Co-Exposure to Manganese and Lead has a greater negative impact on child IQ than singular exposures
We studied the impact of joint exposure to manganese and lead on intelligence quotient (IQ) scores in school-aged children from East Liverpool, Ohio. The negative effect of blood lead on IQ was more pronounced at higher levels of hair and toenail manganese. Our findings suggest that joint exposure to manganese and lead may produce heightened neurocognitive impacts even at blood lead levels below the CDC reference concentration of 5 µg/dL.

The Marietta area population was at times exposed to manganese levels that exceeded US EPA guidelines.
In this study, the US Environmental Protection Agency (EPA) air quality dispersion model (AERMOD) was used to estimate ambient air manganese levels near the refinery in Marietta, Ohio for the years 2008-2013. From 12,000-56,000 individuals, including over 2,000 children aged 0-14 years, were exposed to respirable annual average ambient air manganese levels exceeding 50 ng/m³ in five of the six years. The study shows that AERMOD modeling of ambient air Mn is a viable method for estimating exposure from refinery emissions and that the Marietta area population was at times exposed to Mn levels that exceeded US EPA guidelines.

Manganese Exposure and Neurologic Outcomes in Adult Populations
A current review of the literature that resulted in the following conclusions: Manganese exposure is associated with cognitive and motor impairments in both occupational and community settings. Current studies utilize a variety of novel biomarkers to represent manganese exposure. Neuroimaging is an innovate tool to characterize manganese exposure within the brain and assess neurological outcomes. Elderly populations provide insight into the impacts of chronic manganese exposure and the role of manganese in the development and progression of neurodegenerative diseases.

Impact of air manganese on child neurodevelopment in East Liverpool, Ohio
Children 7-9 years of age from East Liverpool and its surrounding communities were enrolled the CARES study between March 2013-June 2014. Blood and hair were analyzed for manganese and lead, and serum was analyzed for cotinine, a marker of environmental tobacco smoke exposure. Hair manganese was negatively associated with child IQ scores.
**Manganese in household dust related to manganese levels in children's hair.**
A model evaluated routes of manganese ambient air exposure. Manganese found in household dust was a significant contributor to manganese found in children's hair. Factors that contributed significantly to manganese in household dust were annual ambient manganese concentration, time the child spent outside, and manganese concentration in the soil.


**Review: Most research on manganese exposure indicates negative effects on cognition.**
This review of 27 publications regarding the relationship between Mn exposure and cognitive outcomes across the lifespan: early life, school-aged children, and adulthood. Included were 12 pediatric studies, 5 occupational studies and 10 adult environmental studies. The majority of these studies provided evidence of the negative effects of Mn exposure on cognition.


**Computer modeling of ambient air manganese is a viable alternative to sampling.**
The US Environmental Protection Agency’s Air Dispersion Model AERMOD was used to develop ambient air manganese concentrations based on emissions from a ferromanganese factory. The modeled results were compared to measured stationary and personal air sampling and found to represent a suitable alternative.


**Academic-Community partnerships are effective in the conduct of environmental health research.**
An academic-community research partnership was formed in East Liverpool, Ohio to address community concern about manganese exposure, particularly among children. Children and their families were recruited to participate in a pilot study and community member assisted in the development of data disclosure strategies. The partnership proved valuable to researchers and community members.

Manganese exposure - at both low and high levels- had a negative impact on child IQ.
Over 400 children ages 7-9 from Marietta and Cambridge, Ohio provided blood and hair samples and completed testing to measure their intellectual ability. Both high and low levels of manganese in blood and hair were associated with decreases in child IQ scores. Serum cotinine (an indicator that the child has been exposed to nicotine through second hand smoke) was also associated with declines in child mental function.


Secondhand tobacco smoke exposure negatively affected children’s ability to coordinate movements.
Over 400 children ages 7-9 from Marietta and Cambridge, Ohio completed testing regarding some of their physical abilities. Exposure to secondhand tobacco smoke was measured by levels of cotinine, an indicator that the child has been exposed to nicotine through second hand smoke. Higher levels of cotinine were associated with reduced abilities in children’s eye-hand coordination, control of small movements, balance, and strength.


Children with higher manganese exposure had poorer balance.
A group of 55 children who were part of CARES from Marietta completed balance testing. Poorer balance was found with living closer to the ferromanganese refinery, having higher levels of manganese in hair or blood, and having elevated levels of lead in blood.


Children living and attending school nearer the manganese refinery had higher levels of manganese in their personal air samples.
A group of 38 children who participated in CARES from Marietta wore personal air monitors for two days. These children and their families recorded the child's location during the two-day sampling period. Residential and school distance from the ferromanganese refinery (weighted by time spent at each) was associated with levels of manganese in children's air.

Community-based participatory research (CBPR) principles are useful in developing academic-community partnerships.

This publication documents the formation of an academic-community partnership based on community-based participatory research (CBPR) principles. Marietta, Ohio is an Appalachian-American community with a desire to understand the impact of manganese on the cognition and behavior of their children. We formed a community advisory board (CAB), jointly conducted pilot research studies, and used the results to develop a community-driven research agenda.


Disposable computer chip has potential in monitoring heavy metals in blood.

This paper describes development of a lab-on-a-chip sensor for electrochemical detection of highly electronegative heavy metals such as manganese and zinc. The results were favorable and with further development, this sensor would provide reliable and sensitive detection of manganese in the blood for point-of-care monitoring.


Manganese in hair associated with manganese levels in ambient air.

A pilot study was conducted in Marietta, Ohio, home to one of the largest airborne manganese emission sources in the United States, a ferromanganese refinery, to assess residents’ exposure to manganese in the air and its relationship to manganese in hair and blood. 141 residents participated and the relationship between hair manganese and estimated ambient air manganese become significant when genes for iron metabolism were included in linear models.


Pilot test suggests slight impairment in postural balance among those chronically exposed to manganese in air.

A pilot study was conducted among Appalachian Ohio community members exposed chronically to elevated levels of manganese via a nearby ferromanganese refinery. 29 residents aged 19 to 68 provided blood and hair samples and were tested for postural balance. A significantly positive association was found between manganese levels in hair and postural balance (sway area and sway length).