Epidemiologic Characteristics of Children with Blood Lead Levels ≥45 μg/dL

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Objectives To identify risk factors and describe outcomes for children newly identified with blood lead levels (BLLs) ≥45 μg/dL in New York City (NYC) during 2004-2010 to promote timely identification as well as inform clinical practice and public health policy.

Study design Inclusion criteria were residence in NYC and an elevated confirmatory venous test within 2 weeks of the initial BLL ≥45 μg/dL. Data collected during case coordination of these children were linked with blood testing data and home inspection reports. Children with BLLs ≥45 μg/dL also were compared with the general population of children younger than 18 years of age in NYC.

Results A total of 145 children <18 years of age were newly identified with BLLs ≥45 μg/dL. The mean age was 3.83 years, and the median time for BLL to decline below 10 μg/dL was 3.26 years. Major reported risk factors were eating paint (36%), spending time outside the US (34%), having a developmental delay (27%), using imported products (26%), being foreign born (14%), being of Pakistani descent (12%), eating soil (5%), and having sickle cell disease (4%). Compared with the age-standardized NYC population, cases were more likely to be Asian or black and live in housing built before 1940.

Conclusions Although the incidence of lead poisoning has declined in the US, severe cases still occur. Physicians should be especially vigilant in certain at-risk populations including children who eat paint chips or soil, spend time outside the US (particularly in Pakistan), use imported products, or have developmental delays or sickle cell disease. *(J Pediatr 2017;180:229-34).*

National and local policies have led to large reductions in the prevalence of lead poisoning. Two national surveys of children aged 1-5 years showed a decline in the prevalence of blood lead levels (BLLs) ≥10 μg/dL from 88.2% in 1976-1980 to 0.8% in 2007-2010.[1,2] Children in New York City (NYC) newly identified with BLLs ≥10 μg/dL declined 92% from 21 575 to 1634 between 1995 and 2009.[3]

As the incidence of BLLs ≥10 μg/dL has declined and evidence of health effects at lower BLLs has accumulated,[4] attention has been directed increasingly to less severe lead exposures. Although low-level exposures can result in long-term, irreversible cognitive deficits, greater exposures can lead to organ damage and death. Deaths from lead poisoning still occur, with at least 2 child fatalities in the US since 2000, a Sudanese refugee child exposed to lead paint in New Hampshire and a child who swallowed a charm in Minnesota.[5,6]

The objective of this review is to describe NYC children younger than 18 years of age who were newly identified with severe lead poisoning, defined here as BLLs ≥45 μg/dL. Data collected during case coordination and environmental investigation on the potential exposures are presented, as well as demographics, associated risk factors, results of abdominal radiographs, and the time to decline to a BLL <10 μg/dL. Understanding the incidence, sources, and treatment outcomes of lead poisoning at BLLs ≥45 μg/dL can promote timely identification of cases as well as help inform clinical practice and public health policy.

Methods

All cases with initial venous BLLs ≥45 μg/dL among children younger than 18 years of age from 2004 through 2010 were reviewed. Inclusion criteria were residence in NYC and an elevated confirmatory venous test within 2 weeks of the initial BLL ≥45 μg/dL. The institutional review board of the NYC Department of Health and Mental Hygiene (DOHMH) deemed this project exempt research.

BLL	Blood lead level
DOHMH	Department of Health and Mental Hygiene
NYC	New York City
PDD	Pervasive development disorder
RA	Risk assessment
SCD	Sickle cell disease
XRF	X-ray fluorescence

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The Lead Poisoning Prevention Program within the DOHMH maintains a registry containing all blood lead test results on children in NYC. New York State mandates blood lead testing at ages 1 and 2 years. The registry links BLL tests for a child to basic demographic information and notes entered by DOHMH caseworkers. The system is also linked to various city and state data sources including vital records, immunization records, and housing databases.

Home visits by DOHMH inspectors offered to families of children with BLLs ≥15 μg/dL involve an environmental inspection and a standardized interview with an adult family member, typically the child's guardian. A risk assessment (RA) form is completed that includes responses to questions about the child's behavior as well as information about recent home renovations/repairs, occupations/hobbies of household members, and use of imported products. If certain imported items are available, they are tested for lead content.

In 2006, the RA form was revised with 2 notable changes. Before 2006, the RA asked about home renovations in the last 3 months, whereas since 2006, the RA asks about home renovations in the last 12 months. In addition, the RA used since 2006 specifically asks about eating paint. In 2007, the RA was made electronic.

During home visits, inspectors use handheld x-ray fluorescence (XRF) devices to evaluate the lead content of nonintact painted surfaces as well as windowsills regardless of paint condition. An XRF reading ≥1 mg/cm^2 lead is considered a hazard, and the NYC health code mandates landlords abate lead hazards in homes of children with lead poisoning.[7] The presence or absence of lead paint hazards for each case was documented. In homes with more than 1 inspection, XRF results from the earliest inspection were used because an inspection typically results in abatement of lead hazards.

Case coordination staff communicates with health care providers. Providers are advised to obtain an abdominal radiograph to check for recent ingestion of radiopaque material before initiating chelation and use a cathartic if radiopaque particles are found, as some chelating agents may increase lead absorption. Staff asked providers for abdominal radiograph results, and beginning in 2006, for the results of nutritional and developmental assessments. Children originally reported to have language delays or attention deficit hyperactivity disorder but later reported to be autistic were only reported in the autism category.

A single dataset was created by reviewing all demographic fields and case event notes for all the cases that met review criteria in the registry. In addition, RA forms were matched to cases. Electronic RA form data were exported and reviewed in spreadsheets, whereas older forms were reviewed manually. In cases with more than 1 RA form, answers to questions about risk factors were recorded as "yes" if an affirmative response was given on any of the RA forms or in any of the case comments.

Comparison Data

Demographic data including age, sex, race/ethnicity, borough, and poverty by census tract for all children <18 years of age in NYC were obtained from the 2010 US Census and 2005-2009 American Community Survey accessed through NYC EpiQuery.[8] The cases were grouped by year(s) of age (<1; 1-2; 3-4; 5-9; 10-17 years). Each case was classified into 1 of 5 racial/ethnic categories: non-Hispanic Asian, non-Hispanic black, non-Hispanic white, Hispanic of any race, and other (including non-Hispanic mixed race, Native Hawaiian/Pacific Islander, and non-Hispanic of unknown race). In addition, census tracts in which >30% of the population lived below the poverty level were examined.[9] The address at the time of first home inspection was used to look up the year the housing was built in the NYC PLUTO database, and the same database provided a distribution of year built for all buildings in NYC with residential units.[10] We also reviewed NYC immunization records to fill in missing Medicaid data.

Statistical Analyses

Proportions of cases in each demographic group were compared with the proportion in the NYC population standardized by year with EpiQuery. Statistical comparisons were performed with the χ^2 test for categorical variables and *t* test for continuous variables. An exact binomial test was used when expected counts were less than 5. Survival analysis with Bonferroni correction and censoring were used to analyze time to decline to BLL <10 μg/dL. Analyses were performed with SAS 9.1 for Windows (SAS Institute, Cary, North Carolina).[11]

Results

A total of 145 children <18 years of age newly identified with BLLs ≥45 μg/dL from 2004 to 2010 in NYC were found in the database, a mean of 20.7 children annually. Hereafter these are referred to as "cases."

The mean age for cases with BLL ≥45 μg/dL was 3.83 years (95% CI 3.34-4.32). Cases were more likely to be in the 1- to 2-year and 3- to 4-year age groups than in age groups older than 5 years ($P < .001$ for each comparison; **Table I**). Four cases (3%) were newborns (first BLL test at 0-8 days of age) born to mothers with known elevated BLLs.

Distribution of cases differed from the standardized NYC population by race/ethnicity ($P < .001$), borough of residence ($P < .001$), and year housing was built ($P < .001$). Cases were more likely to be Asian ($P < .001$) and black ($P = .005$) and less likely to be white ($P < .001$) than the age-standardized NYC population. Cases were more likely to live in Brooklyn ($P < .001$) and less likely to live in Manhattan ($P = .004$). The residences of cases also were more likely to have been built before 1940 ($P < .001$; **Table I**).

Of the 145 cases, 119 (82%) reported a Medicaid number, and in 2009 only 57.9% of live births in NYC were covered by Medicaid. No difference was found in census tract poverty rates between cases and the NYC population (**Table I**).

Foreign Origin, Travel History, and Use of Imported Products

One hundred twenty-five of the 145 (86%) cases were born in the US. Of the 20 (14%) foreign born, 10 (50%) were born