EPA
www.epa.gov/research
science in ACTION
INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

Children's Lead Exposure: Developing and Applying an Innovative Probabilistic Multimedia Modeling Approach



Problem

Events in Flint, Michigan and East Chicago in recent years have increased awareness that lead remains a public health issue in the United States.

According to the U.S. Centers for Disease Control and Prevention (CDC), there are at least four million U.S. households where children are exposed to high levels of lead in their home, and approximately half a million U.S. children ages 1-5 have blood lead levels above 5 micrograms per deciliter, the reference level at which CDC recommends public health actions be initiated. No safe blood lead level in children has been identified, according to the CDC.

Lead can be found in soil, house dust, drinking water, and air, as well as other sources such as food and consumer products. Since exposure to lead can occur via multiple media, it is critical to understand the contributions from different exposure pathways to better determine how to reduce exposure and blood lead levels. However, it is challenging to comprehensively estimate exposures, given population variability, data limitations and other factors.

Action

EPA scientists, in collaboration with colleagues from other Federal Agencies, conducted an innovative analysis for children's multimedia lead exposures at a national scale. They coupled two EPA computer models to determine the relationship between drinking water lead concentrations and blood lead levels in children, while taking into account multiple routes of exposure. EPA's Stochastic Human Exposure and Dose Simulation (SHEDS)-Multimedia Model was used to generate a range of predictions of lead exposure. It was then coupled with EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) Model to estimate childhood blood lead levels. Harnessing the strengths of these peer-reviewed and well-established tools enabled researchers to (1) consider the variability in blood lead levels across the U.S. population; (2) determine the relationship between daily average drinking water lead concentrations and blood lead levels for scenarios involving exposures to other media; and (3) determine relative contributions by media and exposure pathways to blood lead levels for different age groups and population percentiles.

Available data based on measurements collected in field studies or reported in published literature were used to model children's activity patterns, lead

concentrations, exposure factors, and biokinetic dose factors. To evaluate the SHEDS-IEUBK modeling approach, EPA researchers compared estimated children's blood lead levels to blood lead level observations from CDC's National Health and Nutrition Examination Survey (NHANES).

Results

Using this approach, the modeled blood lead level for young children was similar to observed blood lead levels from CDC NHANES. The analysis showed the relative importance of water ingestion for infants and soil/dust ingestion for toddlers in blood lead levels.

While the focus of this analysis was drinking water, the approach can also be applied more broadly. This work represents a significant advance in lead modeling and provides a strong scientific basis to guide national health-based benchmarks for lead. The results uniquely provide what the relative contributions of various media to blood lead levels are across all population percentiles, especially the higher percentiles, for the U.S. population. This methodology advances the understanding of what drives children's blood lead levels, and highlights the need for additional data, especially at local scales.

EPA is now seeking community-specific multimedia lead data that can be used with this modeling approach to identify areas of highest lead exposures and key factors that may contribute to those exposures.

Related Links

- Centers for Disease Control and Prevention: Lead www.cdc.gov/nceh/lead/
- EPA's Stochastic Human Exposure and Dose Simulation (SHEDS)-Multimedia Model www.epa.gov/chemical-research/stochastic-human-exposure-and-dose-simulation-sheds-estimate-human-exposure
- EPA's Integrated Exposure Uptake and Biokinetic (IEUBK) Model www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals
- CDC's National Health and Nutrition Examination Survey (NHANES). www.cdc.gov/nchs/nhanes/index.htm

References

Zartarian, V., Xue, J., Tornero-Velez, R., and Brown, J. 2017. Children's Lead Exposure: A Multimedia Modeling Analysis to Guide Public Health Decision-Making. *Environmental Health Perspectives.* https://doi.org/10.1289/EHP1605.

Contact

Valerie Zartarian, Ph.D.
EPA Office of Research and Development
617-918-1541
zartarian.valerie@epa.gov