Science and Science-Based Tools to Address Persistent Hazardous Exposures to Lead

Andrew M. Geller, PhD

Editor's Note: The National Environmental Health Association (NEHA) strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, NEHA has partnered with the Office of Research and Development (ORD) within the U.S. Environmental Protection Agency (U.S. EPA) to publish two columns a year in the *Journal*. ORD is the scientific research arm of U.S. EPA. ORD conducts the research for U.S. EPA that provides the foundation for credible decision making to safeguard human health and ecosystems from environmental pollutants.

In these columns, authors from ORD will share insights and information about the research being conducted on pressing environmental health issues. The conclusions in these columns are those of the author(s) and do not necessarily represent the official position of U.S. EPA.

Dr. Andrew Geller is the senior science advisor and executive lead for environmental justice and lead research at U.S. EPA ORD.

Actions by the U.S. Environmental Protection Agency (U.S. EPA) and other federal agencies have significantly reduced the use of lead in automotive gasoline, paint, lead-soldered food containers, and new water system components over the past 40 years. Through the collective effort of federal agencies in partnership with local, state, and tribal governments, blood lead levels (BLLs) measured in children have fallen steadily from the 1970s to the 2020s (Egan et al., 2021; President's Task Force, 2016). One indicator of the success of lead mitigation efforts is the Centers for Disease Control and Prevention's (CDC) reduction of the blood lead reference value (BLRV) from 5.0 to 3.5 µg/dL in October 2021 (Ruckart et al., 2021). The BLRV is a population-based measurement of the 97.5th percentile of BLLs of U.S. children ages 1–5 years. Reduction in the BLRV reflects the decline in BLLs among the children most exposed to lead in the U.S.

Despite this progress, lead exposure in children remains a significant public health concern. More than one half million children ages 1–5 years in the U.S. have detectable BLLs and an estimated 6–10 million lead service lines still connect homes to public drinking water systems (Cornwell et al., 2016). Racial disparities in childhood BLLs persist, with higher BLLs observed in non-Hispanic Black children as compared to non-Hispanic White children from 1999 to 2016 (Breysse et al., in press).

To address the remaining lead exposure issues in our country, U.S. EPA (2021) developed the draft *Strategy to Reduce Lead Exposures and Disparities in U.S. Communities* to set goals for an all-of-U.S. EPA and whole-of-U.S.-government plan to strengthen public health protections, promote environmental justice, and address legacy lead contamination for communities with the greatest exposures. Key components of this strategy hinge on the use of science-based approaches to identify lead exposure hotspots, determine site-specific cleanup levels, sequester lead in contaminated soil, identify drinking water lead service lines for replacement, optimize corrosion control for pipes and plumbing fixtures, and support the revisiting of lead rules and guidance in dust, soil, water, and air.

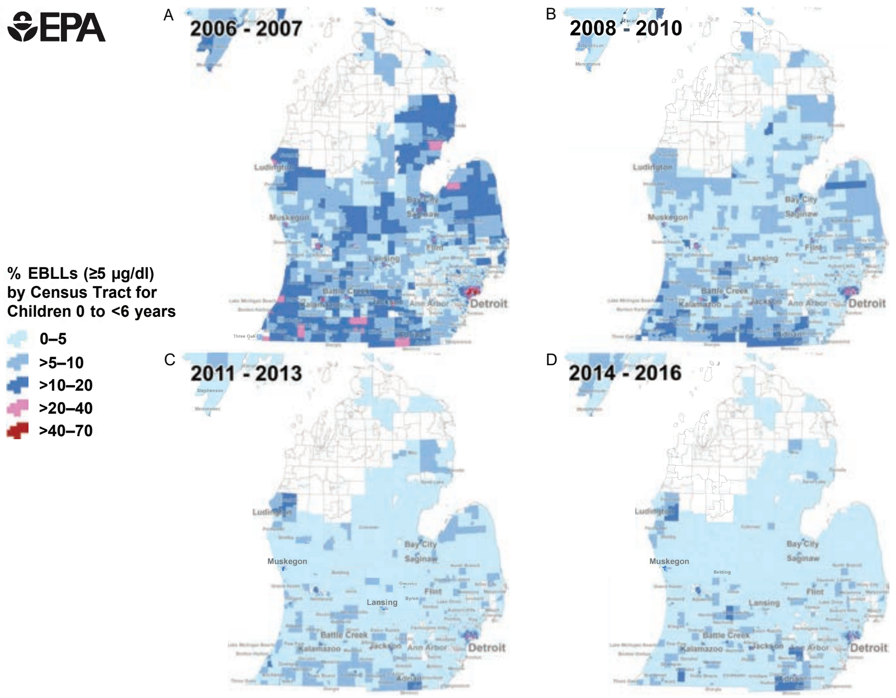
Identifying High Lead Exposure Locations

Public health professionals tasked with primary prevention must know where lead exposure problems remain and what the key sources of lead exposure are in those locations to proactively prevent and mitigate lead exposures and track where progress has been made in reducing lead exposure (Figure 1). U.S. EPA recently published methods for identifying lead exposure hotspots at the census tract level for targeting actions (Xue et al., 2022; Figure 1). For locations where there are BLL data, U.S. EPA developed two methods of identifying hotspots: 1) a top 20th percentile method identifying census tracts with the highest prevalence of elevated BLLs and 2) a geospatial cluster analysis method.

U.S. EPA also explored methods for using exposure-related lead indicators for locations lacking statistically robust and representative

FIGURE 1

Example of Mapping Locations With a High Prevalence of Elevated Blood Lead Levels (EBLLs)



Mapping locations with a high prevalence of EBLLs helps public health practitioners target remediation, outreach, and educational resources and provides a compelling way to visualize success in lead exposure reduction actions. Reproduced with author permission from Xue et al., 2022.

BLL data. These surrogate indicators are largely based on data from the U.S. Census and American Community Survey. For example, U.S. EPA's EJScreen Lead Paint Index (www.epa.gov/ejscreen) and a recent statistical model (Schultz et al., 2017) are based on housing age, race, and income variables. The U.S. Department of Housing and Urban Development's (HUD) Deteriorated Paint Index predicts risk based on pre-1980 homes with large areas of deteriorating paint based on microdata from the American Community Survey and the American Housing Survey (Garrison & Ashley, 2021).

U.S. EPA, HUD, and CDC recently collaborated on a state-of-science summary of publicly available methods, data, and maps for identifying lead hotspots in the U.S. The summary provides descriptions and references for currently available lead indices, BLL data, and environmental data. It also identifies environmental data gaps and data accessibility needs to improve our ability to identify these hotspots (Zartarian et al., in press).

Removing Lead From Drinking Water

The Lead and Copper Rule Revisions (U.S. EPA, 2022a) require water systems to establish service line (i.e., water supply lines to homes and businesses) inventories and proactively replace lead and galvanized service line pipes. U.S. EPA scientists in the Office of Research and Development (ORD) have developed noninvasive methods based on sampling tap water to help speed up identifying these pipes (Hensley et al., 2021; Lytle et al., 2018). In addition, ORD scientists provide technical support to states, consultants, and water system operators to help them reduce the release of lead from pipes and plumbing fixtures. The ORD Small Drinking Water Systems Webinar Series (www.epa.gov/water-research/small-drinking-water-systems-webinar-series) and Annual U.S. EPA Drinking Water Workshops provide state of the art training on lead service line identification, optimizing corrosion control, and evaluating the efficacy of point-of-use water filters (Doré et al., 2021; Harmon et al., 2022; Liggett et al., 2022; Schock et al., 2021). ORD also recently reviewed field analyzers used for rapidly quantifying lead in drinking water samples and provided recommendations for their use (Doré et al., 2020).

Remediating Lead in Soil

Contaminated soil remains a critical driver of elevated BLLs, especially for young children who are exposed by hand-to-mouth contact and by ingestion of dust and soil (Özkaynak et al., 2022; Zartarian et al., 2017). Remediating soil lead is associated with declines in BLLs in children (Klemick et al., 2020; Mielke et al., 2019; Ye et al., 2022), therefore understanding soil lead levels and various remediation approaches is critical for environmental health practitioners.

ORD has developed rapid and cheap methods to estimate how much lead at a particular site can be absorbed when ingested by people or taken up by plants (Bradham et al., 2016, 2017; Griggs et al., 2021; Misenheimer et al., 2018). The integrated biokinetic exposure and uptake model can be used by environmental professionals to estimate specific site cleanup levels (U.S. EPA, 2022b). ORD has also shown that the addition of soil amendments like phosphate can be used to form long-lasting insoluble mineral complexes that help to sequester the lead in the soil, and that new ways to lock up the lead in soil might help reduce removal cleanup efforts and costs (Bradham et al., 2018; Karna et al., 2020; Sowers et al., 2021).

Moving Onward

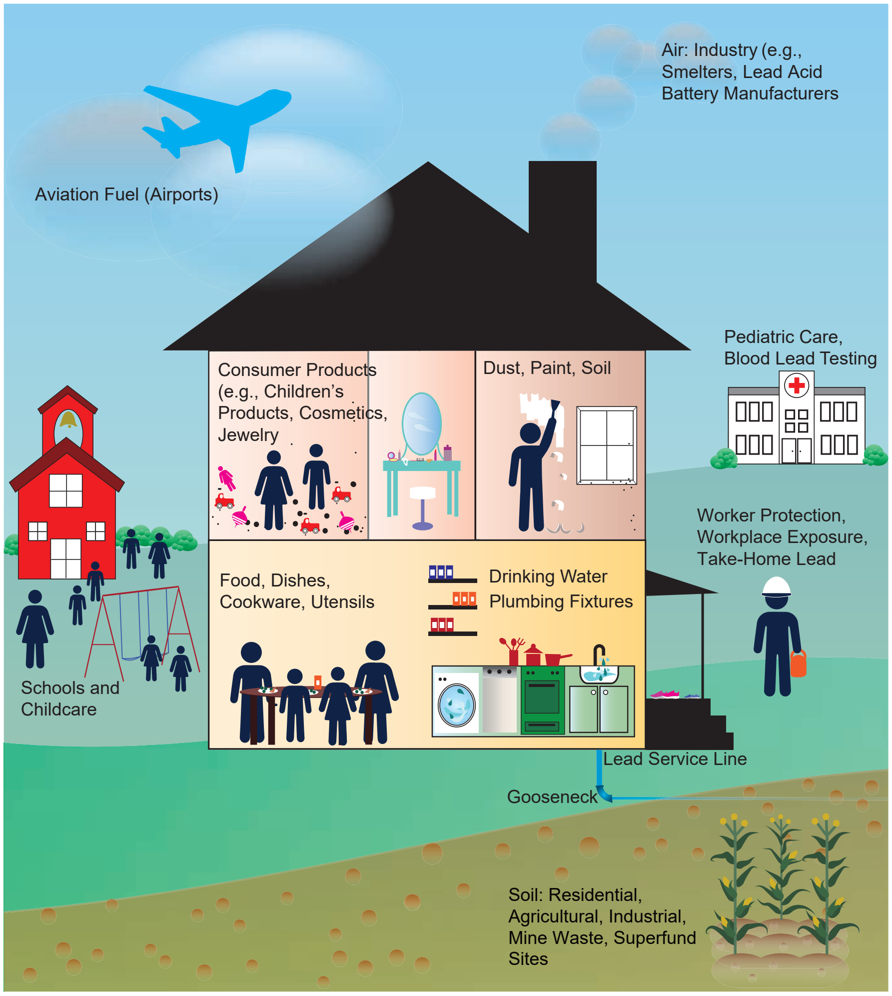
In many ways, lead is the opposite of emerging chemical contaminants—it is a well characterized developmental and adult toxicant that affects multiple human organ systems. Lead sources in the environment are also well known; one indicator of this understanding is the myriad laws and rules that regulate lead (President's Task Force, 2016). Yet repeatedly, it is the legacy chemical that draws our attention to public health emergencies in places (e.g., Flint, Michigan; Syracuse, New York; and East Chicago, Indiana) where exposure resulting from lead in drinking water, old housing, and contaminated soil still affects children and their families.

U.S. EPA is currently revisiting six different lead standards or guidance that affect lead levels in dust, soil, water, aviation fuel, and paint. For this multimedia contaminant, however, collaborations are critical to ensuring success. U.S. EPA and its fellow agencies are working to eliminate this preventable environmental health hazards (Breysse et al., 2022). We will continue to provide tools and data so environmental health practitioners at the local level can identify and remediate remaining environmental lead sources in the places where we live, work, learn, and play (Figure 2).

Corresponding Author: Andrew M Geller, Senior Science Advisor, Immediate Office of the Assistant Administrator, Office of Research and Development, U.S. Environmental Protection Agency, 109 TW Alexander Drive, Mail Code D305-01, Research Triangle Park, NC 27711.
Email: geller.andrew@epa.gov.

FIGURE **2**

Examples of Where Lead Is Present and Regulated Where We Live, Work, Learn, and Play



Science from the U.S. Environmental Protection Agency supports further regulation and remediation of lead levels in dust, soil, paint, water, and air. Reducing lead exposure in all these environments requires partnerships among federal, state, tribal, and local governments and community-based organizations.

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