods with higher traffic density also have higher levels of racial and ethnic diversity, lower household incomes and greater numbers of multi-family buildings. The purpose of this project is to create a quantitative metric of traffic density and examine the associations between traffic density and socioeconomic variables within King County.

Methods: Using geographic information systems (GIS), traffic density values across urban King County were calculated based on inverted distance to the county’s 8 major road classes, weighted for the typical traffic volumes on each class of road. These weighted distance values were aggregated into a single metric called weighted road density (WRD) score on a 0-to-100 scale. The associations between average WRD score by census tract and race/ethnicity, median household income and English proficiency were analyzed using simple linear regression.

Results: At the census tract level, a $10,000 increase in median household income in 2010 was associated with a 3.32 [2.56, 4.08] point decrease in WRD score (p<0.001). A 10 percentage point increase in percent who speak English “very well” was associated with a 7.30 [4.64, 9.95] point decrease in WRD score (p<0.001). A 10 percentage point increase in percent residents of color was associated with a 3.92 [2.72, 5.11] point increase in WRD score (p<0.001).

Conclusions: In urban King County, neighborhood-level socioeconomic status is a significant predictor of traffic density, indicating that traffic density and its health and environmental impacts are not equitably distributed among the county’s demographic groups. King County officials plan to use these findings to inform policy decisions around zoning, traffic management and service delivery in underserved neighborhoods.
Occupational Exposures to Vapors and Gases, Liver Attenuation and Insulin Resistance: The Multi-Ethnic Study of Atherosclerosis

John Linnett
Occupational and Environmental Medicine, MPH
Preceptor: Joel Kaufman

Occupational exposures to vapors and gases, especially organic solvents, have been associated with liver toxicity. At high levels of exposure, solvents—characteristically chlorinated solvents—can cause overt hepatotoxicity, but at lower concentrations they have been associated with fatty liver disease. Accumulation of fat in the liver reflects metabolic changes, similar to those seen in insulin resistance and type 2 diabetes mellitus. Organic solvents are widely used in a variety of occupational settings. Few community-based studies have assessed occupational exposures and their associations with fatty liver disease or insulin resistance.

This is the first large study to date to examine whether occupational exposure to solvents is associated with changes in liver fat or with insulin resistance.

We evaluated relationships between occupational exposures, fatty liver disease, and insulin resistance in working participants aged 45-64 in the Multi-Ethnic Study of Atherosclerosis (MESA). Occupational classes were characterized as having a Vapor and Gas (VG) exposure that was low, medium, or high through the use of a job-exposure matrix, and we used this measure as a surrogate for occupational solvent exposure. Extent of fatty liver changes was measured by CT scan assessment of liver attenuation. Insulin resistance was assessed by the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) via serum measurements of fasting insulin and glucose. We restricted our primary analyses to participants who drank less than 14 alcoholic beverages per week, and adjusted for age, sex, diabetes and adiposity.

A small, but not statistically significant, decrease in hepatic attenuation (consistent with increased fat accumulation in the liver) was seen with increasing VG exposure. We did not observe a significant change in insulin resistance associated with an increase in VG exposure. As in other studies, decreased liver attenuation was strongly associated with obesity, diabetes and with alcohol consumption.

Wendy Miklos
Occupational and Environmental Medicine, MPH
Preceptor: June Spector

Background: Hypertension is associated with substantial morbidity and mortality and is a modifiable risk factor for cardiovascular disease and diabetes mellitus. Occupation may also be associated with hypertension. Occupational and leisure time physical activity have also been shown to impact the prevalence of hypertension.

Purpose: The purpose of this study was to determine whether certain occupational groups were associated with higher hypertension awareness among workers in Washington State (WA) and to describe their level of both occupational and leisure time physical activity by occupation.

Methods: Using the Washington State Behavioral Risk Factor Surveillance System (BRFSS) survey data from 2003, 2005, 2007, and 2009, we estimated the prevalence of hypertension and the adjusted odds ratios of hypertension by occupational groups. We also reported prevalences of respondents’ levels of both occupational and leisure time physical activity by occupation.

Results: The prevalence of hypertension varied among occupational groups. The odds ratios of hypertension were substantially lower for the occupational groups that included mathematical and computer scientists [Adjusted Odds Ratio (AOR), 0.63; 95% Confidence Interval (CI), (0.44 to 0.89)], construction and construction trades [AOR, 0.65; 95% CI,(0.49 to 0.86)], and librarians, archivists, curators, social recreation, religious workers, writers, artists, entertainers, and athletes [AOR, 0.71; 95% CI, (0.57 to 0.90)] in comparison to executive, administrative, and managerial occupations. Occupational and leisure time physical activity had different odds ratios of hypertension depending upon the level of each respective type of physical activity.

Conclusion: Occupation is associated with hypertension awareness. Different levels of both occupational and leisure time physical activity have variable associations with hypertension awareness.
BEBTEH stands for Biostatistics, Epidemiologic and Bioinformatics Training in Environmental Health

The following abstracts are from PhD students whose research are funded by this training grant. The National Institute of Environmental Health Sciences federal training grant (ES015459) supports predoctoral and postdoctoral trainees from the Departments of Biostatistics, Environmental and Occupational Health Sciences, Epidemiology, and Genome Sciences who are pursuing quantitative training with environmental health science applications.
Interaction Between PD-Related Genes and Manganese Exposure inAstroglial-Mediated Mechanisms of Neurodegeneration

Travis Cook
Toxicology, PhD
Preceptors: David Eaton and Jing Zhang

Parkinsonism (PS) is a disabling neurological syndrome possessing symptoms similar to that of Parkinson disease (PD), including: bradykinesia, resting tremor, muscle rigidity, and postural instability. Factors contributing to disease development are poorly understood, but overall evidence implies a role of individual genetic makeup combined with exposure to environmental toxicants.

The SNCA gene is known to be of great importance in PD, as autosomally dominant mutations of it have been found to greatly enhance risk of developing the disease. Additionally, aggregates of its protein product alpha-synuclein are the major component of Lewy bodies, which are intracytoplasmic protein inclusions which serve as a pathologic hallmark of the disease. Despite the recognized importance of SNCA in PD, its biological function remains poorly understood.

A particular environmental agent of interest is manganese (Mn), an essential dietary nutrient of which excessive inhalation exposure has been long known to cause symptoms of PS commonly referred to as manganism. While the association between acute and chronic high-level Mn exposure and PS is well established, a potential role of lower-level chronic exposure in the development of idiopathic PD remains controversial, mainly because the pathology associated with high-level Mn exposure is not consistently seen in the substantia nigra pars compacta (SNpc). Recently, we have demonstrated that one of the major targets of Mn is astroglia, and astroglia without alpha-synuclein have demonstrated resistance to environmental toxicant-induced responses. Consequently, the studies described here are aimed at defining the mechanisms by which SNCA and Mn might interact to communicate in neurodegeneration that is ultimately responsible for clinical PS.
In Vitro Characterization of Rotenone and MPP+-Induced Dopaminergic Neuron Death

Anna Engstrom
Toxicology, PhD
Preceptors: Zhengui Xia

Parkinson’s disease (PD) is the second most common neurodegenerative disorder, and it is characterized by the selective degeneration of dopaminergic (DA) neurons in the substantia nigra pars compacta (SNpc). Epidemiological studies support an association between environmental exposure to pesticides, such as rotenone, and an increased risk of PD. Thus, rotenone and other known toxicants that induce selective DA neuron death and deplete striatal dopamine, such as 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP), are widely used to model sporadic PD in vitro and in vivo. Rotenone and the toxic metabolite of MPTP, MPP+, are thought to mediate toxicity via inhibition of complex I. While rotenone has other known cellular targets, including microtubule destabilization, other molecular targets for MPP+ have not been well characterized. Recent studies have found that complex I-inhibition, alone, is insufficient to cause MPP+-induced DA neuron death, suggesting that inherent, complex I-independent characteristics of DA neurons may make them more vulnerable to MPP+ toxicity. The goal of this study was to further characterize rotenone and MPP+-induced DA neuron death in vitro in order to better understand and identify alternative molecular mechanisms of toxicant-induced, selective DA neuron death. Primary midbrain cultures from embryonic day 14 (E14) mice treated with rotenone or MPP+ for 24 hours exhibited a significant dose-dependent loss of dopaminergic neurons, identified via tyrosine hydroxylase (TH+) and immunostaining. To test the hypothesis that rotenone and/or MPP+ cause microtubule destabilization, primary E14 rat midbrain cultures were treated with 5 or 10nM taxol (a microtubule-stabilizing drug) and rotenone or MPP+ for 24 hours to determine whether taxol could attenuate rotenone or MPP+-induced TH+ neuron death. Co-treatment of 10nM taxol and did not attenuate rotenone-induced TH+ neuron death, however, 2 hour pre-treatment with 5nM taxol significantly attenuated rotenone-induced TH+ neuron death. Results for MPP+ and taxol co-treatment are forthcoming, and together, these results will further our understanding of the underlying mechanisms of toxicant-induced DA neuron death.
Detecting On-Road Emission Sources in Mobile Monitoring Data: A Novel Approach to Thinking About Air Pollution

Jonathan Fintzi
Biostatistics, PhD
Preceptor: Lianne Sheppard

Measurements of air pollution collected by means of a mobile sampling platform allow us to learn about the multivariate pollutant profiles of broad classes of on-road emission sources. Our primary goal is to identify pollution signatures associated with various types of events, such as vehicle plumes from cars and trucks, observed in our sampling campaigns, and to estimate the contribution of these signatures to overall pollution patterns observed in the data. Furthermore, we map the intensity scores of event signatures with the aim of identifying hot spots corresponding to high intensity areas of on-road emissions. Preliminary principal components based analyses indicate that it is indeed possible to come up with multivariate profiles that correspond to physically identifiable events. However, the data exhibit complex short- and long-term spatial and temporal dependencies induced by a variety of factors such as changes in atmospheric mixing depth, secular trends in spatial heterogeneity, and local topographical features or traffic patterns. We detail an alternate proposal for modelling this data via multiresolution Gaussian processes, a framework for learning complex behaviors in time series data that has possible extensions with factor models. This is a novel approach to thinking about road-related emissions that has the potential to contribute to our understanding of the relationships between traffic patterns, road characteristics, and air pollution.
A Coherent Spatiotemporal Modeling Approach for Prediction of Multiple Air Pollutants in the Multi-Ethnic Study of Atherosclerosis and Air Pollution

Joshua Keller
Biostatistics, PhD
Preceptor: Lianne Sheppard

Epidemiological studies of the effects of air pollution in large cohorts, such as the Multi-Ethnic Study of Atherosclerosis and Air Pollution (MESA Air), require accurate estimates of air pollutant concentrations. Four air pollutants of interest are oxides of nitrogen (NOX), nitrogen dioxide (NO2), fine particulate matter (PM2.5), and black carbon (measured by light-absorption coefficient [LAC]). Measurements of these pollutants from the EPA provide lengthy time series in a small number of spatial locations, whereas measurements from MESA Air cover many locations in space but relatively few time points. A complex spatiotemporal statistical model has been developed to estimate long-term pollutant concentrations across space, but previous work has not applied this model to all pollutants in the same manner. We present a coherent approach for applying this statistical model to predict concentrations of NOX, NO2, PM2.5, and LAC in Baltimore, Chicago, Los Angeles, New York, St. Paul, and Winston-Salem.

Partial least squares regression is used to reduce the large number of available geographic covariates and temporal trends are estimated by singular value decomposition. Universal kriging is used to borrow information between spatial locations. Prediction accuracy is assessed for each pollutant and city via cross-validation R2. Fixed sites with long time series are assessed using leave-one-out cross-validation. Monitoring sites at subject homes, which generally have three or fewer measurements, are assessed using 10-fold cross-validation. Model performance is generally good for all pollutants and cities. For NOX, cross-validation R2 ranged from 0.46 to 0.93 at fixes sites and from 0.57 to 0.92 at home sites. For NO2, R2 ranged from 0.25 to 0.96 at fixed sites and from 0.52 to 0.90 at home sites. For PM2.5, R2 ranged from 0.48 to 0.90 at fixed sites and from 0.34 to 0.84 at home sites. For LAC, R2 ranged from 0.16 to 0.95 at fixed sites and from 0.44 to 0.78 at home sites.
Impact of Monitoring Network Design on Exposure Prediction and Health Effect Estimation in Air Pollution Epidemiology

Adel Lee
Biostatistics, Post Doctoral Student
Preceptor: Lianne Sheppard

When studying the association between air pollution and health outcomes, one usually has to rely on an existing monitoring network to predict the exposure levels for the health study participants. If the existing network was designed, for example, to sample areas with higher pollution levels more intensively, the network design may impact exposure predictions and ultimately the validity of the health effect estimate. Preferential sampling (PS) has been defined in the context of geostatistical modeling as dependence between the sampling locations and the process that describes the spatial structure in the data. The effect of PS has been illustrated in the literature most often by studying its impact on the fitted spatial model and the resulting prediction biases. In this work we show that PS also affects the variability of predictions at participant locations and the measurement error that results from using predictions in a second stage analysis on the association between the predicted values and some outcome. We design a simulation study based on national monitoring data from the US Environmental Protection Agency. A universal kriging model is used to predict exposures and linear regression to model the outcome. We find that PS can greatly affect the validity and reliability of the estimate of the regression parameter of interest. We identify conditions under which the universal kriging and linear regression model are most susceptible to the adverse effects of PS.
Assessment of Cadmium Exposure: Urine Measures and Dietary Estimation in the Women’s Health Initiative

Sabah Quraishi
Epidemiology, PhD
Preceptor: Polly Newcomb

Background: Cadmium is a persistent heavy metal that accumulates in the body over time. Primary sources of exposure in non-occupational settings are smoking and diet. Cadmium has been associated with a number of disease outcomes and is classified as a Group I carcinogen by IARC. Measurement of cadmium levels in the body is typically done using biological samples (urine or blood), or estimation from diet. The validity of cadmium exposure estimation from diet in a US population is unclear.

Aims: This study aims to: 1) assess the validity of diet to estimate cadmium exposure in comparison to measurement from urine in post-menopausal women; and 2) assess the individual correlates of cadmium estimated from diet and measured in urine.

Methods: An age-stratified sample of subjects from the Women’s Health Initiative Study who had urine samples and completed food frequency questionnaires were selected. Dietary estimates of cadmium were calculated by mapping FFQ data to FDA market basket cadmium quantifications. Urine measures were done using mass spectrometry. Adjustments by creatinine level were done to account for differences in urine concentration. Pearson correlations were calculated to assess the validity of diet to estimate cadmium exposure and to assess the individual correlates of dietary estimates and urine measurements.

Results: A total of 1,020 subjects were selected and available for analysis. The mean age of subjects was 63.4. In this sample, 565 were never smokers, 363 were former smokers and 92 were current smokers.

In all subjects, the R2 value between dietary estimates and the urine measurements of cadmium were null. Stratifying by smoking status did not improve results. To determine if these null results were due to differences in age distribution of the study population a partial correlation adjusting for age was conducted, which did not improve results.

Individual correlates associated with both dietary estimates and urine measures of cadmium were alcohol intake, fish consumption and red meat consumption. Of the covariates assessed, only food groups were associated with dietary estimates. Covariates that were associated with urine measures included age, smoking status, BMI, and age at menarche.

Conclusions: The correlation of the dietary estimate and the urine measurement of cadmium was poor. The correlates of dietary exposure were food groups, unsurprising since levels were estimated using the same food groups. The correlates of urine measures aligned with expected associations.

Using diet as an estimate for cadmium exposure in post-menopausal women may result in misclassification of exposure and attenuated risk estimates for disease.
Long-term Air Pollution Exposure and Measures of MR Cardiac Structure and Function

Michelle Ross
Biostatistics, PhD
Preceptor: Joel Kaufman

Background: Air pollution has been found to be associated with heart failure morbidity and mortality, however the mechanisms generating these associations are not fully understood. We assessed the longitudinal relation between long-term exposure to PM2.5, and NOx and important end-organ measures of alterations in cardiac function (left ventricular mass index (LVMI) and ejection fraction) in the Multi-Ethnic Study of Atherosclerosis, a multicenter study of adults without previous clinical cardiovascular disease.

Methods: A total of 3,742 eligible participants underwent cardiac magnetic resonance imaging at either exam 1 or exam 5 of the MESA study. A likelihood-based spatio-temporal model was used to predict the NOx and PM2.5 concentrations for each participant. Linear regression was used to model both LVMI and ejection fraction.

Results: After adjusting for age, gender, race/ethnicity, site, income, education, LDL and HDL cholesterol, lipid-lowering medication use, physical activity, current smoking and pack-year history of smoking, hours per week of second hand smoke exposure, diabetes status by fasting glucose criteria, use of diabetes medications, SES, there was no association between LVMI and exposure to NOx or PM2.5. Similarly, there was no association between ejection fraction and exposure to NOx or PM2.5 after adjusting for potential confounders.

Conclusions: While these preliminary analyses found no association between LVMI and exposure to NOx or PM2.5, or between ejection fraction and exposure to NOx or PM2.5 after adjusting for potential confounders, there are further analyses to be performed. These include effect modification analyses as well as sensitivity analyses involving omitted variables not observed to have strong relationships with the exposures. These analyses will allow us to paint a more complete picture of the association between long-term exposure to air pollution and important end-organ measures of alterations in cardiac function.
Phosphorylated Alpha-Synuclein in Human Cerebrospinal Fluid

Tessandra Stewart
Pathology, PhD
Preceptor: Jing Zhang

α-Synuclein (α-syn), a protein that is critical to the pathogenesis of Parkinson’s disease (PD), is lower in cerebrospinal fluid (CSF) of PD compared to control cases, although its role in disease progression is unknown. A phosphorylated form of α-syn, pS129, is involved in the disease pathology, but conflicting human and model organism studies have complicated interpretation of its role. We previously reported that CSF pS129 is higher in PD and correlated with PD severity, but the cross-sectional nature of the study precluded any inferences about its role in PD progression. We investigated longitudinal pS129 and total α-syn changes in CSF of 95 PD patients who participated in the DATATOP (depranyl and tocopherol antioxidative therapy for Parkinsonism) study. Over two years of follow-up, α-syn trended toward decreasing, while pS129 and the pS129/total α-syn ratio significantly increased (6.32±2.89, 95% CI 0.544-12.10, p=0.03; and 0.0388±0.0183, 95% CI 0.0023-0.0752, p=0.04, respectively) with disease progression. These results obtained in human CSF are vital to both clinical and research fields, as they lend insight to the natural course of this critical protein during PD, thereby establishing its roles in creation of appropriate PD models, as a target of therapeutic drugs, and for its potential as a biomarker for disease progression.
Traffic-Related Air Pollution Exposure and Adult Asthma in the Sister Study

Michael Young
Epidemiology, PhD
Preceptor: Joel Kaufman

Background: Previous epidemiologic research has suggested an association between air pollution exposure and adult incident asthma. However, there exists limited research specifically focusing on the effect of PM2.5 on asthma in adults.

Aims: A prospective analysis was performed to estimate the association between ambient air pollution exposures (NOx, PM2.5) and incident asthma and incident onset of respiratory symptoms.

Methods: The Sister Study is a national population-based cohort (n=50,884) of sisters of women with diagnosed breast cancer. Participants were asked questions about medical conditions at enrollment and again at follow-up, an average of 2.9 years later. Participant exposures were year 2006 annual average ambient PM2.5 and NOx concentrations estimated at participant baseline addresses using a national land-use regression kriging model. The primary outcome was incident self-reported doctor-diagnosed asthma at follow-up in individuals who were asthma-free at baseline. Secondary outcomes were new onset of wheeze or cough in individuals who did not report asthma, wheeze or cough at baseline. Logistic regression was used to assess the relationship between participant exposure and outcomes at follow-up. Models were adjusted for the following covariates based on a directed acyclic graph: age at baseline, race/ethnicity, educational attainment, BMI, occupational dust exposure, occupational vapor exposure, baseline smoking status, age first smoked, packs/day at baseline, smoking status between baseline and follow-up, childhood environmental tobacco smoke exposure, healthcare coverage, and dietary fiber consumption.

Results: The Sister Study cohort interquartile range (IQR) of estimated PM2.5 and NO2 were 3.5 µg/m3 and 5.8 ppb respectively. The adjusted OR of incident asthma for PM2.5 was 1.20 (95% CI: 0.99-1.45, p=0.069) for an IQR difference in estimated PM2.5 exposure. The adjusted OR of onset wheeze for PM2.5 was 1.13 (95% CI: 1.02-1.25, p=0.015) for an IQR difference in PM2.5 exposure. PM2.5 was not significantly associated with cough or the combined outcome of cough and wheeze. NO2 was not significantly associated with the either incident asthma or onset of wheeze and/or cough.

Conclusions: PM2.5 exposure may be a risk factor in the development of incident asthma or wheeze, the cardinal symptom of asthma, in adult women.