National Center for Healthy Housing

Issue Brief: Childhood Lead Exposure and Educational Outcomes

Lead exposure, even at low levels, has a significant negative impact on health and educational outcomes. This brief highlights recent research on the dangers posed by low-level lead exposure and the resulting financial and social costs. Lead exposure occurs more frequently in low-income children and children of color and is an important factor in the educational achievement gap between children of different racial and income groups. Investing in the prevention of lead exposure and improved housing quality will yield improvements in educational outcomes.

Childhood Lead Exposure Remains a Serious Public Health Problem

Childhood lead exposure, even at low levels, remains a critical public health issue. Tens of millions of U.S. children have been adversely affected by lead exposure in the years since its negative effects were first discovered. It is also a costly disease, with recent estimates putting its price tag at over $50 billion in a single year due to lost economic productivity resulting from reduced cognitive potential.[1,2] Children are exposed to lead in their homes from deteriorating lead paint and the contaminated dust and soil it generates, lead in water from leaded supply lines or plumbing, and other sources. Once a child's health or cognition has been harmed by lead, the effects are permanent and continue into adulthood.[3,4,5]

Over the past 50 years, a growing body of scientific evidence has documented the connection between elevated childhood blood lead levels (EBLLs) and neurological damage, decreased IQ, increased blood pressure, anemia, gastrointestinal issues, stunted growth, seizures, coma, and—at very high levels—death.[1,6] Recent research has found that even very low levels of lead exposure can have a detrimental impact on a child's IQ, likelihood of having a learning disability, educational attainment, and reading readiness at kindergarten entry.[7–10] Compared to adults, children are at greater risk for two main reasons: First, they are more likely to ingest lead and absorb a higher percentage of ingested lead. Secondly, their rapidly growing minds and bodies are more susceptible to lead's harmful effects.[7] Children of color and children living in poverty are disproportionately at risk for EBLLs.[1]

No safe blood lead level in children has been identified, and there is a direct relationship between childhood blood lead levels (BLLs) and the severity of resulting health and educational problems. Since lead poisoning is an asymptomatic disease at low levels, the only way to find out if a child has lead poisoning is to test his or her blood. The extent to which testing occurs varies greatly around the country. Some states, such as New York, Massachusetts, and Rhode Island, require universal screening.[11] In these states, every child must be tested for lead poisoning before entering school. Other states follow the Centers for Disease Control and Prevention's (CDC) guidelines, which call for targeted screening based on a set of risk factors. Medicaid requires that children be screened at ages 1 and 2.[12]

CDC has gradually lowered the blood lead level of concern (the BLL where intervention is recommended) from 60 micrograms of lead per deciliter of blood (µg/dL) in 1960 to 10 µg/dL in 1991.[13] Most recently, in January 2012, the Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended dropping the term "level of concern" entirely and using a "reference value" to provide a way to compare an individual child's blood lead level to a population of children the same age.[13] CDC concurred with this recommendation in May 2012. An accumulation of evidence showing negative health effects at very low levels of exposure supported this change. The current reference value is 5 µg/dL and will shift with population blood lead levels. An estimated 535,000 U.S. children ages 1–5 have BLLs greater than 5 µg/dL.[14] The ACCLPP report highlighted the importance of primary prevention, "a strategy that emphasizes the prevention of lead exposure, rather than a response to exposure after it has taken place."[13]

Childhood Lead Exposure Results in Negative Educational Outcomes

There is no safe level of lead exposure for children; lead affects intelligence even at very low levels.[1,3,8,15,16] Indeed, the rate of IQ loss per 1 µg/dL is greatest at lead levels below 10 µg/dL. As a child's BLL increases from 1 to 10 µg/dL, experts estimate a child may lose anywhere from 3.9 to 7.4 IQ points, but from 10 to 30 µg/dL the decrement is 2.5 to 3.0 IQ points. Low-level chronic exposure may have an even greater effect on IQ than a single instance of very high BLL.[17]

Research indicates that a five-point negative shift in IQ at the population level would increase the number of children with an "extremely low" IQ by 57%, substantially increasing the cost of special education programs.[4] Considering the costs to the special education system alone, one study conservatively estimated that it costs $38,000 over three years to educate a child with lead poisoning.[18] Low-level exposure to lead has also been linked to factors other than IQ that can further impact educational outcomes. EBLLs are associated with Attention Deficit Hyperactivity Disorder (ADHD) and antisocial behavior, which in turn increase the likelihood of conduct disorder, criminal activity, and drug abuse.[1,7] Each 1 µg/dL reduction in the average preschool blood lead level saves $13.4 billion from the direct and indirect costs of crime.[1]

Several recent studies have explored the specific effects of lead on educational outcomes. These studies show a strong relationship between slightly elevated blood lead levels in young children and decreased scores on end-of-grade tests in elementary school. While similar educational effects were documented for higher blood lead levels decades ago,[19] the recent studies confirm that the connection between blood lead and poor educational outcomes remains true for blood lead levels as low as 3–4 µg/dL.

These recent findings on the relationship between childhood BLL, educational potential, and performance on school tests puts IQ research in perspective.

- A series of North Carolina studies of over 57,000 children found that children with a BLL as low as 4 µg/dL at three years of age were significantly more likely to be classified as learning-disabled than children with a BLL of 1 µg/dL.[9] Researchers also found a dose-response relationship between end-of-grade test scores and BLL: BLLs of 3 µg/dL and above were associated with decreases in test scores.[20] Furthermore, children with a higher BLL were *less likely* to place into advanced and intellectually gifted programs. These results held true even when researchers accounted for factors such as race, family income, and other factors that might affect learning-disabled status. These results have been replicated in Connecticut, and researchers observed the same associations between elevated BLL and decreased achievement on reading and math tests.[21]
- In a study of over 48,000 school children in Chicago, BLLs as low as 5 µg/dL were associated with lower scores on third grade reading and math tests.[22] Researchers determined BLL had a strong relationship with test scores, similar to factors such as birth weight, maternal education, and race/ethnicity. Non-Hispanic black students in this study had an average BLL more than twice that of non-Hispanic white students.[22]
- A study of 3,400 kindergarten students in Providence, Rhode Island demonstrated that increased BLLs were associated with decreased scores on the Phonological Awareness Literacy Screening for Kindergarten (PALS-K), a standardized assessment of children's cognitive development and literary skills. Children with BLLs of $\geq$10µg/dL had PALS-K scores that were 13 points lower than children with BLLs $\leq$2µg/dL. The negative relationship between BLL and reading readiness persisted even after adjustment for demographic factors, primary language, and socio-economic status.[10]

Together, these recent studies show an alarming and consistent link between low-level lead exposure and the ability of children to do well in school. Despite these established connections, children may not be receiving the timely and appropriate educational services they need.[i] The Individuals with Disabilities Education Act (IDEA) requires that schools provide free, appropriate public education to all students with disabilities and obligates school systems to locate, identify, and evaluate children suspected of having a disability. IDEA explicitly references lead poisoning in one of the disability classifications, "Other Health Impairment," under which children ages 3 to 21 become eligible for special education services.[22] Additionally, under IDEA, infants and toddlers are eligible for early intervention if they are experiencing, or have a condition that is likely to result in, developmental delays.[24] However, states and local school systems do not fully use IDEA to ensure appropriate treatment for children with a history of lead poisoning, and parents often encounter difficulties navigating the system.

Childhood Lead Poisoning is Widening the Achievement Gap

Low-income children and children of color are at particular risk for suffering the adverse effects of lead exposure.[13] Studies of North Carolina school children highlight lead's contribution to the educational achievement gap between racial groups by linking individual children's BLL data to subsequent school performance. Consistent with prior disparities research, black children in these studies fell disproportionately into groups with EBLLs while white children were more likely to have low BLLs. Only one in four black children included in one study had a BLL of 3 µg/dL or less, while almost half of white children had a BLL at or below 3 µg/dL.[20] In the Chicago study of BLL and third grade test scores, non-Hispanic black students had a mean blood lead level of 7.7 µg/dL—more than twice that of non-Hispanic white students at 3.7 µg/dL.[22] Environmental lead exposure can be the deciding factor in whether children of color test into advanced learning programs or are placed in learning-disabled groups.[9] One of the North Carolina studies found that once BLL was taken into account, race was no longer a predictor of being classified as learning-disabled. In the Rhode Island study, approximately 35% of students did not meet the minimum threshold for PALS-K performance in the fall of their kindergarten year. Fall scores were consistently lower for children of Hispanic ethnicity, who received a free lunch, and had a geometric mean BLL $\geq$10µg/dL.[10]

Lead Exposure Results in Inequities that Span Across Generations

The impacts of low-level lead exposure extend across generations through the close relationship between health and educational outcomes. Maternal education and socioeconomic status are strong predictors of lifelong health. Reducing the average BLL of today's children will improve educational achievement for tomorrow's parents, and will, in turn, set the stage for both improved health and educational outcomes for their children. This positive feedback loop indicates that the Healthy People 2020 objectives for lead and education are inextricably linked. If the U.S. achieves the Healthy People 2020 goal to lower the average BLL of the population aged one to five years to 1.4 µg/dL, then attaining a rate of 82.4 percent of students attending public schools and graduating with a regular diploma 4 years after starting 9th grade will become a more achievable goal.[25] Consequently, higher educational achievement will contribute to improved health for the U.S. population.

Investing in Lead Poisoning Prevention Will Positively Affect Health and Educational Outcomes and Produce Societal Benefits

As the nation strives to improve its education system and school performance, lead exposure cannot be overlooked as a critical determinant of educational outcomes. Reducing childhood lead exposure will require a long-term commitment to lead poisoning prevention from schools, parents, and all levels of government. In addition, the recent findings on the relationship between childhood lead exposure and the educational achievement gap highlight the need for improved interagency coordination between those concerned about lead poisoning prevention and those focused on education system improvements. In the case of the Providence study of BLLs and reading readiness, the analysis could be conducted only because the ongoing relationships and collaboration between the public health and educational systems made the data linkages possible. Lead exposures can be reduced, and children, their families, and society as a whole will share the benefits through improved health outcomes, improved educational outcomes, and decreased costs.

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[i] *The Advisory Committee on Childhood Lead Poisoning Prevention has charged the Educational Interventions for Lead-Exposed Children Work Group with updating existing CDC guidance on the developmental needs of lead-exposed children. The Work Group is charged with: compiling existing evidence; reviewing IDEA parts B and C, Special Education and model regulations to provide guidance to state and local governments; and describing specific action steps for parents, clinicians and educators. For more information, visit: http://www.cdc.gov/nceh/lead/ACCLPP/educationWG.htm.*

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