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Perspectives on Childhood Lead Exposure Prevention: Looking Back and Looking Ahead

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Abstract

Lead's neurotoxic properties and potential harmful effects to humans, particularly young children, have been recognized for decades, influencing public health policies to reduce its admixture in house paint and passenger car gasoline. We signal 3 emergent trends: firearm proliferation, complex international food supply chains, and equally complex product marketing strategies, which have opened opportunities for lead exposure to children from guns and ammunition, and lead contamination in children's food and consumer goods. Readers will also be apprised of Childhood Lead Poisoning Prevention Program and education strategies cultivated and advanced by the Centers for Disease Control and Prevention and its lead prevention partners. A national governmental policy update is included, as are future considerations.

TRACKING THE EMERGING SOURCES OF LEAD

Lead is a naturally occurring metal, ubiquitous in the environment, and for centuries has been used in historic and current-day products and technologies. Its neurotoxic properties and potential harmful effects to humans, particularly young children, have been recognized for decades, influencing public health policies to reduce its admixture in consumer products such as house paint and passenger car gasoline.¹ As a result, the median blood lead levels (BLLs) of children ages 1–5 years from 1976 to 1980, which was measured at 15.2 mg/dL, had declined by 96% and leveled to 0.6 mg/dL in 2017–March 2020.^{2,3} Similar to many diseases and conditions, lead exposure is frequently socially and economically

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determined. Disparities in higher BLLs are observed among some resource-limited and some racial/ethnic minority children.^{2,4} Most experts agree that no level of lead exposure is without some health or behavioral consequences.³ Moreover, level of toxicity and harm may vary not only by route or dose of exposure, but also by the physiology, age, health status, and nutritional adequacy of the child.⁵ One thing is clear: the scientific evidence points to a panoply of neurologic, developmental, and behavioral harms associated with lead exposure among children 0–5 years of age. Low-dose chronic exposure may take the expression of hyperactivity or short attention span.⁶ Greater dose chronic exposure may result in developmental delays and at the highest levels of acute exposure, permanent brain damage, and even death are possible.⁶ Thus, as the Centers for Disease Control and Prevention (CDC) editors of this supplement, we employ a Janus-faced approach to lead exposure prevention in public health. Looking backward, we acknowledge the past policies of the 1970s–1990s in the United States, which eliminated major sources of lead exposure in house paint and in passenger car fuel.¹ These achievements demonstrate that effective governmental public health policy interventions can and do result in reduced morbidity and mortality. At the same time, we look forward to the emerging, complex new sources of lead that can be traced to (1) firearm use, (2) current food production and distributions strategies, and (3) consumer product marketing trends, all of which use current marketing technologies that aid in exposure proliferation. These trends are important contextual considerations that render lead exposure as a hidden public health problem unless there is a nationally prominent outbreak that is reported by traditional and social media. We describe 3 emerging sources of lead exposure.

A POTENTIAL SOURCE OF LEAD EXPOSURE LINKED TO FIREARM PROLIFERATION

First, the trend of gun ownership in the United States has grown steadily since the 1970s, and access to firearms and ammunition is a potential source of lead. According to a widely referenced report from Switzerland's Small Arms Survey, there are 120 guns per 100 people in the United States.⁷ According to a recent Pew Research Survey report, 4 in 10 Americans surveyed live in a household with at least 1 gun.⁸ Gun owners are more likely to have earned less than a college degree and live in rural areas.⁸ A recent CDC study on gun-related injuries among children provided evidence that some children had access to parents' unsecured stored guns.⁹ These findings suggest that some children may be handling guns and ammunition without adult supervision. Importantly, potentially harmful lead exposure is a rarely recognized hazard associated with guns and ammunition. A groundbreaking study by Hoover et al at the Harvard Chan School of Public Health yielded evidence for the link between lead gun ammunition and high BLLs in children, likely from exposure to lead dust contamination on clothing or shoes brought into the home after parents' hunting or target shooting activities.¹⁰ Another study by Totoni et al identified lead-contaminated hunters' meat as a potential source of lead exposure in meats donated to food banks.¹¹ Hunters for the Hungry, a program in 40 states sponsored by the National Rifle Association, encourages game hunters to donate meat harvested with guns to local food banks. There are no consistent inspections conducted on this meat for lead bullet fragments.¹¹ Their study emphasized the dangers posed to child consumers of meat donated to food banks, but the

hunters' children may also be at risk for consuming meat products contaminated by lead bullets. Lead exposure in young children through the routes of gun ownership and usage is an area of research we hope to see increase now and in the future.

THE COMPLEX FOOD SUPPLY CHAIN AND OPPORTUNITIES FOR CONTAMINATION OF PRODUCTS CONSUMED BY CHILDREN

Second, current food supply chains are complex and involve global partners, with foods traveling long distances between the producer and the final consumer. Multiple middle persons (eg, manufacturers, suppliers, packers, distributors, transportation) have contact with food components or products as they travel to food retailers.¹² These circumstances create opportunities for deliberate or unintentional contaminations as health, safety, and nutrition may become secondary to profit. Among the potential hazards, additives including lead may be contained in food products. The recent 2023 lead-contaminated applesauce recall is a prime example. In North Carolina, in the fall of 2023, clusters of young children were found to be exposed to high levels of lead contained in cinnamon-flavored applesauce pouches, the type designed for consumption among toddlers. A recall of certain brand name products was issued, but the number of children exposed to lead through consumption of the applesauce pouches continued to increase.¹³ US Food and Drug Administration (FDA) investigators found that the products were manufactured and distributed by a company in Ecuador and demonstrated that the cinnamon used to flavor the products was the source of the lead. The cinnamon was obtained by another supplier, also in Ecuador.¹⁴ The cinnamon supplier does not ship products directly to the United States.¹⁴ The lack of direct importation into the United States opens a gap in inspection capabilities because the FDA has limited authority to inspect suppliers that do not ship directly to the United States. According to a recent update from the FDA, the source of lead in the cinnamon was traced to yet another link in the food supply chain, an Ecuadorian spice processor.¹³ The cinnamon in stick form was originally sourced from Sri Lanka and found to have no lead contamination.¹³ Multiple suppliers and processors in the global food supply chain create additional opportunities for contaminants and adulterants to enter food products.

The applesauce pouches have a long shelf life, and children may continue to be at risk for consuming previously purchased tainted applesauce long after the event is out of the media headlines.^{13,15} One of the challenges highlighted by this outbreak is developing a case definition that could capture all potentially affected children, given no safe level of lead exposure has been identified. Another is the potential inspection and/or testing gaps in foods imported from other countries in a highly complex food chain.

With the United States importing 15% of its food products annually, including 32% of fresh vegetables, 55% of fruits, and 94% of seafood, involving >200 countries and territories and multiple facilities, health and safety procedures to avoid distribution of contaminated and/or adulterated food products may need to be enhanced.¹⁶ Public health professionals must champion the issue of ensuring the food supply is safe for all, especially for children in their developing years.

COMPLEX PRODUCT MARKETING STRATEGIES WITH WEAK GUARDRAILS

Third, similar to the complexities in food supply chains, nonfood products (eg, toys, cookware, make-up, baby products) supply chains are often equally large, intricate, geographically dispersed, involving multiple individuals with online marketing seizing an increasing proportion of retail sales. The convenience, ease, and savings in time and transportation cost are all factors that contribute to the appeal of online shopping. In the third quarter of 2023, online shopping captured 15% of sales, more than double the proportion of sales in the first quarter of 2014.¹⁷ According to a recent Pew Research Center report, in the third quarter of 2023, the largest proportion of online retail sales went to nonstore retailers amounting to 61.8% of sales, and \$168 billion.¹⁸ Taking these facts together, one can infer that the origins of many products and their component parts sold online may be difficult to trace. Nonstore sellers could be anyone with a Web site, which creates opportunities for merchandizing potentially unsafe toys, cookware, or other products containing lead.

In 2019, a global online e-commerce platform known for its third-party sellers was cited by the *Wall Street Journal* as marketing counterfeit or unsafe products, including toys containing lead.^{19,20} Third-party sellers represented almost 60% of this platform's physical merchandise sales in 2018. The proliferation of third-party sellers on a largely anonymous e-commerce platform makes it challenging to identify who manufactured a product or where it originated.^{20,21} The business model of the current supply chain opens the door for "entrepreneurs" to become third- or even fourth-party suppliers, creating lucrative cash operations with little or no oversight for product quality or safety.

The preceding example demonstrates the relative ease with which unsafe products can be marketed in a highly complicated global supply chain. The US Consumer Product Safety Commission has recently issued recalls for multiple children's products, including toys and other items, sold primarily online, which contain unacceptable amounts of lead. A small sampling of these products include the Children's Rhinestone Silver Tiara,²² multiple stainless steel cup sets sold by different marketers,²³⁻²⁵ and toy houses.²⁶ There have been multiple additional products identified as containing lead, sold primarily online, obtained from sources outside of the United States and distributed through third- and fourth-party sellers. Some of these unsafe products are also sold in big box stores and budget retailers. The 3 emerging threats detailed here demonstrate that regardless of our past accomplishments, public health work is never complete, and we should be watchful for new threats on the horizon that contribute to lead exposure and other potential environmental hazards.

WHAT IS TO BE DONE? CDC PLAN OF ACTION

The CDC is committed to keeping lead exposure prevention at the forefront of public health inquiry, research, prevention, and program activities. In the past 2 years, we have developed a number of tools to provide education to the general public and public health professionals to spread the word among US citizens, residents, and internationally regarding lead exposure and its consequences and improve methods for blood lead testing.

LOWERING THE BLOOD LEAD REFERENCE VALUE IN 2021

The blood lead reference value (BLRV) is a touchstone or guide to actuate medical, environmental or behavioral follow up for children exposed to lead. Based on recent data from the NHANES, CDC lowered the BLRV from 5 μdL to 3.5 μdL in 2021.²⁷ Lowering the value assists with prioritizing care for children most in need.

LEAD EXPOSURE PREVENTION EDUCATION TOOLS

The CDC, in partnership with the American Academy of Pediatrics, developed a series of lead exposure prevention education videos suitable for posting online, sharing on social media, and other opportunities to reach medical professionals and general audiences. These videos provide overviews of what lead is, where it is found, and why it is important to protect young children from its exposure. Our video training resources take a much-needed step toward health equity by increasing access to educational materials among affected populations and the health care providers that serve them, and by promoting medical self-advocacy surrounding lead exposure in populations that can benefit the most.²⁸

BLOOD LEAD TESTING CHALLENGE

Testing for lead exposure is best accomplished by a health care provider with a blood lead test to determine the extent of lead in the blood. Since 2006, no new point-of-care testing systems have been developed and approved by the FDA for use in laboratories. The currently available point-of-care system's lower limit of detection is 3.3 mg/dL.²⁹ Though the CDC's current BLRV (a trigger for action and follow-up) is 3.5 mg/dL, no amount of lead exposure for children has been definitively established.²⁹ Thus, there is a need for an improved test that can detect lead in blood at much lower levels. In November 2023, the CDC in collaboration with the National Aeronautics and Space Administration and Luminary Laboratories issued the national Lead Detect Prize challenge, requesting submission of concept proposals/development plans for an improved blood lead testing system.³⁰ A panel of experts will be used to identify a winner of the \$1 million prize in late 2024.

COLLABORATION WITH FEDERAL PARTNERS

The CDC works closely with multiple federal partners to identify and respond to emerging public health crises that involve lead and other exposures. As an example, in November 2023, the CDC worked closely with the FDA and state and local public health officials to identify children exposed to high levels of lead associated with consuming the cinnamon applesauce pouches referenced previously. The CDC issued a number of communications to our internal, external, and online partners advancing knowledge of the product recall and providing preliminary guidance to medical professionals, consumers, food marketers, parents, schools, and others including a Health Advisory Network alert.³¹

In addition, another major collaboration effort is the CDC's Lead Exposure and Prevention Advisory Committee (LEPAC), which is a Congressionally mandated Federal Advisory Committee that includes a collective body of public health experts with experience in lead

exposure prevention science, medicine, program, and laboratory fields of study and practice. LEPAC membership is drawn from multiple federal agencies including the Department of Health and Human Services, the Consumer Product Safety Commission, Department of Agriculture, Department of Education, Department of Housing and Urban Development, Environmental Protection Agency, and experts from academia and state and local public health agencies. The 15 members of the LEPAC provide regular review of federal lead prevention programs; stay current with research trends to inform lead prevention policies; identify best practices for lead screening and prevention; identify medical, educational, behavioral, or nutritional services required for populations exposed to lead and other activities to support health policy recommendations; and serve as liaison to the Secretary of the Department of Health and Human Services on matters related to national lead exposure prevention.^{27,32}

NATIONAL GOVERNMENTAL POLICY UPDATES

In December 2021, White House officials announced implementation of a large national infrastructure program to replace lead-contaminated water pipes and service lines installed decades earlier that affect as many as 10 million American households. In addition, the program plans to address the 24 million older housing units with lead paint risks over the next 10 years. Lead in water pipes and lead paint in older homes disproportionately impact communities with lower access to economic resources and those who are in historically marginalized populations. Guided by evidence from the CDC and Environmental Protection Agency, and in the interest of providing safe drinking water to children in their homes and childcare centers and in making dwellings safer for habitation, the bipartisan supported program combines the activities of 10 federal agencies to identify and replace thousands of lead pipes that provide water to communities at risk and eliminate lead paint in housing built before 1978.³³

FUTURE CONSIDERATIONS

The ubiquitous nature of lead coupled with the complexity of 3 emerging contextual trends discussed previously require that we as public health professionals deploy all of the 10 essential services of public health simultaneously.

1. Assess and monitor population health status, factors that influence health, and community needs and assets.
2. Investigate, diagnose, and address health problems and hazards affecting the population.
3. Communicate effectively to inform and educate people about health, factors that influence it, and how to improve it.
4. Strengthen, support, and mobilize communities and partnerships to improve health.
5. Create, champion, and implement policies, plans, and laws that impact health.

6. Use legal and regulatory actions designed to improve and protect the public's health.
7. Assure an effective system that enables equitable access to the individual services and care needed to be healthy.
8. Build and support a diverse and skilled public health workforce.
9. Improve and innovate public health functions through ongoing evaluation, research, and continuous quality improvement.
10. Build and maintain a strong organizational infrastructure for public health.³⁴

We should approach lead exposure prevention holistically, keeping social determinants of health, (the structural conditions into which people are born, grow, live, work, and play), and the principles of health equity (equal access to optimal health and health care), in mind as we monitor population health needs for lead exposure prevention, investigate exposures, communicate health information with the public and champion policies to protect the health of all Americans. We must also improve strategies to anticipate and detect potential lead exposures based on knowledge of current trends that inadvertently create exposure routes, and economic practices that create loopholes for unsafe food and nonfood products to reach consumers.

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ABBREVIATIONS

BLL	blood lead level
BLRV	blood lead reference value
CDC	Centers for Disease Control and Prevention
FDA	Food and Drug Administration
LEPAC	Lead Exposure and Prevention Advisory Committee

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