# Preventing Childhood Lead Poisoning: A Review of Illinois' Efforts

**Dhitinut Ratnapradipa, Ph.D., Frida Fokum, Ph.D., Alicia Wodika, M.S., Sam Churchill, M.S.**

**ABSTRACT**

*Childhood lead poisoning can cause an array of symptoms that vary in severity depending on dose. Over the last decade the United States has taken drastic measures to administer preventive screening methods to decrease the number of children with elevated blood lead levels (EBLL). Historically, Illinois has had many issues with lead poisoning prevention, and although the number of children with EBLL has decreased over the last few decades, Illinois continues to lead the nation with one of the highest rates of EBLL. This article evaluates the compiled data pertaining to Illinois and the U.S, collected over ten years to assess patterns in lead poisoning screenings, prevention strategies, and outreach. State and national levels were researched for lead screening rates, percentage of children with EBLL 5/10µg/dL (5 and 10 micrograms per deciliter), specific counties and lead poisoning results (in Illinois), estimated numbers of homes built before 1980, and outreach efforts being utilized in Illinois and across the nation. Although Illinois continues to lead the nation in the number of reported childhood lead poisoning cases, the screenings tended to increase over time while reported cases of EBLL ≥10µg/dL decreased significantly.*

*Umwelt und Gesundheit Online, 2011; 4, 61-66.*

## Introduction

According to the United States Agency for Toxic Substances and Disease Registry (ASTDR) (2007), lead is ubiquitous in the environment, yet a majority of our exposure to lead is from anthropogenic activities including the output from factories and from the usage of fossil fuels. Although researchers identified paint as a source of childhood lead poisoning by the early 1900s (Gibson, 1904; Rabin, 1989; Silbergeld, 1997; Lanphear, 2005), the U.S. did not ban lead in paint until 1978 (Rabin, 1989; Lanphear, 2005). Leaded gasoline was also a source of lead contamination until it was banned in 1996 (U.S. Environmental Protection Agency, 1996; ATSDR, 2007).

Lead-based paint is problematic in older homes because it leads to lead-contaminated dust and paint chipping which is costly to remediate (Miranda, Dolinoy, & Overstreet, 2002). Childhood lead poisoning primarily affects children who reside in outdated rental units and those who dwell in older homes (Lanphear, 2005). In 2000, approximately 38 million homes across the U.S. had lead-based paint (Jacobs et al., 2002; Curtis et al., 2004; Jacobs & Nevin, 2006; Levin et al., 2008), many of which are disproportionately owned by low income families (Levin et al., 2008). Thus, although lead poisoning is non-discriminatory, is has been associated with minority and low socioeconomic status (Silbergeld, 1997; Illinois Department of Public Health, 2008). In general, Hispanic and African American children tend to have higher blood lead levels (BLL) than Caucasian children (Pirkle et al., 1998; Lanphear et al., 2002; Lanphear, 2005).

Lead poisoning occurs when an abundance of lead accumulates within the body, mostly caused by inhalation of dust or ingestion of lead-contaminated paint and/or other products (Illinois Department of Public Health, 2009a). Although BLL may go down if the lead source is remediated, lead can cause many irreversibly damaging effects to children (Bellinger & Dietrich, 1994; Lanphear, 1998). Lead poisoning can cause an array of symptoms that vary in severity depending on the amount consumed and acuteness. According to ATSDR (2007), children who consume an immense amount of lead over a short period of time can have extreme stomach pain, anemia, damage to the brain, and muscle weakness while exposure over a more prolonged period of time can cause impairments to the brain that may impede learning abilities and negatively affect the child's physical growth. In addition, lead exposure can occur through the maternal blood barrier causing "premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children" (ATSDR, 2007). The effects of lead exposure can also cause issues later in a child's development, and can even lead to concerns with school and increase the risk for criminal activity (Needleman et al., 1979; Denno, 1990; Needleman et al., 1990; Needleman et al., 1996; Dietrich, 2001; Wright, Dietrich, & Ris, 2004; Lanphear, 2005).

According to the Centers for Disease Control and Prevention (CDC) (2010), BLL ≥10µg/dL

(micrograms per deciliter) are cause for concern and require public health action. This number has been lowered over the last few decades when lead poisoning was associated with BLL greater than 60µg/dL (Lanphear, 1998). Although the action level has decreased, thereby classifying a larger pool of samples as "elevated," the number of children with elevated blood lead levels (EBLL) has decreased over the last few decades. In 1970, as much as 88% of children across the U.S. had EBLL (Annest, et al., 1983; Lanphear, 2005), whereas the National Health and Nutrition Examination Survey (NHANES) from 1976-1980 found that ~700,000 children had EBLL (Mahaffey, et al., 1982; Rabin, 1989). In the 1990s, however, blood lead levels decreased significantly in children under the age of six, with only 5% of this population having a level of 10µg/dL or greater (Pirkle, et al., 1998; Lanphear, 2005).

*Lead Poisoning in Illinois*

The Illinois Department of Public Health (IDPH) has monitored childhood lead poisoning cases since 1973 (IDPH, 2009b). In 1993, Illinois mandated lead screenings for children age 6 and under (IDPH, 2011). In 1995, Illinois required that children living in "targeted" or high risk ZIP codes be tested for lead exposure (Binns et al., 1994). Risk factors used to determine targeted areas included poverty levels and a ranking of the age of the housing: pre-1950s housing was at highest risk and post-1978 housing had the least risk. According to IDPH (2008), Illinois is estimated to have ~2 million housing units that contain lead-based paint, the vast majority of which are occupied; of this 2 million, approximately 20% are occupied by low income families.

Although the number of cases in Illinois has dramatically decreased since the late 1990s (IDPH, 2009a), Illinois continues be among the states with the most EBLL cases in the nation (CDC, 2010; IDPH, 2009b). In 2006, 4.2% of children in the state had EBLL; this is greater than the national average of 2.5% (IDPH, 2008). Mehta and Binns (1998) revealed that approximately 11% of children in Chicago who were tested had a BLL ≥15µg/dL.

Although EBLL can be fairly common with children dwelling in cities, many parents do not know how to prevent this from happening to their children. In a study by Mehta and Binns (1998) surveying Chicago parents for their knowledge on lead poisoning, they found that only 34% of parents obtained information regarding childhood lead poisoning from a physician. Using a combination of environmental and medical management strategies (Table 1), IDPH has taken many steps to try and reduce the number of children with EBLL.

## Purpose

We describe and analyze the trends of BLL and lead poisoning prevention in Illinois for 1997-2008. Over the decade, IDPH compiled, in the *Illinois Lead Program Annual Surveillance Reports*, data pertaining to the screening rates, EBLL, and specific county descriptive statistics on lead screening and outreach for the State of Illinois. This paper assesses the compiled data, pertaining to Illinois and the U.S. overall for patterns in lead poisoning prevention strategies and outreach. Illinois is one of the leading states with large numbers of children with lead poisoning (IDPH, 2009a); therefore, it is important to evaluate current research regarding lead screening rates and awareness.

## Methods

*Illinois Lead Assessment 1997-2008*

To determine the patterns for lead poisoning prevention and awareness, the *Illinois Lead Program Annual Surveillance Report* for both 2007 and 2008 were analyzed and compared with national data. All data pertaining to the state of Illinois was obtained from the IDPH Lead Program, whereas national data was obtained from the CDC. Data is primarily compared for the years through 2007 (the last year for which CDC data is available), although additional state data is included. In particular, both state and national levels were researched regarding the following topics: lead screening rates, percentage of children with EBLL 5/10µg/dL (5 and 10 micrograms per deciliter), estimated numbers of homes built before 1980, and outreach efforts being utilized in Illinois and across the nation.

## Results

*Illinois Screening Rates and Blood Lead Levels*

According to the U.S. Census Bureau, the estimated population for the U.S. in 2007 was 300,465,879 of which 24,755,834 were children aged 0-5 years. The estimated Illinois population for 2007 was 12,817,756 of which 1,066,553 were children aged 0-5 years, and another 179,560 were age 6. According to IDPH (2008), Illinois reported test results for 296,998 children (age 15 years and under) in 2007, of which 95% were age 6 years and under; the screening rate for children ≤6 years was 23.9% compared to a national screening rate of 14% in 2006 for children ≤5 years. In regards to race/ethnicity of children in Illinois with EBLL, in 2008, African American children had the highest percentage EBLL (5.7%), followed by Hispanic (5.0%), Asian (5.1%), and Caucasian (2.8%). As the screening rates in Illinois gradually increased from 19.6% in 1996 to 24.5% in 2008, the percentage of children in the state with EBLL decreased from 20.1% to 1.7%.

*State-by-State Comparison*

According to the CDC (2010), 16 states had at least 1,000 cases of children aged less than 6 years with BLL above 10µg/dL in 1997, but Illinois exceeded all states with 29,992 cases. By 2007, most states, with the exception of New Jersey and California, had drastic decreases in their reported cases of childhood EBLL. Pennsylvania and Illinois lead the nation with the most lead poisoning cases in the country, with 4,094 and 3,521 cases respectively (CDC, 2010). New York, another state with a history of lead poisoning cases, has significantly decreased their numbers over the last 30 years. According to Freudenberg and Golub (1987), New York saw a decrease in the lead poisoning cases from 30.4% (2,649 cases) in 1970 to 6.4% (1337 cases) in 1985 (Freudenberg & Golub, 1987). This decrease was recognized as being part of two key events: successful screening programs and the decline of leaded gasoline fumes.

*National Lead Statistics 1997-2008*

Across the U.S., the CDC compiled blood lead test results for approximately 3,262,866 children in 2006 with ~39,526 children having EBLL (1.2% rate) (IDPH, 2008). According to the 1999-2002 NHANES survey, there was a decrease in the number of children with lead poisoning (0.7%) when compared to the 1991-1994 survey (2.2%) (CDC, 2005). The 1999-2002 NHANES survey found that Caucasian children had the least amount of EBLL (0.5%) as opposed to African American (1.4%) and Hispanic children (1.5%). The average BLL for children 1-5 years old during the 2001-2004 NHANES survey was 1.7µg/dL, with African American children having the highest average (1.69 µg/dL). The 1999-2004 NHANES indicated a decreasing trend in the geometric mean for BLL for most age groups except children ages 1-5 (2.23, 1.70, 1.77 µg/dL) and children aged 12-19 years (1.10, 0.942, 0.946 µg/dL). Jones et al. (2009) examined the NHANES for the last 16 years and found a 84% decrease in the blood lead levels (≥10 µg/dL) of the nation's children from 8.6% in 1988-1991 to 1.4% in 1999 to 2004.

## Discussion

Differences in reporting can make direct comparisons of state and national data difficult. State of Illinois data reported total numbers of tests and EBLL, even when core fields (gender, age, address) had missing data. These "error" cases were not included in the CDC numbers, essentially leading to underreporting at the national level. Another difficulty in directly comparing the state and national data is the reporting age. Illinois collects data for children up to age 15 years, and often reports childhood data aggregated for age 6 and under, while CDC data is reported for children aged less than 72 months. Another data management difficulty is the use of population estimates to determine rates. Although US Census Bureau data was used in all cases, the estimated population used to determine rates was often the 2000 data rather than using yearly adjustments. The 2007 estimated population for Illinois highlights these differences: the CDC report was 1,059,993 children age less than 72 months, but the Illinois estimate was 1,243,832 children age ≤6 years.

In general, Illinois has significantly reduced the number of children with EBLL from 18.7% (45,809) in 1997 to 1.8% (5,270) in 2007 (IDPH, 2008). According to IDPH (2009b), a variety of prevention strategies are used to combat childhood lead poisoning (Table 1). Screening across the state is not uniform; rather, a risk management technique is used to target high-risk zip codes, supplemented with risk assessment questionnaires. The at-risk screening is required for children aged 6 months to 6 years prior to entering Head Start, preschool, daycare, or school. Results for all blood lead tests are required to be sent to IDPH for surveillance purposes. In addition, IDPH and local health departments offer educational outreach to all children with EBLL, including follow-up nursing visits. In addition to medical case management, IDPH oversees environmental remediation which includes home inspections for children with EBLL; homes with high lead levels receive remediation. The Illinois Lead Program extends beyond surveillance and treatment by proving education materials to a variety of target groups, including: physicians, schools, parents, real estate agents, schools, and home inspectors and contractors. Environmental remediation is not limited to Illinois. The decrease in the number of children with EBLL across the U.S. has been linked to the decrease in homes with lead-based paint; only ~39 million homes in 2000 from 64 million in 1990 (Jacobs et al., 2002; CDC, 2005).

**Table 1. Triage of Lead Poisoning Preventions Strategies**

| IDPH Strategy | Primary | Secondary | Tertiary |
|---|---|---|---|
| 1 | Avoid lead exposure | Early detection and intervention | Damages that are caused are irreversible |
| 2 | Identify sources of lead in the home | Increase rates of screening | Chelate to remove toxins from body |
| 3 | Focus on high-risk (minorities, low-income) | Intervene to reduce long-term damage | Improve quality of life for those who have lead poisoning with outreach |
| 4 | Remediate high-risk housing | Encourage home visits | Eat foods that have iron and calcium |
| 5 | Evaluate and control hazards | Initiate environmental inspections for those with lead poisoning | |
| 6 | Educate | | |

Note: Information based on *Illinois Lead Program Surveillance Survey* (2009)

## Conclusion

Lead poisoning has been a significant problem throughout the early part of the 20th century, and still continues to affect the health of many children across the country. Despite the lead poisoning cases still present, trends have demonstrated a significant decrease in the numbers of children with EBLL, nationally and at the state level. Although Illinois has seen a significant drop in the number of children with EBLL over the last decade, it still remains one of the top states for total numbers of cases. As such, Illinois continues to offer extensive prevention programs to combat this important public health issue. As childhood lead poisonings decrease and funds are shifted to other challenges, it is important that preventive screenings continue to target high risk populations living in older housing units that have not yet been remediated to ensure the best use of case management, treatment, and prevention resources.

## References


Agency for Toxic Substances and Disease Registry. (2007). Lead. Retrieved July 21, 2010 from: http://www.atsdr.cdc.gov/tfacts13.pdf.

Annest, J.L., Pirkle, J.L., Makuc, D., Neese, J.W., Bayse, D.D., & Kovar, M.G. (1983). Chronological trend in blood lead levels between 1976 and 1980. *New England Journal of Medicine, 308*, 1373-1377.

Bellinger, D. & Dietrich, K.N. (1994). Low-level lead exposure and cognitive function in children. *Pediatric Annals, 23*, 600-605.

Binns, H.J., LeBailly, S.A., Poncher, J., Kinsella, R., Saunders, S.E., & the Pediatric Practice Research Group. (1994). Is there lead in the suburbs? Risk assessment in Chicago suburban pediatric practices. *Pediatrics, 93*(2), 164-171.

Centers for Disease Control and Prevention. (2005). Blood lead levels ---United States, 1999—2002. *Morbidity and Mortality Weekly Report, 54*(20), 513-516.

Centers for Disease Control and Prevention. (2010). National surveillance data (1997-2007). Retrieved July 27, 2010 from: http://www.cdc.gov/nceh/lead/data/national.htm.

Curtis, G.B., Braggio, J.T., Fokum, F., Roberts, J.P., Scott, R., Staley, F., et al. (2004). Using GIS to assess and direct childhood lead poisoning prevention. *Centers for Disease Control and Prevention*, 1-40. Retrieved May 20, 2010 from: http://www.cdc.gov/nceh/lead/publications/UsingGIS.pdf.

Deitrich, K., Ris, M., Succop, P., Berger, O., & Bornshein, R. (2001). Early exposure to lead and juvenile delinquency. *Neurotoxicology Teratology, 23*, 511-518.

Denno, D. (1990). *Biology and violence.* New York, NY: Cambridge University Press.

Freudenberg, N., & Golub, M. (1987). Health education, public policy and disease prevention: A case history of the New York City coalition to end lead poisoning. *Health Education & Behavior, 14*, 387-401.

Gibson, J.L. (1904). A plea for painted railings and painted walls of rooms as the source of lead

poisoning amongst Queensland children. *Australasian Medical Gazette*, 149-153.

Illinois Department of Public Health. (2008). Illinois lead program surveillance report – 2007. Springfield, Illinois.

Illinois Department of Public Health. (2009a). Childhood lead poisoning. Retrieved July 21, 2010 from: http://www.idph.state.il.us/public/hb/hblead.htm.

Illinois Department of Public Health. (2009b). Illinois lead program surveillance report – 2008. Springfield, Illinois.

Illinois Department of Public Health. (2009a). Childhood lead poisoning. Retrieved July 21, 2010 from: http://www.idph.state.il.us/public/hb/hblead.htm.

Illinois Department of Public Health (2011). Childhood lead poisoning surveillance report. Retrieved February 4, 2011 from: http://www.idph.state.il.us/health/statshome.htm#Childlead.

Jacobs, D.E., Clickner, R.P., Zhou, J.Y., Viet, S.M., Marker, D.A., Rogers, J.W., et al. (2002). The prevalence of lead-base paint hazards in US housing. *Environmental Health Perspectives*, *110*, 599-606.

Jacobs, D.E. & Nevin, R. (2006). Validation of a 20-year forecast of U.S. childhood lead poisoning: Updated prospects for 2010. *Environmental Research*, 102(3), 352-364.

Lanphear, B.P. (1998). The paradox of lead poisoning prevention. *Science*, *281*(5383), 1617-1618.

Lanphear, B.P., Hornung, R., Ho, M., Howard, C.R., Eberly, S., & Knauf, K. (2002). Environmental lead exposure during early childhood. *Journal of Pediatrics*, *140*, 40-47.

Lanphear, B.P. (2005). Childhood lead poisoning prevention: Too little, too late. *Journal of the American Medical Association*, *293*(18), 2274-2276.

Levin, R., Brown, M.J., Kashtock, M.E., Jacobs, D.E., Whelan, E.A., Rodman, J., et al. (2008). Lead exposures in U.S. children 2008: Implications for prevention. *Environmental Health Perspectives*, *116*(10), 1285-1293.

Mahaffey KR, Annest JL, Roberts J, & Murphy RS, (1982). National Estimates of blood lead levels: United States, 1976-1980: association with selected demographic and socioeconomic factors. *New England Journal Medicine*, *307*, 149-159.

Mehta, S. & Binns, H.J. (1998). What do parents know about lead poisoning? *Archives of Pediatric and Adolescent Medicine*, *152*, 1213-1218.

Miranda, M.L., Dolinoy, D.C., & Overstreet, M.A. (2002). Mapping for prevention: GIS models for directing childhood lead poisoning prevention programs. *Environmental Health Perspectives*, *110*(9), 947-953.

Needleman, H.L. Gunnoe, C., Leviton, A., Reed, R., Peresie, H., Maher, C., et al. (1979). Deficits in psychologic and classroom performance of children with elevated dentine lead levels. *New England Journal of Medicine*, *300*, 689-695.

Needleman, H.L., Schell, A., Bellinger, D., Leviton, A., & Allred, E.N. (1990). The long-term effects of exposure to low doses of lead in children: An 11-year follow-up report. *New England Journal of Medicine*, *322*, 83-88.

Needleman, H.L., Reiss, J.A., Tobin, M.J., Biesecker, G.E., & Greenhouse, J.B. (1996). Bone lead levels and delinquent behavior. *Journal of the American Medical Association*, *275*, 363-369.

Pirkle, J.L., Kaufmann, R.B., Brody, D.J., Hickman, T., Gunter, E.W., & Pashcal, D.C. (1998). Exposure of the U.S. population to lead, 1991-1994. *Environmental Health Perspectives*, *106*, 745-750.

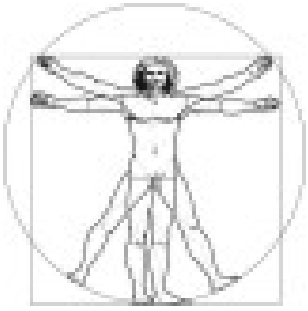
Rabin, R. (1989). Warnings unheeded: A history of child lead poisoning. *American Journal of Public Health*, *79*(12), 1668-1674.

Silbergeld, E.K. (1997). Preventing lead poisoning in children. *Annual Review of Public Health*, *18*, 187-210.

U.S. Census Bureau. (2007). State single year or age and sex population estimates: April 1, 2000 to July 1, 2007 – Civilian. Retrieved February 5, 2011 from: http://www.census.gov/popest/archives/2000s/vintage_2007/.

U.S. Environmental Protection Agency. (1996). EPA takes final step in phaseout of leaded gasoline. Retrieved July 22, 2010 from: http://www.epa.gov/history/topics/lead/02.htm.

Wright, J.P, Dietrich, K.N., & Ris, D. (2004). The effect of early lead exposure on adult criminal behavior: Evidence from a 24 year longitudinal study. *The Criminologist*, *29*(4).




**ABOUT THE AUTHORS**

Dhitinut Ratnapradipa (dhitinut@siu.edu) is Assistant Professor of Health Education, Southern Illinois University, Carbondale, Illinois, USA. Frida Fokum (Frida.Fokum@illinois.gov) and Sam Churchill (Sam.Churchill@illinois.gov) are with the Division of Environmental Health, Illinois Department of Public Health, Springfield, Illinois, USA. Alicia Wodika (awodika@siu.edu) is a doctoral student in the Department of Health Education and Recreation, Southern Illinois University, Carbondale, Illinois, USA.


An earlier version of this paper was presented at the 4th International Consortium for Interdisciplinary Education about Health and the Environment, Cologne, Germany, December 2010.