A29
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Silicone-based wristband passive samplers in the detection of firefighter occupational carcinogenic exposures

First responders (i.e., paramedics and firefighters) are exposed to hazardous chemicals in the conduct of their work duties such as Polycyclic Aromatic Hydrocarbons (PAHs). Linking mixed chemical exposures to health conditions (e.g., cancer) is difficult given the latency period of disease, the magnitude of the potential doses or interactions of carcinogenic compounds present while firefighting. To understand the relationship between environmental exposures and resulting toxicity, passive personal sampling devices (PSDs) have been used to monitor. In the present study, we 1) describe the type of chemical exposures encountered by firefighters in their work environment; 2) characterize and compare chemical exposures by work-shift activities (e.g., fire suppression, emergency medical services, hazmat) and 3) field test the use of silicone-based wristbands for monitoring chemical exposures in firefighters.

Methods: Twenty-four wristbands were deployed across various fire services throughout South Florida. Prior to deployment, bands were cleaned using a standardized cleaning protocol to remove contamination and optimize the surface for absorption. Wristbands were then packaged in air-tight bags to prevent contamination. Wristbands were worn on fire service personnel and collected at the end of a 24-hour work shift. Chemical contaminants were then extracted from the wristband and analyzed for PAHs—identified using the EPA IRIS, California Proposition 65, and IRAC datasets— using gas chromatography-mass spectrometry.

Results: The average number of chemicals found across all wristbands (n=24) was 23 with 4 categorized as carcinogenic to humans (i.e., Benzo[b]fluoranthene, Benzo[j]fluoranthene, Chrysene, and Naphthalene). All bands had at least one PAH present, specifically, 87.5% contained Benzo[b]fluoranthene (mean=5.23 ng/band), 50% contained Benzo[j]fluoranthene (mean=2.05 ng/band), 79.2% contained Chrysene (mean=9.55 ng/band), and 100% contained Napthalene (mean=176.53 ng/band). Actual types of exposure compounds is likely to be larger than the observed data as the group of PAHs detected was limited to three existing datasets.

Discussion: Silicone-based wristbands are feasible to use within the fire service to detect and characterize ambient hazardous chemical compounds. These personal self-samplers used during a 24-hour collection period identified various PAHs in the firefighter work environment. Objective measures of harmful chemical exposures in the fire service should be monitored with a comprehensive surveillance system that includes personal sampler devices.

PR06
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This abstract is also being presented as Poster A07.

North Carolina environmental quality is associated with distant/metastatic breast cancer: evidence for rural-urban disparities

Breast cancer is a complex and multifactorial disease, and there is increasing evidence of association between breast cancer incidence and environmental factors. This study sought to investigate the effects of cumulative environmental quality on aggressive breast cancer in North Carolina. We hypothesized that environmental quality plays a role in aggressive breast cancer incidence, and additionally that these effects vary by rural-urban context. The USEPA generates an environmental quality index (EQI), which contains county-level data on environmental quality across five domains – air, water, land, sociodemographic, and built. To address our hypothesis, we compared the odds of having distant/metastatic breast cancer versus ductal carcinoma in situ (DCIS) based on total and domain-specific EQI values, with cancer case information extracted from the North Carolina Central Cancer Registry (years 2009-2014) and based on staging criteria from the Surveillance, Epidemiology, and End Results Program (SEER). We used generalized estimating equation (GEE) models to generate odds ratios for having distant/metastatic breast cancer using DCIS patients as controls and quartiled EQI domain values, adjusting for individual age, BMI, and smoking status. We also stratified patients into rural-urban categories based on their county at diagnosis, representing more urbanized to more thinly populated areas. Each EQI domain is composed of several individual environmental factors, so we then investigated which of these individual factors were driving domain specific effects. Results show that there is an effect of environmental quality on distant/metastatic breast cancer. For example, patients residing in a county with the worst land environmental quality were 5% more likely to have distant/metastatic breast cancer than DCIS (OR 1.05, 95% CI 1.01-1.09, p=0.0063). This effect was stronger in more rural areas. Within the land domain, higher use of agricultural chemicals such as herbicides and insecticides had effects on increased distant/metastatic breast cancer incidence in more urban areas, whereas the number of animal facilities had a large effect in more rural areas. Additionally, patients residing in a county with the worst sociodemographic environmental quality were 6% more likely to have distant/metastatic breast cancer than DCIS (OR 1.06, 95% CI 1.02-1.09, p=0.0006), which was consistent across rural/urban areas. Within the sociodemographic domain, higher income and higher household value decreased odds of having distant/metastatic breast cancer regardless of whether the area was rural or urban. In conclusion, we have shown that cumulative environmental quality is associated with distant/metastatic breast cancer, and that these effects can differ by rural-urban area. This is relevant for further studies of environmental exposures associated with aggressive breast cancers.

PR07
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This abstract is also being presented as Poster A31.

Latent Class Analysis of Multi-Pollutant Exposure

Recent work suggests that air pollutants, toxic chemicals, and other environmental exposures negatively impact health in a synergistic way. In order to measure and understand this impact, we propose a latent class mixture model of multi-pollutant exposure. Our model incorporates the joint behaviour of individual pollutants that inform overall exposure levels and provides clear measures of multi-pollutant exposure. We identify low, medium and high levels of joint exposure to volatile organic compounds (VOC), particulate matter (PM) and heavy metals (HM), and present estimated class-membership for each census tract in the US (>76,000). We use publicly available data from the EPA, including the National Air Toxics Assessment (NATA), measured at the census tract level. Model results indicate that mixtures of 5 levels of VOC, 2 levels of PM, and 4 levels of HM best fit data at the national level. Twelve percent of U.S. census tracts are in the highest levels of all 3 categories of pollutants. While frequently observed in metropolitan areas, rural areas are sometimes detected at the highest levels, as well. Our next focus is to incorporate spatial correlations as well as linkages to our earlier latent model work on socio-economic status (SES). Taken together, these extensions can then be incorporated into a holistic, exposome modelling framework for estimating disparities in cancer survival.

PR04
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This abstract is also being presented as Poster A44.

Exposure-based assessment and economic valuation of adverse birth outcomes and cancer risk due to nitrate in United States drinking water

Background: Nitrate ingestion from drinking water has been associated with an increased risk of adverse birth outcomes as well as elevated risk of colorectal cancer and several other cancers. Yet, to date, no studies have attempted to quantify the health and economic impacts due to nitrate in drinking water in the United States.

Methods: This study presents a first-of-its-kind comprehensive assessment of nitrate exposure from drinking water for the entire United States population. This exposure assessment serves as the basis for our analysis of the annual nitrate-attributable disease cases in the United States and the associated economic losses due to medical costs and lost productivity. Additionally, through a meta-analysis of studies on drinking water nitrate and colorectal cancer, we examine the exposure-response relationship for nitrate and cancer risk.

Results: On the basis of national nitrate occurrence data and relative risk ratios reported in the epidemiology literature, we calculated that annually, 2,939 cases of very low birth weight, 1,725 cases of very preterm birth, and 41 cases of neural tube defects could be related to nitrate exposure from drinking water. For cancer risk, combining nitrate-specific risk estimates for colorectal, ovarian, thyroid, kidney, and bladder cancers results in a range of 2,300 to 12,594 annual nitrate-attributable cancer cases (mean: 6537 estimated cases). For medical expenditures alone, this burden of cancer corresponds to an annual economic cost of 250 million to 1.5 billion U.S. dollars, together with a potential 1.3 to 6.5 billion dollar impact due to lost productivity. With the meta-analysis of eight studies of drinking water nitrate and colorectal cancer, we observed a statistically significant positive association for nitrate exposure and colorectal cancer risk and calculated a one-in-one million cancer risk level of 0.14 mg/L nitrate in drinking water.

Conclusion: Health and economic analyses presented here suggest that lowering exposure to nitrate in drinking water could bring economic benefits by alleviating the impacts of nitrate-associated diseases.