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International Implications of Lead Poisoning in School Aged Children

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International Implications of Lead Poisoning in School Aged Children

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Abstract

The United States and the World Health Organization have worked to decrease lead exposure in children, but despite these efforts lead poisoning continues to exist in industrialized and developing countries. Prevention is the only way to preclude the health, academic and behavioral problems that occur due to the effects of lead. Public awareness remains a critical factor in prevention as the problem has not gone away, yet research on the effects of lead poisoning on school aged children is largely absent in educational journals. The effect of lead poisoning on health, academics, and behavior is reviewed.

Keywords

lead poisoning in children, lead poisoning effects

Introduction

Despite efforts by the United States and the World Health Organization to decrease lead exposure in children, lead poisoning continues to exist in industrialized and developing countries. Lead poisoning has long range effects on children, physically, academically, and behaviorally. A small amount of lead toxicity can cause physical harm and is associated with learning and behavioral problems**.** While Blood Lead Levels (BLLs) have continued to decrease in Industrialized/developed countries there is disparity among race and socioeconomic status. Lead continues to pose a major health hazard to developing countries with marginalized populations, where 90% of children with elevated lead levels reside. Population-wide loss of IQ points from lead exposure leads to decreased productivity and loss of earning potential.

What Are the Effects of Lead Poisoning and How Does It Occur?

Wick (2013) reports lead exposure causes irreversible cognitive and neurobehavioral abnormalities that reduce IQ. Schwartz (1994) estimates a 2.6 point decrease in IQ for every 10 pg/dL. Even low levels of 3-8 can cause mild IQ decreases and/or attention deficit disorder. Effects of lead exposure can also be growth related, as children exposed to lead are typically smaller sized than same aged peers. Lack of energy, lack of appetite, anemia, neuropathy, central nervous system damage, seizures, delayed development, learning problems, behavior problems, and/or renal dysfunction are additional effects that can occur (Center for

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Disease Control and Prevention, 2015).

Lead poisoning occurs by swallowing or inhaling a substance with lead. Lead gets into the blood stream and the body stores it in organs, tissues, bones and teeth. Lead poisoning can occur suddenly when an individual is exposed to a large quantity of lead, but it usually builds up in the body slowly over months or even years, as seen in children exposed to small amounts of lead over time (Center for Disease Control and Prevention, 2015). Research shows that lead can also be transmitted prenatally (O'Malley & O'Malley, 2015; Ris, Dietrich, Succop, Berger, & Bornschein, 2004).

In Industrialized countries, products imported from countries that do not regulate or enforce lead guidelines continue to expose consumers to lead. Products such as candies, toys, children's jewelry, mini blinds for example may not be on consumers' radar as a health concern, but may contain lead. Drinking water can also be contaminated when lead leaches into the water as it flows through lead pipes, solder, valves or brass fixtures. The most common sources of children's lead exposure occur from paint chips or dust even when paint is not peeling, and from contaminated soil. When paint becomes old or worn from activity like rubbing (such as doors, windowsills, painted cupboards or stairs), lead paint can get ground and scattered, and dust and soil can become contaminated. The same happens when paint is disturbed during remodeling or destruction (Center for Disease Control and Prevention, 2015). Children who play on porches can be exposed to porch dust containing lead (Wilson, Dixon, Jacobs, Akoto, Korfmacher, & Breysse, 2015).

Parents may also bring home lead particles on their clothing, or bring scrap materials home from work environments (construction, repair shops) or hobbies (fishing weights, bullets, or stained glass). Exterior dust can be tracked in or blown in, contaminating floors and surfaces. Communities with high traffic areas and/or industrial pollution may have soil contaminated with lead (Center for Disease Control and Prevention, 2015).

Children under six are most at risk because they crawl on the floor, often put their hands in their mouths, and may eat non-edibles. Young children experience more significant effects of lead as growing bodies absorb lead at a higher rate, and children's brains are developing quickly throughout the time when they are most likely to be exposed (O'Malley & O'Malley, 2015).

What Are Acceptable Lead Levels?

Any amount of lead can cause toxicity, and even low levels are associated with learning and behavioral problems. Subsequently, in June 2012, The Center for Disease Control (CDC) decreased the reference value from 10 micrograms to a marker of 5 micrograms per deciliter (5 pg/dL). Evens (2012) posits that often the assigned level by the CDC is interpreted as an acceptable or safe level of lead that does not warrant action or concern, unduly allowing children to continue to be exposed to lead. Additionally, the CDC threshold levels are considered as benchmarks by other agencies "when setting action levels for lead in dust, water, food, consumer products and in other environments" (p. 116).

Although guidelines vary by country, any amount of lead can cause toxicity, and even low levels are associated with learning and behavioral problems. Subsequently, in June 2012, The Center for Disease Control (CDC) decreased the reference value from 10 micrograms to a marker of 5 micrograms per deciliter (5 pg/dL). Currently, over 450,000 children in the United States have blood lead levels greater than 5 micrograms per deciliter. Evens (2012) posits that often the assigned level by the CDC is interpreted as an acceptable or safe level of lead, that does not warrant action or concern, allowing children to continue to be exposed to lead. Additionally, not all countries follow the CDC guideline. Germany set a more aggressive guideline at 3.5 micrograms per deciliter (3.5 pg/dL).

In contrast, Canadian researchers O'Grady and Perron (2011) claim "Canadian public health discourse portrays this [lead] issue as a problem of the past or a US problem" thwarting public concern, however, they explain political power struggles resulted with Health Canada as the "dominant authority, thereby regulating important research initiatives to obscurity and also shaping a vastly weaker regulatory response to lead than occurred in the United States" leaving no legislative protection for Canadian children (p. S176). Canadian lead issues were thought to be a problem of the past since lead was removed from paint and gasoline; however, children are still living in lead contaminated environments. O'Grady and Perron assert Canada has "unfinished business with lead-based paint" (p. S182). Further, monitoring in Canada is inconsistent or non-existent across communities, and when monitoring does occur, higher guidance levels of 10 micrograms per deciliter identify less lead exposed children.

Taylor, Winder, and Lanphear (2014) assert policies that aim to keep lead below a particular bar are "obsolete and will inevitably fail to protect children from the toxic effects of lead" (p. 114). Taylor et al. state that in Australia, there is overwhelming evidence that the lead level set (10 pg/dL) is too high, and "procrastination on this issue will be the thief of an equitable and healthy start to life for Australia's lead exposed children" (p. 116).

Lead Poisoning and Academic Achievement

The results from Ris et al. (2004) investigation indicates prenatal exposure to lead has an impact during the early years particularly for males in the area of attention and visuoconstruction (fine motor visual-spatial awareness and construction), with effects diminishing by the end of preschool, while post-natal exposure for both males and females has more long term wide range developmental effects.

Other studies show that even low levels of lead poisoning in early childhood can impede education in the elementary school years, and also contribute to the achievement gap. The objective of Miranda, Kim, Overstreet Galeano, Paul, Hull and Morgan's research (2007) was to determine if blood lead levels in early childhood were related to educational achievement in elementary school, as measured by end of grade testing. Using the same sample population, they linked blood lead level surveillance data from a state registry in North Carolina to later academic achievement, controlling for limited English proficiency. They assert positive blood lead levels in early childhood are related to lower educational achievement, with more impact being noted in reading than mathematics. They also noted that a higher proportion of black children had higher lead levels, stating "low-income and minority children are systematically exposed to more lead in North Carolina and nationally" (p. 1247). Evens (2012) also notes that lead poisoning rates are consistently reported to be higher in urban geographic areas across the United States.

Zhang, Baker, Tufts, Raymond, Salihu, and Elliott (2013) assessed the long term effects of early childhood lead exposure by linking surveillance data from the Detroit Public Health Department and academic achievement, more specifically, standardized test scores in grades 3, 5, and 8, adjusting for racial and socioeconomic disparities. Their data set consisted of 21,281 students (8831 in grade 3, 7708 in grade 5 and 4742 in grade 8). The sample was 56% male, and 91% black. Zhang et al. found a significant association between lead exposure and the academic achievement scores as measured by the MEAP, a standardized test taken by Michigan public school students from elementary through junior high school. Applying multivariate logistic regression analysis to determine the effects of childhood lead exposure in respect to math, science, and reading scores, they found the response relationship suggests the higher a student's blood lead level was in early childhood, the worse he or she performed on the test. Their study also showed that lead levels less than 5 pg/dL was still adversely associated with academic achievement. Significant is the fact that their study looked at affects at grade 8, demonstrating that early lead exposure can have long term effects on cognitive outcomes.

Though the focus of studies tends to be centered on urban areas, lead poisoning can occur in any geographic location. Thatcher, Lester, McAlaster, Horst and Ignasias (1983) conducted one of the few studies with a rural population on the eastern shore of Maryland. Their sample of 149 children were primarily white (124), with 68 of them being males and 81 females. Although all students were in the public school system, participants were recruited via newspaper advertisements and with cooperation form the Somerset County Board of Education. The researchers were unaware of each student's academic standing and cognitive abilities. Psychometric tests were administered, with children 6 to 16 assessed using the Wechsler Intelligence Scale for Children (WISC-R) and the Wechsler Preschool and Primary Scale of Intelligence administered to 5 year olds. In addition, the Wide Range Achievement Test (WRAT) was used to assess school achievement; the Motor Impairment Test (MIT) was administered to assess gross body coordination and manual dexterity, and the Purdue Pegboard Test to assess fine motor movements. Groups were established based on academic standing of gifted, normal, low achievers, and very low achievers, based on each child's WISC-R and WRAT scores. Using hair sample taken from the nape of the neck, Thatcher et al. discovered, by using regression analyses, a systematic and strong relationship exists between the concentration of lead in children's hair and their intelligence test performance. They assert that cognitive function is "affected before any signs of gross motor impairment are seen" (p. 355). Exposure to low levels of lead affected cognitive processes; however, motor movements were not affected, leading the researchers to believe cognitive functioning "seem to be more sensitive indicators of the effects of low levels of lead" (p. 358).

Lead Poisoning and Behavior

The Treatment of Lead Exposed Children study enrolled 780 urban children exposed to lead from four geographic areas (Baltimore, Newark, Philadelphia, and Cincinnati), measuring blood lead levels in the children periodically between age 2 and 7. At age 5, the Conners' Parent Rating Scale- Revised (CPRS-R) was administered, and at age 7, the Behavior Assessment System for Children (BASC) was administered. Controlling for IQ, data showed that lead exposure was associated with behavior problems, with "increased risk for teacher rated externalizing and school behavior problems and parent rated behavioral symptoms index" (Chen, Cai, Dietrich, Radcliffe, & Rogan, 2007, p. 654).

The effects of lead poisoning on behavior have been documented to go beyond the childhood years. In a longitudinal study conducted by Dietrich, Ris, Succop, Berger, and Bornschein (2001), they found both prenatal and postnatal lead poisoning was associated with antisocial acts and delinquency. The researchers recruited 216 adjudicated delinquent youths from the Cincinnati Lead Study. In a case control study, they found these youth had significantly higher concentrations of bone lead than a control group of socio-demographically youth from students who attended high school in Pittsburg. The subjects, between 15-17 years of age, and their parents reported increased frequency of delinquent acts, not associated with other risk factors.

Wright, Dietrich, Ris, Hornung, Wessel, Lanphear, Ho, and Rae (2008) followed lead exposed children into young adulthood. In Cincinnati, Ohio, they compared the arrest records of 250 individuals aged 19-24, whose families were recruited at birth for the study, between 1979 and 1984. Prenatal blood exposure was measured in the late first or early second trimester, and the children were measured first quarterly, then biannually, through age 6.5 years old. Arrest records were obtained from Hamilton County spanning from age 18 to the participants current age. The sample was largely African American (90%), with relatively equal amounts of males and females, with 73% of the families having the lowest or second lowest socioeconomic status as measured by the Hollingshead Four Factor Index of Social Position. The researchers identified a total of 800 arrests, with 108 for violent offenses, with no significant difference by sex, demonstrating "an association between developmental exposure to lead and adult criminal behavior" (p. 732). The researchers' question whether "one factor in the disproportional representation of African-Americans in crime statistics could well be the historically higher exposure to lead in these communities" (p. 101). Needleman, McFarland, Ness, Fienberg, and Tobin (2002) conducted a similar study of 194 adolescents aged 12-18 in Alleghany County, Pennsylvania, and did not find delinquent behavior confined to one race or ethnicity. Their data showed an "association between lead at asymptomatic doses and adjudicated delinquency" (p. 716).

Why and Where Does Lead Poisoning Occur?

Industrialized Countries

Despite initiatives by the United States to ban lead from paint in 1978 and from gasoline in 1996, lead poisoning still remains a problem in the nation today. Childhood lead exposure occurs in industrialized countries, where poor government decisions and environmental accidents have negatively affected or potentially affect the well-being of their children. Simply overlooking geographic pockets where there are residual high levels of lead is also problematic.

Accidental Exposure

The Gold King Mine waste spill in 2015 created an environmental disaster near Silverton, Colorado when workers accidentally released three million gallons of mustard yellow colored toxic waste water from the mine into Cement Creek, a tributary of the Animas River. The acid mine waste water contained lead, and other metals and toxic elements. The Environmental Protection Agency (EPA), who took responsibility for the spill, was criticized for not letting the residents of Colorado and New Mexico know until the day after the spill. Local residents were warned not to drink, bathe in or fish in the waters. Environmental impact included contaminated wells in flood plains, and fishing, farming, and implications for animals including livestock until sedimentation dilutes the pollutants. Although the mustard color of the water disappeared, invisible toxins remained. The EPA continues to monitor the water, irrigation waterways have been flushed and water has returned to pre-spill levels. While short term consequences have been addressed, the long term effects are yet to be determined (Chief, Artiola, Wilkinson, Beamer, & Maier, 2015).

In April 2014, in Flint, Michigan, as a cost saving measure, the state switched the water supply for the city of Flint from Lake Huron to the Flint River. The decision proved dangerous and costly to the residents of Flint, exposing over 100,000 residents (over 9,000 children six and under) to lead and other contaminants when corrosive Flint River water caused lead to leach from pipes and fixtures into the water. Data collection indicated lead levels doubled and in some cases tripled in toddlers who were tested. The city of 100,000 no longer has a grocery store, which compounds access to clean bottled water. As exposure to lead has a long term effect, local pediatrician Hanna-Attisha (in Ganim and Tran, 2016) states:

> If you were to put something in a population to keep them down for generation and generations to come, it would be lead. It's a well-known, potent neurotoxin. There's tons of evidence on what lead does to a child, and it is one of the most damning things that you can do to a population. It drops your IQ, it affects your behavior, it's been linked to criminality, it has multigenerational impacts. There is no safe level of lead in a child. (http://www.cnn.com/2016/01/11/health/toxic-tap-water-flint-michigan/)

Disproportionality by Income and Race

In the United States, there are disproportionate numbers of children who test positive for lead poisoning by income and race. Although strides have been made over the last 40 years, racial disparities remain firmly intact. With the dwindling of public resources, lead poisoning is placed low on public health and education agendas.

Currie (2005) indicates that poor and black children are more likely to demonstrate unsafe lead levels, "increasingly correlated with minority status, poverty, and residence in decaying older neighborhoods" (p. 125). Zhang et al. (2013) assert that a significant number of properties in low income areas have been poorly maintained, and "inadequate attention to this issue may lead to the reemergence of this preventable environmental problem, turning the clock back on years of national, state, and local successes" (p. 72). Further compounding the problem, Waterhouse and Smith (2015) report that the state of Indiana is not on target to meet the goal to eradicate lead by 2020. "The state continues to fall short of the federal minimum screening guideline, which requires that all Medicaid recipients be tested" but Indiana "consistently tests fewer than 36% of Medicaid recipient children" (p. 100). Additionally, Indiana uses the higher guideline of 10 pg/dL, and according to Waterhouse and Smith (2015), this undercuts the number of children identified as being exposed to lead in the state. This demonstrates the inconsistencies evident in lead screening and interpretation of guidelines, as well as supports the assertion that lead poisoning is placed low on the public health agenda. Indiana also focuses on lead based paint; however, much of the exposure to the children in the state comes from soil-based contamination.

Evens (2010) states that children who were born outside the country or those who lived outside the country within six months before their blood tests also showed particularly elevated risks for lead poisoning, in comparison to their U.S. born peers (p. 19). The CDC (2015) also reports that parents may rely on home remedies of medications from foreign countries that are not regulated for lead. Examples of such remedies are Greta or Azacon, a Hispanic remedy for upset stomach, Litargirio used as a deodorant especially in the Dominican Republic, and Ba-baw-san, a Chinese herb used to treat colic. Ghasard, a tonic used in India and Daw Tray, a digestive aid used in Thailand, as well as other traditional cultural medicines and remedies have all been traced back to cases of lead poisoning (Mayo Clinic, 2015).

Developing Countries

While Blood Lead Levels (BLLs) have continued to decrease in Industrialized/developed countries, they continue to pose a major health hazard to marginalized populations, as 90% of children with elevated lead levels reside in developing countries. Population wide loss of IQ points leads to decreased productivity and loss of earning potential. Attina and Trasande (2013) report an estimated total cost of $977 billion of international dollars lost by low and middle income countries based on the "relationship between lead exposure and dose-related decrements in IQ score, the latter in turn being associated with decreased lifetime earning power" (p. 1099). Public awareness of the harmful effects of lead are low in many of these communities, and the rest of the world is not paying attention (Kessler, 2014). Sources of lead exposure can come from environmental circumstances such as living near lead mining, smelting, battery recycling, or gold-ore processing plants. Despite some mine closures, scavenging of metal scraps in abandoned mines and wastes continue to serve as sources of metal pollution.

In Kabwe, the capital of Zambia's central province, extensive soil contamination from lead-zinc mining poses a significant health hazard (Yabe, Nakayama, Ikenaka, Yohannes, Bortey-Sam, Oroszlany, Muzandu, Choongo, Kabalo, Ntapisha, Mweene, Umemura, & Ishizuka, 2015). Yabe et al. report that few studies investigating the impact of mining and processing plants in developing countries occur. Their study focused on identifying high lead levels in children under the age of seven who need medical intervention, in two towns where high BLLs were found. The townships were selected due to high levels of lead in the soil, likely due to vehicle traffic and mine dust. Of the 246 children tested, all had alarming BLLs of toxicity, eight children demonstrating levels of 150 through 427 micrograms per deciliter, well above the guidance level of 5 micrograms per deciliter (Yabe et al., 2015).

In Nigeria, more than 400 children died, and others were left with numerous long-term neurological impairments as a result of gold-ore mining and processing. Exposure to lead dust through ingestion and/ or inhalation caused widespread outbreaks of childhood lead poisoning in Nigeria villages where gold-ore processing occurs (Yo, Dooyema, Neri, Durant, Jefferies, Medina-Marino, de Ravello, Thoroughman, Davis, Dankoli, Samson, Ibrahim, Okechukwu, Umar-Tsafe, Dama, & Brown, 2012). As the world-wide demand for gold has increased, rural communities have adopted small scale gold ore processing. Yo et al. (2012) investigated an outbreak of lead poisoning in children in two rural Nigerian villages. In these villages, 25% of the children under the age of five died from confirmed lead poisoning in the previous 12 months, with 82% experiencing convulsions before death. In response, their "objective was to rapidly identify and prioritize villages with childhood lead poisoning for interventions" (p. 1451). They collected indoor environmental samples from household floor dust from areas in villages where children ate and slept, and outdoor environmental soil samples from public areas. One hundred thirty one villages were identified, and the team focused on 114 of them due to time and logistical restraints; however 40 of these villages were not visited due to poor road conditions that made them inaccessible. Yo et al. (2012) assert that the environmental impacts of small scale gold-ore processing are often overlooked, illustrating the need for monitoring and prevention. Even with interventions such as public education about ways to reduce lead exposure, recontamination can occur when exposure factors are not eliminated (p. 1454).

Prevention is Multifaceted

Cost-Benefit Analysis

Gould (2009) completed a cost-benefit analysis in the United States. In a study that reviewed a cohort of children ages six and under who were exposed to lead based paint, she compared the cost of hazard control against the benefits of risk reduction (health care, lifetime earnings, special education, and the direct costs of crime). Gould determined, "given the high costs of societal costs of inaction, lead hazard control appears well worth the price" of targeted early interventions (p. 1162). Comparing the range of state surveillance data and national surveys against a range of costs of prevention and control, she estimated the cost of hazard control to be between $1-11 billion, far less than benefits reduction estimates (health care- $11-53 billion; lifetime earnings- $165-233 billion; tax revenue- $25-35 billion; special education- $30-146 billion; attention-deficit disorder- $267 million, and direct costs of crime- $181-269 billion), representing a net savings of $181-269 billion (p. 1162).

Awareness

As awareness about the implications of lead poisoning is spread by the World Health Organization and other international health organizations, many countries are attempting to decrease lead exposure. Research in Pakistan demonstrates the need to further explore sources of lead, after lead in petrol has been eliminated, but other sources such as lead based paints, traditional health care remedies, occupational hazards, lead in water sources, and cosmetics continue to be a major source of elevated lead levels among children. Further, maintenance of houses is relatively poor (Kadir, Janjua, Kristensen, Fatmi, & Sathiakumar, 2008). Kadir et al. report that it is difficult to garner a complete picture of the status of lead exposure in Pakistan as most studies were a result of convenience sampling.

Attempts to decrease lead exposure occurred in China in 2011 with the implementation of strict lead control policies, state Chen, Huang, Yan, Li, Sun and Bi (2014). China's childhood lead levels were significantly higher than developed countries, and Chen et al. (2014) assert lead poisoning still remains a common public health problem. Lead mines, lead processing plants, electronic waste recycling centers, and wire rope factories were cited as potential causes of lead exposure for children living near these sources. Chen et al. followed 106 children, ages one through 14 years old, each with a median time of four years of residence near a wire rope factory in the Zhuhang subdistrict. Environmental sampling included dust and soil sampling, vegetable and rice sampling, and drinking water sampling to measure lead exposure before and after lead usage control policies were implemented. Chen et al. posit there is widespread "disregard for environmental control" in lead related industries "in pursuit of economic growth" leading to weak and limited control by some local governments in China. Chen et al. found that strict lead pollution controls on the wire rope industry demonstrated success in decreasing lead levels in children living near wire rope factories, and "given the high childhood BLL in China, strict environmental control regulations in lead-related industries should be implemented to prevent lead poisoning in millions of Chinese children" (p. 12935). Li, Cao, Xu, Cai, Shen, and Yan (2014) agree that although the Chinese government has made strides in improving and preventing lead poisoning, "lead pollution and its adverse effects are still common in China" (p. 116).

Zhang et al. (2013) asserts that delayed or missed identification of children with elevated lead levels impacts school achievement and their health. Newman, Lowry, Mall and Berger (2013) discuss an "environmental health gap," noting that medical students and pediatricians "report low self-efficacy regarding environmental history taking, discussing environmental exposures with parents, and finding diagnostic and treatment resources related to environmental exposures" (p. 9). Ris, et al. (2004) alert us to the effects of prenatal lead exposure. Consistently completing an environmental assessment of expectant mothers and young children would identify children who are at risk of lead exposure sooner. Ducatman (2002) states that it can take greater than 10 years to turn over one half the body's stored lead, as lead in hair, nails and teeth has a very slow turn-over rate, which emphasizes the importance of early identification.

Maintaining a healthy and well balanced diet is important for all children, regardless of locality, in the fight against lead poisoning. Children who have insufficient calcium, iron and zinc tend to absorb more lead (Currie, 2005). Simple hand washing before eating can also cut down on lead particles being transmitted to food, or children placing contaminated hands into their mouths. Caregivers of young children should teach proper hand washing techniques that, hopefully, will carry over into other environments.

Furthermore, consumers who are completing minor home repair projects should take care against exposure to lead. Attempting to remove paint by sanding generates a large amount of small particles, and painting over it may not seal in the lead. Removal of lead paint should be supervised by a lead safe certified contractor, who will dispose of hazardous waste appropriately, according to the Environmental Protection Agency (2014). A list of lead safe certified contractors can be found on the EPA website. Waterhouse and Smith (2015) maintain in the United States, increased funding is necessary to address clean up measures. Individuals who live at or near the poverty line "should not be required to channel their limited resources to cleaning up the dangerous mess made by the unrestrained and remediated pollution caused by some of America's most successful companies" (p. 113).

"Lead in porch dust can expose children through direct contact or track-in to the home" state Wilson et al. (2015, p. 129). In Rochester, New York, they sampled 79 homes immediately after lead removal and found that the lead levels on the porches increased significantly, immediately after work was completed elsewhere in the home, but not on the porch. They assert that inadequate clean up after lead hazard removal can create areas that are more hazardous after the work was completed than before it was done. Wilson et al. advocate for guidelines or standards to be set for porch lead dust post clean up, "so lead hazard control activities do not inadvertently expose children to hazardous levels of lead dust" (p. 135).

Parents should also stay informed of product recalls, staying alert by checking the Food and Drug Administration website, searching for product recalls related to lead. Another way to stay informed of product recalls is by searching www.recalls.gov website. Parents and consumers can search this site specific to lead.

Summary

Lead poisoning in childhood remains a critical health concern despite public awareness. Given what we know about lead poisoning, researchers posit that the primary way to control for it is through prevention, as not only does exposure to lead affect school readiness, academic functioning, and behavior, it can have long term consequences for health and wellness (Currie, 2005; Evens, 2010; Miranda et al., 2007; Schwartz, 1994; Thatcher et al., 1983; Wilson, et al., Zhang et al., 2013). According to Kessler (2014), public health workers in the United States, who have been working to decrease lead levels across the nation, simply assumed that the rest of the world had followed suit. However, lead based paints continue to be freely sold in at least 40 countries, and although lead in gasoline/petrol has been eliminated in many countries, the residual effects of leaded gasoline remain.

Recommendations

The most critical factor in decreasing childhood lead poisoning is making the public aware of the adverse effects of lead exposure. While there are best practices for testing for lead exposure, there is little repercussion for not adhering to the current laws. Mandatory screening at school entry would identify additional children, but harmful effects of lead may have already occurred during the preschool years. Routine screenings during well baby exams are the best possibility for early identification. Equipment and testing supplies, however, can be costly and not readily available at all pediatricians' offices, resulting in many children falling through the cracks.

School personnel must address the needs of students affected by lead poisoning, and work with families to raise awareness as well as facilitate community connections regarding prevention and cleanup. Although recent literature can be found in health and medical journals, the absence of current literature in education data bases alludes that it is no longer on the radar of educational researchers. Considering the educational and societal implications, the lead problem warrants our attention.

The most significant impact on the war on lead will require eliminating exposure to lead contaminates. This will require enforcing regulations and funding for cleanup, including appropriate disposal of lead toxins. Ogunseitan and Smith (2007) assert that the return on the investment of lead hazard control is significant. The benefits derived from lead prevention in the long run could save billions of dollars per year. Though over time, costs of remediation can be 2-20 times higher than estimated costs of prevention, the upfront expenses associated with lead hazard control are of concern to tax payers and politicians who do not realize immediate benefits (Jones, 2012), and are overwhelmed by the potential costs. Legislation, however, can only be effective as a primary prevention strategy if consistently implemented. Rogers, Lucht, Sylvaria, Cigna, Vanderslice, and Vivier (2014) did not find consistent implementation due to non-compliant rental properties and properties with exemptions.

Subsequently, decreasing lead poisoning will require a collaborative and coordinated effort from parents, pediatricians, school personnel, housing authorities, nutritionists, and community organizations, with support and funding from local, state and national governments. Working as a team, the challenges of lead poisoning can and must be addressed.

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