Lead Exposure and Environmental Justice

Challenges, Opportunities, and Solutions in Environmental Health

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Message from the Executive Director

Lead is a pervasive environmental contaminant that has particularly grave health impacts on women and children, who are most vulnerable to its effects.

Harm from lead exposure has been recognized since times of antiquity, being described by Hippocrates and the Romans. Regretfully, the metals' remarkable industrial properties have given rise to its continued use. At the same time, the deleterious health effects of lead, particularly on children, are a national tragedy. A child's developing organ systems are vulnerable to lead and lead exposure can result in permanent detriments to the nervous system, development, learning, and behavior. In adults, acute lead toxicity can result in kidney damage, impaired cognitive function, seizures, coma, and even death. Pregnant mothers are also at risk and can suffer from thyroid dysfunction and lead stores leaching into breast milk. Their unborn children can suffer from low birth weight or premature birth.

While lead is often thought of as a problem solved long ago, lead poisoning remains a public health dilemma. Exposure to lead can occur in the home through paint dust and chips, aging pipes and solder, soil from contaminants that have settled out of the air, and hazardous waste landfills and Superfund sites. Unregulated industry and a legacy of leaded gasoline have dispersed this heavy metal throughout the United States, often leaving marginalized populations the most susceptible to exposure.

Lead exposure can be eliminated in our lifetime. It is a winnable battle, if we find the courage and resources necessary to ensure every American resident reaches their full human potential free from environmental lead.

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Executive Summary

Lead exposure has severe health effects on children, primarily due to its impacts on developing organ systems. Exposure can impact the brain and nervous system, development, learning and behavior. Pregnant women and unborn children are vulnerable, as lead exposure can have deleterious effects during pregnancy including placing the child at risk for premature birth and low birth weight, both of which are associated with negative health effects.

Decades of racial residential segregation and other housing policies in the United States have led to disproportionate burdens on low-income communities and communities of color. Between 1997 and 2001, more than 80% of children in the United States with confirmed elevated blood lead levels were of minority race or ethnicity, and 60% were non-Hispanic Black. Finding those at risk is also difficult. For example, in 2017, 23 out of 39 states in a major study was able to identify fewer than half of children suspected to have elevated blood lead levels. This highlights a need to improve testing and screening.

Communicating the gravity of the lead crisis in the United States and methods for reducing exposure has the potential to improve outcomes for many populations, especially children of color and children living in low-income communities. This report shares findings from current research on lead exposure, sources of lead exposure, and the environmental injustice of lead exposure.

Introduction

The Environmental Justice Movement

The U.S. Environmental Protection Agency (EPA) has two goals for environmental justice: "Equal protection from environmental and health hazards [as well as] equal access to the decision-making process to have a healthy environment in which to live, learn, and work," (EPA, 2020d). The environmental justice movement began in 1982 in Warren County, North Carolina. A small, predominantly African-American community in the county was selected as the disposal site for soil contaminated with toxic waste that was illegally dumped along roadways. Although several other sites were considered, this small community of color was chosen (Office of Legacy Management, n.d.). Various agencies protested the site of the disposal facility but were unsuccessful in overturning the decision. As a result, a loose, national, multicultural coalition of community groups formed to advocate against environmental injustices and to raise awareness among the general public. Pressure from these groups resulted in a United States Government Accountability Office (GAO) review of decisions regarding hazardous waste disposal sites (Office of Legacy Management, n.d.).

There is a historical precedence in the pattern of hazardous municipal waste disposal siting. In 1983, a GAO paper investigated the placement of hazardous waste landfills near communities of color and low-income communities. State records for landfill permits indicate that a large percentage of sites were placed near communities of color, with little deviation from this pattern (GAO, 1983). These discoveries added to mounting evidence of environmental injustice, sparking intense citizen opposition (Bullard, 1983). This inequitable distribution of harmful environmental exposures near certain communities incited the push for environmental justice. (Gracia et al., 2011).

Making the Case for Humanity

The impacts of lead on human health are well-documented and established within the literature, highlighting the effects of lead exposure, which are particularly devastating for women and children (Ettinger et al, 2013; Hong et al., 2014; Krieger et al., 2002; Leech et al., 2016; Whitehead & Buchanan, 2019; Yuan et al., 2006; Zhu et al., 2010). As stated in a study by Hanna-Attisha et al. (2018), lead is a toxin that is distributed throughout the body to the brain, liver, and kidneys. Long-term, lead is stored in teeth and bones where it accumulates over time.

For mothers, stores of lead accumulated in the body throughout life are released during pregnancy, circulate through the plasma, and leach into breast milk (Ettinger et al., 2014; Hong et al., 2014). Although calcium supplementation can reduce these effects, lead exposure can result in pre-term birth, low birth weight, small for gestational age, and low body weight for up to 48 months (Hong et al., 2014). Studies in mice have found lead concentrations in murine milk to be around 25 times the level found in plasma (Ettinger et al., 2013).

In both children and adults, lead exposure can result in kidney damage, peripheral neuropathy, encephalopathy, impaired cognitive function, thyroid dysfunction, seizures, coma, and death (CDC, 2017; Hackley & Katz-Jacobson, 2003; World Health Organization [WHO], 2019; Zhu et al., 2010). In addition, lead is associated with multiple forms of cancer, chronic obstructive pulmonary disease, and heart disease (Shaffer & Gilbert, 2018). Small amounts of lead exposure may not produce symptoms in adults can cause major complications in children due to the ongoing development of the nervous and organ systems (Hong et al., 2014). Lead targets all biological systems and is toxic at all levels, and there is no safe level of lead exposure (CDC, 2017; Leech et al., 2016; Hackley & Katz-Jacobson, 2003). Because lead exposure can impact development, its effects on children are permanent (CDC, 2014; Dwayne et al., 2019). Lead exposure does not only cause physiological harm, but is correlated with delinquency, anxiety, anti-social behavior, difficulty concentrating, reduced IQ, and impaired reasoning capabilities (Dwayne et al., 2019; Liu et al., 2014; Needleman et al., 2002; WHO, 2019).

DID YOU KNOW? New Orleans's traditional Mardi Gras event is celebrated with Mardi Gras beads. Research shows there are high concentrations of lead in these beads. More than 60% of beads tested have concentrations of lead above 100 parts per million (VerdiGras, 2013).

Sources of Lead Exposure

Pregnant women and children are particularly vulnerable to the negative health effects of lead in the environment. Lead exposure in children can result in impairments to the brain and nervous system, growth, and development, and learning and behavior (Hong et al., 2014; Krieger et al., 2002; Whitehead & Buchanan, 2019; Yuan et al., 2006). A case-control study found a correlation between delinquency, anti-social behavior, and bone lead levels (Needleman et al., 2002). There is no safe level of lead exposure, although there are many opportunities for children to accumulate lead in their bodies (Leech et al., 2016).

Lead exposure also has detrimental effects on maternal health, including thyroid dysfunction, bone stores recirculating into plasma and milk, low birth weight, premature birth, kidney damage, encephalopathy, and impaired cognition (Ettinger et al., 2013; Hackley & Katz-Jacobson, 2003; Hong et al., 2014; Zhu et al., 2010). Studies have shown there is no safe threshold for maternal effects (Ettinger et al., 2013; Hong et al., 2014; Zhu et al., 2010).

Because lead has such dramatic consequences on the health of children and pregnant women, providing education about sources of lead exposure is important. Paint, piping, and untreated water are the most common sources of lead exposure. Other sources include deposition of leaded gasoline in soil,

industrial sites, and intergenerational exposures (Leech et al., 2016). However, unconventional sources including jewelry, toys, spices, and traditional medicine practices can also lead to harmful amounts of lead exposure.

Lead has been identified in a wide variety of jewelry items including rings, earrings, necklaces, pendants, and piercings (Weidenhamer & Clement, 2007). A study testing a variety of 285 pieces of jewelry found the mean percentage of lead to be 31% by weight. Although individuals are unlikely to be exposed simply from wearing jewelry containing lead, these items pose a risk to children who may chew on or swallow them (Centers for Disease Control and Prevention [CDC], 2020).

Toy manufacturing often uses metals, including lead, as stabilizers in paint. In recent years, there have been numerous recalls of toys due to chemical safety hazards. In 2012, two million toys were recalled by the company Mattel for violating lead paint standards (Guney & Zagury, 2012). A study investigating the recall found that metal-contaminated toys are a widespread problem in the United States. Young children are susceptible to lead exposure from toys due to mouthing behaviors (Cui et al., 2015; Guney & Zagury, 2012).

A third unconventional source for lead exposure is spices contaminated with heavy metals (Angelon-Gaetz et al., 2018; Lin et al., 2010; Woolf & Woolf, 2005). Since 1998 sales of imported spices have doubled; however, regulation of internet sales, international purchases, and importation from family members remains challenging (Angelon-Gaetz et al., 2018). Multiple case studies have shown that internationally imported spices can cause elevated blood lead levels in children (Woolf & Woolf, 2005).

Other unconventional sources of lead exposure are related to two common cultural practices. Pica is the compulsive eating of substances that have no nutritional value, such as soil (Leung, 2019). Soil is a major source for lead exposure through settled air contaminants and pulverized paint chips (Leech et al., 2016; Mielke & Reagan, 1998). Geophagy, a form of pica, has existed for thousands of years and is ubiquitous worldwide as a common practice related to fertility in many cultures (Abrahams & Parsons, 1996).

DID YOU KNOW? In 2011, a county in North Carolina witnessed a spike in elevated blood lead levels in children. However, this spike was not attributed to paint or other traditional sources of exposure as most of the children lived in new housing. Samples taken from spices at their homes revealed high levels of contamination with lead (Angelon-Gaetz et al., 2018).

Traditional medicine practices such as Ayurvedic medicine and Rasa shastra have gained popularity worldwide in recent decades but are associated with lead contamination and poisoning (Mathee et al., 2015; Mikulski et al., 2018; Raviraja et al., 2010; Saper et al., 2004). A study found that 65% of 252 Ayurvedic medicine samples contained lead, with 36% exceeding the recommended daily intake values by several thousand times. There have also been several reports of metal toxicity associated with Ayurvedic products from the United States, Canada, England, New Zealand, and India (Mikulski et al., 2018). Although many Ayurvedic medicines are comprised primarily of herbs, Rasa shastra uses heavy metals (Mathee et al., 2015; Mikulski et al., 2018; Raviraja et al., 2010; Saper et al., 2004). In addition, many of the medicinal products used in these practices are classified as supplements, making them subject to minimal or no regulations (Mathee et al., 2015; Mikulski et al., 2018; Saper et al., 2004). These examples demonstrate how cultural or religious beliefs can make diagnosis and treatment of lead exposure challenging. Increasing awareness and testing among populations that practice traditional cultural celebrations, cooking methods, or medicinal practices is important for addressing these sources of lead exposure.

Inequities of Exposure

Lead policies, inconsistent screenings, and physician misconceptions have all contributed to low-income communities and communities of color being disproportionately affected by lead exposure. Between 1997 and 2001, more than 80% of all children in the United States with confirmed elevated blood lead levels were of minority race or ethnicity, and 60% were non-Hispanic Black (Leech et al., 2016).

Urban decay and deteriorating housing infrastructures cause ongoing exposure to sources of lead, such as paint or old piping, which disproportionately affect minority populations (Leech et al., 2016). As wealthier people move away from areas with environmental health hazards, prices drop, and housing becomes more affordable. With a shortage of affordable housing in the United States, this exacerbates the concentration of poverty in hazardous areas. A 2005 American Housing Survey revealed that 7.5% of non-Hispanic Blacks reside in moderately substandard housing and 2.9% reside in severely substandard housing, compared to 2.8% and 1.6%, respectively, of non-Hispanic Whites (U.S. Census Bureau, 2006). Policies at the institutional level should address improving housing infrastructures in low-income communities to reduce exposures to lead.

The Lead-Based Paint Hazard Reduction Act of 1992 requires sellers and landlords to disclose known lead-based paint exposures before the sale or lease of housing built before 1978. However, this law does not obligate sellers or landlords to perform remediation activities, which involve permanent removal of the lead source to restore the property to non-hazardous levels. Policies such as this disproportionately affect low-income families that are aware of an exposure source but are unable to fix it due to financial barriers (EPA, 2020a; Leech et al., 2016). Exposure to lead is greater among renters than homeowners, highlighting racial disparities related to homeowner financing approval (Leech et al., 2016; Yoon & Timmins, 2015). A study by Kuebler and Rugh (2013) found that Black Americans in the Northeastern United States were 31% less likely to own a home than White Americans during the period of 2008-2010.

Barriers to screening for lead exposure include lack of reliable testing and misconceptions around lead poisoning. X-Ray Fluorescence is the most effective, non-invasive tool for testing, yet it is used only for clinical research and not in practice. Health care provider misconceptions and outdated guidelines can lead to missed screening opportunities, suggesting that provider education is needed to improve lead screening rates. Current guidelines state that children should only be tested up until age 2, but a retrospective case-control study found a need to test for late-onset childhood lead poisoning (Raymond et al., 2009). There is also concern about a misconception among pediatric providers that lead is no longer an issue. In a recent study, 23 out of 39 states reported identifying fewer than half of all estimated cases of children with elevated BLLs (Roberts et al., 2017). This deficit reveals the need for provider education on testing guidelines, vulnerable populations, and sources of exposure.

Threats to Public Health

Lead-related disasters can impact public health and cause environmental harm. The water crises in Washington, D.C. and Flint, Michigan are two prominent recent disasters resulting from water corrosiveness, suboptimal corrosion control, and antiquated infrastructure (Roy & Edwards, 2019). Historical smelting industries in Baltimore, Maryland have led to wide-spread contamination of soil in residential areas (Brattin & Griffin, 2011). In 2006, the EPA visited Site 43 in Maryland, which is located in a primarily residential area, and identified lead-contaminated soil (Maryland Department of the Environment, 2012). Superfund sites along Hurricane Katrina's path in Louisiana, Alabama, and Mississippi were exposed to lead through materials relocated by flood waters. Hurricane recovery efforts focused on mitigating the risks of lead-contaminated buildings, a majority of which were built during a period when lead paint was commonly used (EPA, 2016; Rabito et al., 2012). These recent events are indicative of an increase in future challenges in mitigating lead exposure from environmental hazards. As aging infrastructure continues to deteriorate, lead exposure will continue

to pose a serious concern, especially where limited funding is available for remediation activities.

Where is Lead Found?

There's No Place like Home

In 1978, lead was banned as a paint ingredient and the Lead-Based Paint Hazard Reduction Act of 1992 required disclosure of the lead source, but not remediation (EPA, 2020a). While this was a step toward protecting families from lead exposure in the home, remediation is the most effective way to treat lead exposure long-term. Lead paint in homes remains a widespread problem due to the large number of homes built prior to 1978 (Anthony et al., 2019; Cuyahoga County Board of Health [CCBH], 2020; Get the Lead Out, 2020; Meyer et al., 2008). More than half of homes built before 1978 contain trace amounts of lead-based paint, and this percentage increases to 76% and 86% for homes built before 1960 and 1940, respectively (Pew Charitable Trusts, 2017).

In the United States, lead in paint remains the greatest source of lead exposure for children (Agency for Toxic Substances and Disease Registry, 2019; CDC, 2003; CDC, 2014; CDC, 2017; Whitehead & Buchanan, 2019; Johnson, 2007). Children are most vulnerable to the neurological impacts of lead at the time they begin exploring their environments by crawling (Anthony et al., 2019). Children can inhale lead dust from high-friction and impact surfaces with lead paint, such as windows and doors (Agency for Toxic Substances and Disease Registry, 2019; CCBH, 2020; Get the Lead Out, 2020). Lead has a sweet taste, making it appealing to children. Hand-to-mouth behaviors in children also put them at risk for lead exposure from unconventional sources such as toys and jewelry containing lead paint (Allegheny County Health Department, 2020; Greenway & Gerstenberger, 2010; Meyer et al., 2008; Pew Charitable Trusts, 2017).

Children from low-income communities and communities of color are disproportionately affected by lead poisoning because they are more likely to live in houses containing lead paint (Leech et al., 2016; Johnson, 2007). A public awareness campaign called Get the Lead Out in Allegheny County, Pennsylvania illustrates the association of lead paint in homes with the segregation of groups by income and race that is common in many urban centers (Get the Lead Out, 2020; CCBH, 2020). Lead paint is often misrepresented as an outdated issue because it has been banned, and ongoing vigilance is required to combat this misconception. It is important to create policy that requires homes to be inspected prior to residents' occupation to ensure a healthy and safe living environment.

DID YOU KNOW? Massachusetts and Ohio, which mandate inspection and treatment of housing units with hazards, are 79% less likely than Mississippi, which lacks any mandate, to have residential addresses that repeatedly contribute to elevated blood lead levels in children (Pew Charitable Trusts, 2017).

The magnitude of the lead crisis is directly impacted by state policies on lead regulation. In Rochester, New York, 87% of homes were built before 1950 and 60% of homes are rented. Because lead paint is often found in houses with these characteristics, the city passed an ordinance in December of 2005 requiring regular inspections for lead paint hazards as part of a certificate process for listing rental properties. Prior to this policy in 2004, 900 children were identified with elevated blood lead levels. By 2015, this number was reduced to 206. (Pew Charitable Trusts, 2017). In 2008, Washington, D.C. passed a similar Lead Hazard Prevention and Elimination Act that requires property owners to show that no lead-based paint hazards were present in the home within the last 12 months. Since 1994, Maryland has required registration of houses with the Maryland Department of the Environment to indicate that they are free of chipping paint, peeling paint, and lead-contaminated dust. This certification must be done by an accredited inspector prior to a

change in occupancy (Pew Charitable Trusts, 2017). Housing policy is a critical component of prevention because it can mitigate exposures faced by communities living in high-risk housing structures.

Lead Beneath our Feet

The issue of lead contamination extends beyond the household, as contaminated lead paint dust can settle outside the home and into the soil. This can occur from window paint, high-friction and impact surfaces, remodeling or reconstruction to the home, and household waste (i.e., lead contaminated water, paint solutions, spills, etc.).

Levels of lead in the soil of urban residential areas are three times higher than in non-urbanized areas. A study of Pittsburgh, Detroit, Chicago, and Birmingham found urban soil to be the predominant source of atmospheric lead (Frank et al., 2019; Laidlaw et al., 2012). In addition, lead aerosol patterns were three times higher on weekdays due to turbulence from cars, and highest during summer and autumn. These seasonal patterns were confirmed by Centers for Disease Control and Prevention (CDC) surveillance, which noted a larger proportion of elevated blood lead cases identified during warm months (CDC, 2017; Laidlaw et al., 2012).

Certain populations are disproportionately affected by exposure to lead in soil. People unable to afford air conditioning are more likely to be exposed to lead aerosols from soil due to opening windows and spending an increased amount of time outside. Two observational studies in New Orleans found that children exposed to higher levels of lead in soil were majority Black, of low socioeconomic status, and living in areas lacking recreational spaces free of lead (Pew Charitable Trusts, 2017). Another example of lead-contaminated environments is in the city of East Chicago, Indiana, where three neighborhoods have lead-soil concentrations that are high enough to be declared a Superfund site by the EPA (Stark et al., 2018). Superfund sites are heavily polluted areas requiring long-term cleanup of hazardous materials and chemicals. A sector of East Chicago was given Superfund status after high concentrations of lead were found just outside the former Carrie Gosch Elementary School in Chicago, now known as Excavation Areas 1 and 2, despite there being no safe levels of lead exposure for children (EPA, 2020b). Similarly, a study in Cleveland found heavy metal concentrations well above background levels, with several areas throughout the city designated as Brownfield sites. A Brownfield site is a property where "the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant," (EPA, 2020e). The levels of contamination found in Cleveland were high enough to warrant reduced access to the area and require remediation (Petersen et al., 2006).

Currently, policies are being developed to control and reduce levels of lead in the soil based on historical levels of deposition. New York City maintains a system to identify and intervene in potentially unsafe renovations. In Washington, D.C., where 75% of housing was built before 1978, contractors must obtain EPA-required training to conduct renovations. In Rhode Island, contractors must hold a Lead-Safe Remodeler/Renovator certification. New Orleans uses a soil replacement system at childcare centers, replacing contaminated soil with a water-permeable barrier and a 6-inch layer of clean soil (Pew Charitable Trusts, 2017). As knowledge of lead remediation techniques advance, it is important to update policy and practices to prevent further contamination of residential environments.

Where the Water Flows

Immense progress has been made with the EPA's Lead and Copper Rule, including requiring monitoring of customer water taps for lead and copper levels as a measure of effective corrosion control treatment (EPA, 2019a; EPA, 2019b). However, aging pipelines throughout the United States remains an issue. Most of the pipe infrastructure found throughout the Eastern United States is older than 50 years, with many smaller networks older than 100 years (Schnoor, 2016).

In 2014 the city of Flint, Michigan switched its water source from the Detroit Water and Sewerage Department to the Flint River to save money

DID YOU KNOW? LeeAnne Walters, a resident of Flint, Michigan, had a water-lead content of 104 ppb at her water taps, which is well-above EPA's limit of 15 ppb. Walters's three children were diagnosed with lead poisoning (Kennedy, 2016). When the city refused to address this issue, Walters began investigating with the help of an EPA regional manager and a Virginia Polytechnical Institute and State University professor. Walters sampled water from every ZIP Code and collected over 800 samples with a 90% response rate. Her research found the levels of contamination were so high that they were above what is deemed hazardous waste by the EPA, with one in six homes exceeding EPA's safety threshold. Following her investigation, she launched the grassroots advocacy group Water You Fighting For? in 2015 to continue to fight for clean water. She later won the Goldman Environmental Prize in 2018 for her work in citizen science (Goldman Environmental Foundation, 2020; Persio, 2018). Similar stories of high lead levels in water were found in Baltimore in 1992, Los Angeles in 2008, and most recently, Newark in 2016 (Gostin, 2016).

(Denchak, 2018; Kennedy, 2016; Schnoor, 2016). The Flint River was chosen despite its history of pollution. The city of Flint neglected to treat the water to prevent corrosion after the switch, ignored worried inquiries of residents, and suppressed water quality findings for many months (Denchak, 2018; Kennedy, 2016).

Elevated lead levels in water and in low-income and communities of color is often ignored or deliberately disguised. Lead piping was identified as a concern in Baltimore, but rather than correct or replace the lead pipes, officials encouraged residents to use bottled water, citing cost-effectiveness (Gostin, 2016). In Newark, New Jersey, 20% of households contained lead levels above the action level in a community comprised of 83% people of color and 28.2% of people below the poverty line (Clauser, 2019). However, the city failed to investigate water sample levels further. It was later discovered that lead had leached into the water due to a malfunction at the water treatment plant, depriving the pipes of necessary anti-corrosive chemicals (Clauser, 2019). These are examples of communities that have suffered from lack of appropriate action or policy to address lead exposures.

Policies are being developed across the nation to address remediation of lead in water. One policy making significant progress is the EPA's Lead and Copper Rule, which requires water sample testing every 3 years (EPA, 2019a). As a result of its previous crisis, the Water and Sewage Department in Newark expanded this policy by requiring 100 water samples to be tested every 6 months (Clauser, 2019). In 2016, 12 states and Washington, D.C. began testing tap water in school districts and replacing or shutting down water sources with high lead levels (Pew Charitable Trusts, 2017). In 2016, the Centers for Medicare and Medicaid Services authorized Michigan's Children's Health Insurance Program to pay for water pipe and fixture replacement. Currently in Milwaukee, the city is using grant money to fund a program that helps cover the cost of private pipelines. Under the program, the property owner is responsible for no more than one-third of the cost up to $1,600 (Pew Charitable Trusts, 2017).

In Cincinnati, the Lead Service Line Replacement Program (LSLRP) was launched in 2017 to replace the city's lead pipes within 15 years. LSLRP provides financial assistance for replacing pipes, requiring the property owner to pay only 40% of the replacement up to $1,500 (Greater Cincinnati Water Works, 2018). Through more frequent testing of public water supplies and cost-sharing policies aimed at replacing infrastructure, great strides can be made in reducing lead exposure and poisoning.

Person, Place, and Policy

Hazardous waste sites, many of which have been designated Superfund sites, are a significant source of lead exposure. Historically, these sites were placed in low-income neighborhoods with access to major highways or waterways. Many studies have also demonstrated the overrepresentation of low-income communities and communities of color near highly trafficked roads (Leech et al., 2016). The disparities between communities become wider with higher levels of toxicity (Hipp & Lakon, 2010). In addition, EPA's Resource Conservation & Recovery Act (RCRA) sites designated in the 1990s are clustered in communities of color, with disproportionate placement in Hispanic communities (Baden & Coursey, 2002; Hipp & Lakon, 2010).

There is also a strong correlation between education level and proximity to hazardous wastes. Residents with higher levels of education continue to have low, and declining, proximity to toxic wastes (Hipp & Lakon, 2010). Similar inequalities are seen for landfill sites across the United States. There are 19 active solid waste landfills, six of which are within a five-mile radius of low-income communities (Wesley & Jackson, 2012). These sites are often contaminated with lead from old electronics, as well as other sources.

There are policies in place to protect the public from hazardous waste and to take care of established waste sites. The EPA has enacted the RCRA, which regulates facilities that produce hazardous waste, and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund, which addresses hazardous waste sites (EPA, 2011). The National Environmental Policy Act (NEPA) requires federal agencies to determine the environmental effects of various decisions such as permits, land management, and highways or public facilities (EPA, 2017). Each of these policies were passed within a decade of each other following societal pressure to protect the environment and consider potential health effects. These policies demonstrate the role of regulation as an important safeguard for the public, ensuring oversight in areas that can be detrimental to human health.

Life, Liberty, and the Pursuit of Justice

The purpose of environmental justice is to address and reduce inequities in health outcomes between different population groups and give communities a voice in decisions concerning the environment in which they live (EPA, 2020d; Gracia et al., 2011). The populations with the fewest resources and highest burdens of disease are most vulnerable to the effects of climate change (American Public Health Association, 2020). Although many cities have a sustainability plan, incorporation of an environmental justice component is often limited or omitted. Despite public traction waning in favor of broader topics, environmental remains essential (Pearsall & Piece, 2010).

To illustrate this, a study in 2010 found significant disparities across children of different racial and ethnic backgrounds in the prevalence of three common diseases correlated with environmental factors – asthma, lead poisoning, and obesity (Landrigan et al., 2010). Climate change affects air quality, food security, and natural disaster prevalence. Air pollution exacerbates allergies, asthma, and heart disease. Food insecurity exacerbates weight problems. Increased flooding spreads contaminants (American Public Health Association, 2020).

It is generally recognized that high risk chemical facilities are more likely to be found in low-income communities and communities of color. Larger, more intensive chemical facilities tend to be located

in counties with African-American communities, and these facilities also pose a great risk of accident and injury. Another environmental justice issue is unequal prioritization of environmental remediation. A study by Eckerd and Keeler looked at the likelihood and temporal prioritization of Brownfields remediation and found that Brownfields sites, which are areas that may contain a hazardous pollutant or contaminant, were more likely to be located communities of color and low-income communities; however, sites located in low-income communities were cleaned up more quickly than sites in communities of color (Eckerd & Keeler, 2012). Cleaning up and reinvesting in these sites enables job growth, conserves undeveloped land, and improves and protects the environment (EPA, 2020e).

Screening and awareness of lead exposure are two critical issues that could impact environmental justice issues. Public education about the dangers of lead exposure and prevention methods can have beneficial health impacts on vulnerable populations. For example, calcium, Vitamin C, and iron supplements are known to decrease lead-gastrointestinal absorption (Allegheny County Health Department, 2020; Bruening et al., 1999; Allegheny County Health Department, 2020). An example of a public education campaign comes from the lead prevention program in Allegheny County, Pennsylvania, which put together a video demonstrating how to reduce lead exposure in the home by wetting surfaces, washing hands, and wiping pets' feet, among other strategies. (Allegheny County Health Department, 2020).

Environmental justice includes protection for workers who deal with hazardous chemicals, including lead. Federal occupational standards are based on information and limits developed in the 1970s (Shaffer & Gilbert, 2018). However, exposure to levels of lead even lower than the current limits set by the Occupational Safety and Health Administration (OSHA) has been linked to high blood pressure, decreased kidney function, reproductive effects, and neurological impairments (Shaffer & Gilbert, 2018). Individuals should be made aware of risks associated with their work and tested regularly to ensure they are within safe levels. Some occupational areas at risk for lead exposure include battery manufacturing and recycling, alumina production and processing, mining, construction, automotive/electrical/mechanical services, and indoor shooting ranges (Shaffer & Gilbert, 2018).

Public traction for environmental justice has waned, as explained by a recent GAO report. According to the report, "Federal efforts need better planning, coordination, and methods to assess progress" (GAO, 2019). Agencies' progress toward environmental justice is difficult to measure because most do not have updated strategic plans and do not report on their methods to assess progress. Setting clear goals for collaboration between agencies, regularly updating strategic plans and annual reports, and conducting continuous evaluation would all improve progress toward environmental justice (GAO, 2019).

A Future without Lead

There are many viable recommendations to address the lead crisis in the United States. Suggestions were provided by the Allegheny County Health Department (ACHD), Louisville Metro Department of Public Health and Wellness (LMPHW), and Houston Health Department (HHD), when they were invited to participate in the Health in All Policies (HiAP) and Lead Collaborative, led by the National Environmental Health Association (NEHA), National Association of County and City Health Officials (NACCHO), National Center for Healthy Housing (NCHH), and Association of State and Territorial Health Officials (ASTHO), with support from CDC. In October 2017, each of these health departments were awarded a grant for $20,000 that provided opportunities for HiAP capacity building to support developing cross-sectoral lead prevention implementation plans, as well as technical assistance to address childhood lead poisoning (Shapiro, 2019). The goal of the HiAP and Lead Collaborative initiative is to incorporate health into policy, enhance data systems, leverage resources for individuals affected by lead exposure, and strengthen population-based interventions (NCHH, 2019a, 2019b, 2019c, 2019d).

Although the program was originally intended to end in July 2019, a continuation of funding allowed for additional recipients to be selected mid-2020.

Most (86%) of housing in Allegheny County, Pennsylvania was built before 1978, and over 300 children across the county are identified with elevated BLLs each year (NCHH, 2019a). ACHD is the only organization tasked with investigation of exposure in the county, case management of children identified with elevated BLLs, enforcement when hazards are discovered, and education for families to prevent childhood exposures. ACHD faces challenges in enforcement capacity, demographics, the high rate of exposure throughout the county, and a low number of referrals of early interventions for children (NCHH, 2019a).

During its participation in the HiAP and Lead Collaborative, ACHD partnered with Women for a Healthy Environment to take a policy and education-based approach that focused primarily on forming a countywide coalition. ACHD rebooted the Lead Safe Pittsburgh coalition as the Lead Safe Allegheny coalition, convened monthly, and established standing committees within the coalition. ACHD partnered with community organizations to expand the coalition to include health care providers, contractors, trainers, and housing authorities. Together, ACHD and Women for a Healthy Environment were able to establish the Lead Safe Allegheny coalition to increase efforts for prevention of childhood lead poisoning, address the quarterly lead report lag time, increase referrals of children to early intervention staff, partner with cross-sectoral organizations, and streamline case and investigation data with the help of the City of Pittsburgh Housing Authority (NCHH, 2019a). By forming a network with various organizations and community groups, local health departments are able to build capacity and improve health outcomes for vulnerable populations. Although ACHD was able to provide innovative solutions to address its lead crisis using HiAP, it was only one of three regions chosen for the HiAP and Lead Collaborative.

Louisville, Kentucky has the highest burden of children with elevated BLLs in the state. LMPHW data indicates that Black children, as well as the growing refugee community, are disproportionately affected by lead. Populations affected by elevated BLLs overlap with pre-1950 housing and the highest concentrations of people living below the poverty line, which have been linked with historically inequitable housing. Despite this high burden of elevated BLLs, LMPHW manages fewer than 300 cases per year. Therefore, their initiative, as part of the HiAP and Lead Collaborative, aimed to focus efforts on children and pregnant women in high-risk ZIP Codes (NCHH, 2019d).

LMPHW partnered with Unite Us, an online database for enhancing workforce capacity and resource delivery for follow-ups regarding referrals between community members and social services to ensure comprehensive care. Through this database, Louisville's Childhood Lead Poisoning Prevention Program (CLPPP) identified gaps in data management which led to better case management. In addition, LMPHW engaged in outreach to physicians to advocate for prenatal testing and held educational nutrition classes in five at-risk ZIP Codes as part of case management to emphasize the protective effect nutrition has against lead poisoning. LMPHW was also able to re-establish the Lead and Healthy Homes Collaborative (LHHC) in the Louisville metro area, and this served to increase cross-sector partnerships, engage community stakeholders, advance policies and practices that impact childhood lead poisoning, increase testing and identification of lead hazards, and increase enforcement of local housing codes. Ultimately, LMPHW was able to achieve four major milestones – improving data systems, increasing provider engagement, initiating an educational nutrition campaign, and re-establishing the LHHC in Louisville.

The Houston Health Department (HHD) focused on reducing childhood lead poisoning in the Fifth Ward district. 78% of homes in this district potentially contain lead paint hazards and 51% of screened children have elevated BLLs. The prevalence of lead hazards in low income housing motivated HHD to address gaps in data and form cross-sectoral partnerships, which could decrease the prevalence of elevated BLLs through referral of community

members for abatement and blood screening, particularly children under six years old (NCHH, 2019b).

As part of the HiAP and Lead Collaborative, HHD partnered with another anchor program in the Near Northside of Houston to develop cross-sector relationships and integrate research, evaluation, and data systems into the lead program. HHD identified hot spots of lead poisoning through a parcel-level housing map of the entire Fifth Ward, identifying homes at risk and homes that have already received abatement; then overlaid the number of elevated BLLs in children, by block group, from 2007 to 2016. This risk map enabled community partners to evaluate lead hazards in the communities, identify homes with signs of lead-based paint, refer homes that potentially qualify for the Lead-Based Paint Hazard Control Program (LBPHCP), and track progress based on referrals through a Hazard Housing Database. Achievements through this effort included partnerships with the Local Initiatives Support Corporation (LISC), Fifth Ward Community Redevelopment Corporation, Greater Opportunity Neighborhoods, Coalition of Community Organizations, and much more. In addition, HHD created a lead hazard map, promoted an app for surveyors to upload individual housing information, increased community capacity through workshops, and created the "block captain system" (NCHH, 2019b).

HHD's strategy to combat lead made effective use of two additional strategies – Geographic Information Systems (GIS) and community-based participatory research (CBPR). GIS can be used to pair data from pediatric blood tests with housing construction year information extracted from public records in order to produce a map of areas that are most at risk. This can be further stratified into pre-1950, 1950-1977, and post-1977 housing, as is consistent with CDC recommendations (Akkus & Ozdenerol, 2014). The use of this technology does not have to be restricted to housing alone. For example, one study paired demographic data and distance of communities from municipal landfills. It is important to disseminate this data to the environmental justice communities it is collected from (Wesley & Jackson, 2012).

Allowing public access to this data empowers local municipalities to conduct CBPR (Wesley & Jackson, 2012). This was demonstrated through HHD with the "block captain system" and accompanying app to record at-risk housing. WE ACT, New York's first environmental justice organization, was created to improve environmental health and quality of life in communities of color. The main objective for WE ACT is to "build healthy communities by ensuring that people of color and/or low-income residents participate meaningfully in the creation of sound and fair environmental health and protection policies and practices." (WE ACT, 2020). There is evidence of successful collaboration to address complex environmental concerns impacting marginalized communities through the development of capacity, technical expertise, and tools using CBPR. Issues that were addressed included siting and location of point sources of pollution that were impacting health outcomes of the surrounding communities. These included legacies of contamination of drinking and recreational water, mining, military, and agricultural impacts (McOliver et al., 2015). By using these innovations and empowering communities, it is possible to tackle various aspects of the lead crisis and address lead poisoning in vulnerable populations.

Read NEHA's official position statement on racism and environmental health:

https://www.neha.org/sites/default/files/publications/position-papers/NEHA-Racism-Position-Statement-July2020.pdf

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