CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
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Project Number
S1808

Project Title
Nasal Responses of Exposure to Ultrafine Iron Soot Particles in Mice

Abstract

Objectives/Goals
Respiratory and cardiovascular diseases are associated with ultrafine particles in air pollution from fuel combustion. Since iron is a transition metal that is predominant in air pollution, my research study examined mucin production, epithelium growth, and iron particle deposition in iron soot exposed mice. My research objective is to better understand the negative health effects caused by ultrafine particles.

Methods/Materials
Mice were exposed to ultrafine iron soot particles produced from a laminar diffusion flame system for 8 days, 6 hours each day, and mice nasal tissue was sectioned to 5 μm slices by Center for Health and the Environment staff. I stained these fixed mice nasal tissue and carbon nanotube exposed rat tissue with Alcian Blue Periodic Acid Schiff's for mucin and Perl's Prussian Blue for ferric iron. I then used light microscopy to capture images of nasal tissue based on grids identified within the nasal cavity. ImageJ software was used to measure mucin volume, epithelium volume, basal lamina area, and iron soot particle volume by thresholding the stained areas.

Results
My research found that in exposed mice, there was a statistically significant increase in mucin within grid 5 or the septal region of the nasal cavity (p-value=0.0348). In addition to a significant increase in total epithelium volume for the exposed mice (p-value=0.0393), there was also a significant increase in epithelium volume for grid 5 specifically (p-value=0.0336). No quantifiable amount of iron soot particles were found within the iron soot mice epithelium, but positive iron labeling was present in the olfactory nerve fascicles of the carbon nanotube exposed rats.

Conclusions/Discussion
My results indicate negative biological responses from short-term iron soot particle exposure. The significant increase in mucin and epithelium volume in grid 5 of the exposed group suggests a localized immune response due to a high impact region of the septum as well as inflammation within the nasal cavity. My findings also suggest selective uptake of iron by the nerve fascicles in the olfactory nerve layer, which could render our brain vulnerable to damage. From these findings, it can be better understood how the iron soot particles in particulate matter evoke negative health effects. Being one of the few studies on mice noses, my findings could potentially provide information useful to reducing the impact of pollution on our health.

Summary Statement
Short-term exposure to ultrafine iron soot particles causes negative health responses such as mucosal defense, inflammation, and the possible transport of particles to the brain.

Help Received
Research was conducted at the Center for Health and the Environment at UC Davis under the guidance of Dr. Kent Pinkerton and Laurie Hopkins. Carbon nanotube exposed rat nasal tissue was donated by Dr. Gunter Oberdörster at University of Rochester. Ms. Alonzo helped with science fair supervision.