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Issue Brief

Lead and Crime: A Review of the Evidence and the Path Forward

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Introduction

The "lead-crime hypothesis" holds that childhood exposure to toxic lead is a major driver of criminal behavior in adulthood. It has circulated among academics for a long time and was brought into more general public view by an article in *Mother Jones* in 2013.[1] Now is a good time to revisit the issue, as federal legislators push to spend billions of dollars getting rid of the nation's remaining lead pipes and service lines.

Several careful, well-designed studies conclude that lead exposure affects crime rates, but there is also a continuing debate regarding exactly how strong the relationship is. A recent meta-analysis, for example, estimates that lead reduction could have driven anywhere from 0% to 36% of the decline in homicides during the 1990s. Meanwhile, the blood-lead levels in American children are a small fraction of what they were decades ago, with only a small percentage of children having clearly problematic levels. Among these children, there are several key sources of lead exposure—and while water is among those sources, it is not the dominant problem. This paper reviews the evidence for the link between lead exposure and crime, explains the status quo regarding Americans' lead exposure, and recommends that Congress should pursue a less water-focused attempt to reduce lead levels further. In any event—given how small the remaining problem is—policymakers should not expect dramatic improvements in nationwide crime rates or other outcomes to result.

The Case for the Lead-Crime Link

Lead is a neurotoxin. Chemically similar to calcium, it can penetrate the blood-brain barrier.[2] Once in a human brain, especially one belonging to a developing child, lead damages the organ and interferes with development.[3] Reductions in IQ and self-control are two of its documented effects.[4]

As a result, hardly anyone would deny the possibility that lead can affect criminal behavior. But the question is: How much? Could it, for example, have been a major driver of the nationwide violent crime rate for much of the previous century?

The theory that lead has been a major driver begins with a striking relationship between two trends. The lead content of gasoline rose steadily from the 1940s until about 1970, after which point it fell quickly, reaching approximately zero by the end of the 1980s. The violent crime rate, as measured by the FBI's Uniform Crime Reports (UCR), followed exactly the same shape—only delayed by a little more than 20 years.[5] The intriguing possibility is that early-childhood lead exposure drove the increase *and* the decrease in crime as the children affected by these changes became adults.

By itself, this linkage is far from airtight. It could be a coincidence, not to mention that the UCR trendline is only one way of looking at crime. As a 2016 paper[6] pointed out, because the FBI data come from police departments, they do not include crimes that are not reported to the police or not recorded properly. Other measures present a different picture. The records of homicides are much stronger, for example, than those of other crimes—not only because of the severity of the crime but because public-health authorities, in addition to police departments, track homicide deaths. These records show different trends during the 1970s and 1980s, a mostly steady level with some ups and downs, rather than a constant rise. The trends are similar in surveys asking Americans about their experiences with crime, another major way of measuring crime trends. Moreover, the soaring number of violent crimes recorded in UCR during this period may be the result of changes other than actual crime, including the growing use of computers and 911 call systems to keep records, as well as shifting attitudes toward violence against women. And, of course, lead competes with numerous other theories when it comes to explaining broad crime trends—especially the 1990s crime decline—from changes in incarceration, to the use of CompStat as a policing tool, to even the legalization of abortion.[7]

But that's where a number of much stronger analyses, many from just the past decade, come in. They don't merely show a simple correlation between lead and crime—which could be dismissed as a coincidence, as suggested above, or as a result of the fact that lead exposure is correlated with other variables linked to crime, such as poverty. Instead, they found "natural experiments" in which lead levels changed more or less randomly across different places, allowing researchers to divide such places into treatment and control groups.

Thus, in the U.S. and Sweden, the end of leaded gasoline affected different places in different ways and at different times. This allowed researchers to study whether shifting exposure patterns correspond to changes in crime rates. In other words, researchers did not look crudely at broad nationwide lead and crime trends; instead, they checked to see if differences in lead trends can be matched with differences in crime trends within a country.

In a 2007 study using American data, Jessica Wolpaw Reyes found that a 10% change in lead exposure from gasoline corresponded to, on average, an 8% change in violent crime two decades later—and that the overall elimination of leaded gas could have reduced violent crime by more than half. (There was less evidence of an effect on murder and little evidence of one on property crime, however.)[8] And a Swedish study last year found that changes in lead exposure, as measured in the moss found in different neighborhoods, corresponded to changes in criminal convictions, as well as academic performance in high school.[9]

Another study of U.S. data looked at crime in the 1920s and 1930s, by which point some cities had been using lead pipes to deliver water for decades. Whether cities exposed their residents to lead this way depended on several random factors—such as the rail distance from the city to the nearest lead refinery (which affected how expensive lead pipes were, relative to iron ones) and the acidity of the water (as acidity corrodes lead, causing it to leach into the water). Homicide rates were far higher in cities exposed to lead through these factors—more than twice as high, in one version of the analysis.[10]

A New Challenge

There is a growing literature of striking claims about the relationship between lead and crime. However, a recent meta-analysis—which aggregates the existing literature and looks for patterns in the statistics—has challenged the emerging consensus.[11]

The paper raises important questions. First, the rigorous studies in the U.S. and Sweden noted above are in the minority; most of the existing lead-crime research relies on much simpler and less compelling research designs. Second, there are extremely strong signs of "publication bias," in which results supporting a lead-crime link are published while other results are missing from the literature. (Such bias leaves behind statistical evidence, even if the unpublished studies are never seen, typically depicted in a "funnel plot.") Third, when the authors of the meta-analysis extrapolate their results to estimate how much of the 1990s decline in homicides lead could explain, they found a range of 0%–5% when relying on the statistics from the strongest studies and a far wider range of 3%–36% when including all the studies. Obviously, this does not rule out a substantial lead-crime link, but it's a very different picture from the one presented above.

Naturally, this isn't the end of the matter, and one should expect the academic debate to continue. In the wide-ranging and growing literature on lead crime, a meta-analysis necessarily includes judgment calls about which studies are worth paying the most attention to and which results within those studies are most likely to represent the true effect, and even how to express the findings mathematically.

For instance, in order to combine so many studies into a single analysis, the authors needed to convert all the results to a single metric—a "partial correlation," which expresses the strength of a relationship between two variables, in this case lead and crime, on a scale of –1 to 1. In some cases, studies touting enormous results appear much weaker in the context of the meta-analysis. According to the meta-analysis, the typical partial correlation in the 2007 Reyes study is about 0.06, considered a very small effect—while the headline result from the study itself is a large "elasticity" of 0.8 between lead and violent crime, meaning that when lead exposure goes up 10%, violent crime goes up 8%.

Reached via e-mail, Reyes said that the meta-analysis was "interesting" and appeared "carefully done" but noted that economists generally see elasticities as a useful way of thinking about effects and that she remained "confident that there is a strong causal relationship in which childhood lead exposure increases the likelihood of committing violent crimes." She added that, given the diverse settings and approaches of the lead-crime literature, it may be an especially difficult area to collapse into a single meta-analysis.

What's Next?

In a certain sense, however, the debate about 20th-century lead-crime trends is academic. The sky-high lead levels of 50 years ago are gone, never to return.

Blood-lead levels are measured in micrograms per deciliter (µg/dL), and in the worst years of America's lead problem, double-digit blood-lead levels were the norm, not the exception. In 1960, these levels weren't considered elevated unless they exceeded 60 µg/dL. By 1991, however, levels had fallen to the point that the Centers for Disease Control (CDC) could begin using 10 µg/dL as the cutoff. In 2012, it cut that number in half.[12]

Per CDC's most recent "exposure report," the median blood-lead level as of 2015–16 was below 1 µg/dL, for children aged 1–5 and for the general population. Even at the 95th percentile of the population, those levels were below 3 µg/dL, meaning that 19 out of 20 Americans have lower blood-lead levels than that.[13]

This progress has been the product of much effort and policy change. Americans stopped burning leaded gasoline, using fresh lead paint, and installing new lead pipes decades ago. Under federal law, lead levels are monitored in the water that we drink,[14] the air that we breathe,[15] and our children's blood[16] to identify lingering problems and remediate them. Numerous funding sources are available when action is needed.[17]

The current environment raises a new question: How much lead is too much?

It is commonly said that there is "no known safe level" of lead, and there is talk of bringing the CDC threshold even lower, on the strength of some studies finding a link between lead levels below 5 µg/dL and outcomes such as IQ.[18] The Swedish study discussed above, however, muddies the discussion. It finds that there are thresholds where lowering lead levels has little detectable effect on many key outcomes. As mentioned, that study relies on a measure of lead levels in neighborhood moss, but the authors report that the key thresholds correspond to average blood-lead levels in those neighborhoods of about 5 µg/dL for high school completion and noncognitive skills and 7 µg/dL for crime—though there isn't a clear threshold effect for high school GPA. For cognitive skills at age 18, meanwhile, the authors failed to find a significant effect, even at higher thresholds. (Thanks to Sweden's low traffic density and its banning of lead paint and pipes as far back as the 1920s, however, even the earliest cohorts in the study had average levels below 10 µg/dL.) The authors further highlight some limitations of studies that reach more alarming results, including small sample sizes and an inability to address statistical confounding, and they call for more research to confirm the location of any important thresholds.

Still, it seems fair to say that lead levels above 5 µg/dL should be a cause of great concern, that levels somewhat below that should make us wary as well, and that we should be open to further evidence. Our largest concern for the time being, in other words, should be children who have lead levels well above the national median.

Importantly, given how much of the problem has already been addressed and how few of these children there are, we should expect only marginal improvements in national outcomes as a result—not the night-and-day differences that some researchers attribute to the de-leading of decades past.

Nevertheless, there are numerous remaining sources of lead exposure. Some homes still have lead paint, which crumbles into toxic chips and dust. Some soil is still contaminated by the long-ago use of leaded gasoline and exterior lead paint—and can be "resuspended" in the air, especially during the dry months of the year (leading to a "seasonality" in blood-lead levels).[19] Some water sources, including private wells,[20] still involve lead plumbing.

There is no definitive tally of the relative importance of each of these sources, but in 2017, four scientists with the Environmental Protection Agency (EPA) released estimates from an elaborate mathematical model that brought together various sources of data. In that simulation, the top 10% of one-year-old children had levels of 2.39 μg/dL and up. Soil and dust accounted for 77% of their exposure, with food chipping in 16% and water accounting for just 7%. The numbers were similar for children aged 2–5. Water was much more important, however, for infants 0–6 months old, thanks to the tap water used to mix formula. In that youngest age range, the top 10% of children had levels of 2.15 μg/dL and up, with 52% of the exposure coming from soil and dust and 39% from water.[21]

The Biden administration painted a similar picture in a recent regulatory document:

> EPA estimates that drinking water can make up 20 percent or more of a person's total exposure to lead. Infants who consume mostly formula mixed with tap water can, depending on the level of lead in the system and other sources of lead in the home, receive 40 to 60 percent of their exposure to lead from drinking water used in the formula.[22]

The supporting, rather than leading, role of water should not be a surprise, given that federal law already requires water systems to monitor their lead levels and treat water with "corrosion control" measures, if needed. With these measures properly implemented—and they are not always implemented—the nation's 6 to 10 million remaining lead service lines[23] can be reasonably safe, delivering water with low levels of lead and keeping residents' blood-lead levels well below the clearly problematic levels.[24]

Consider the water crisis in Flint, Michigan, in the previous decade. This was an undeniable disaster in which water delivered through lead plumbing was not treated properly; yet blood-lead levels did not increase as much as one might have feared. "No child should have been unnecessarily exposed to drinking water with elevated lead concentrations," noted a study in the *Journal of Pediatrics*, but "changes in [lead levels] in young children in Flint, Michigan, during the Flint River water exposure did not meet the level of an environmental emergency." In 2015, 3.7% of Flint children tested for lead at Hurley Medical Center—the "major single source that analyzes pediatric BLLS [blood-lead levels] in Flint"—had levels above 5 μg/dL; this was an increase from the previous two years, when the numbers were 2.2% and 3.3%, yet actually below the numbers recorded in 2012 and earlier.[25]

Policy Changes

Several efforts are under way to implement further lead remediation, often heavily focused on water. For example, tightening up EPA's Lead and Copper Rule, which governs the approach that water systems must take to lead, has been the focus of much effort by the executive branch. The Trump administration remade the rule last year,[26] but the Biden administration has suspended the changes to review them.[27] More aggressively, President Biden has pushed for $45 billion to remove all the lead pipes and services lines in the country, though the bipartisan Senate infrastructure package that recently passed the Senate contains only $15 billion dedicated to that purpose, half of which states will disburse as loans rather than grants. The bill also includes about $12 billion in more general drinking-water funds that governments can choose to apply to lead-pipe removal, as well as money to remediate former energy and industrial sites.[28]

In the context of the federal government, $15 billion or even $45 billion might be considered a drop in the bucket, so to speak, though reasonable people may disagree as to which level of government should be funding local pipe removal. While it's not possible to do a compelling cost-benefit analysis, owing to uncertainties about the effects of lead and the key thresholds, it is worth noting that crime alone—to say nothing about the other outcomes that lead affects, from school performance to cardiovascular disease—probably does about $1 trillion in harm per year (though the number is difficult to estimate with any precision).[29]

However, Congress should consider making its lead efforts less focused on water, a point that has been raised even by environmental groups that strongly support the removal of lead pipes. In a letter to the Biden administration earlier this year, the Green & Healthy Homes Initiative pointed out that "the biggest source of lead poisoning is from lead-based paint and its toxic lead dust."[30] A federal survey conducted about 15 years ago estimated that 37 million homes still had some lead paint.[31]

Beyond constituting only a small share of the country's overall lead problem, replacing lead pipes in many places poses immense practical and cost considerations. Some cities don't even have records of where all their lead pipes and service lines are located, and many service lines are considered private property.[32] Some experts doubt that even $45 billion would be enough to replace all our lead plumbing.[33]

If a locality's water has acceptable lead levels despite some use of lead plumbing, yet officials can point to other forms of lead exposure that could be addressed with additional funding, there's no reason to insist that federal money be spent on water. Congress could dedicate a separate funding stream to other sources such as lead paint—a Democratic bill in the current Congress includes $45 billion to address lead paint in low-income housing[34]—or simply allow localities to obtain funding based on the scope of their problems and their plans for stepping up remediation, whether they involve paint, soil, water, or case-by-case interventions to find out what's happening to specific children with high lead levels.

Such interventions were the subject of another "natural experiment" study. Children in Charlotte, North Carolina, who tested above 10 μg/dL twice in a row—which made them eligible for a lead intervention—had *better* outcomes, including when it came to antisocial behavior and school performance, than children who tested high once but slightly below the threshold the second time (meaning that they didn't receive the intervention).[35] Indeed, these case-by-case efforts seem to reverse much of the damage done by earlier lead exposure. To go along with a more flexible funding stream, federal agencies might also consider producing cost-effectiveness guidelines to facilitate easier comparison: if a place has $x to spend on remediation and soil, water, and paint exposure of A, B, and C, which use of the money will reduce blood-lead levels the most?

Removing lead from the environment has been a major success. But the work is mostly done; at this point, even the complete elimination of lead would probably not cause night-and-day changes in crime rates or other outcomes. Instead of a sprawling attempt to replace all lead water pipes nationwide, perhaps it is wiser to undertake carefully targeted efforts to help the very small share of Americans who still have high blood-lead levels, whatever the source of their lead exposure.

Endnotes

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