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Risk factors for elevated blood lead levels among African refugee children in New Hampshire, 2004 ☆

Rachel N. Plotinsky [a,b,*], Masja Straetemans [a,c], Lee-Yang Wong [d], Mary Jean Brown [d], Timothy Dignam [d], W. Dana Flanders [d], Megan Tehan [b], Eduardo Azziz-Baumgartner [a,c], Richard Dipentima [e], Elizabeth A. Talbot [b,f]

[a] *Epidemic Intelligence Service, Office of Workforce and Career Development, Centers for Disease Control and Prevention, Atlanta, GA, USA*
[b] *Division of Public Health Services, New Hampshire Department of Health and Human Services, Concord, NH, USA*
[c] *Health Studies Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA*
[d] *Lead Poisoning Prevention Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA, USA*
[e] *Manchester Health Department, Manchester, NH, USA*
[f] *Dartmouth College, Hanover, NH, USA*

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A B S T R A C T

Objectives: Surveillance blood lead screening of refugee children resettled in Manchester, NH, in 2004 revealed that 39 (42%) of 92 children had elevated levels ($\geqslant$10 μg/dL) after resettlement. Furthermore, 27/92 children (29%) had nonelevated screening blood lead levels on arrival (BLL1) but had elevated follow-up blood lead levels 3–6 months after settlement (BLL2). The main objective was to identify risk factors for increasing lead levels among refugee children after resettlement in Manchester in 2004.
Patients and methods: We conducted a cohort study, with completion of household interviews and home assessments for refugee families who had resettled in 2004 in Manchester, NH. Blood lead level (BLL) data were abstracted from the New Hampshire (NH) Childhood Lead Poisoning Prevention Program. To assess acute and chronic malnutrition among refugees, we used anthropometric data from International Organization of Migration documents to calculate nutritional indices.
Results and discussion: Of the 93 African refugee children in 42 families who participated, 60 (65%) had been born in a refugee camp. Median age was 5.5 years at the time of BLL2 measurement. Thirty-six (39%) of the refugee children had BLL2$\geqslant$10 μg/dL. Liberians and those born in refugee camps had higher geometric mean BLL2 than those not Liberian or not born in camps. Younger children and children with nutritional wasting before immigrating to the United States had a greater increase in geometric mean from BLL1 to BLL2, compared to older children and those without nutritional wasting.

Follow-up blood lead testing of refugee children, particularly those resettled in areas with older housing stock, as in Manchester, is important for identifying lead exposure occurring after resettlement. Increased attention to improve nutritional status of children in refugee camps and after arrival in the United States and awareness of children who were born in refugee camps should be incorporated into lead-poisoning prevention strategies.

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1. Introduction

Although blood lead levels (BLLs) among children aged 1–5 years are decreasing in the United States (US) because of reductions in lead hazards and improvements in screening practices, the risk for lead poisoning remains high for refugees who resettle in the US (Geltman et al., 2001a, b). Children migrating to the US from resource-limited countries can have elevated BLLs as a result of lead exposure before arrival in the US (CDC, 1991, 2000). Lead exposure can persist in children in the US because of lead-containing glazes, medications, or jewelry brought from other countries (Binns et al., 2001).

A Sudanese refugee child died from lead poisoning shortly after resettlement in New Hampshire (NH) in 2000 (CDC, 2001). The NH Childhood Lead Poisoning Prevention Program (CLPPP) guidelines recommend that refugee children aged 6 months–15 years undergo initial screening of BLLs by capillary blood sampling

☆ The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

* Corresponding author at: Providence St. Vincent Medical Center, 9155 SW Barnes Road, Portland, OR 97225, USA. Fax: +1 503 216 6999.
E-mail address: plotinsky@hotmail.com (R.N. Plotinsky).

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within 3 months after arrival in NH (CDC, 2006). Because this lead-poisoning death resulted from exposure to lead after resettlement, these guidelines also recommend that refugee children aged <6 years undergo follow-up testing of BLLs by venous blood sampling at 3–6 months after initial screening. Testing as recommended by NH CLPPP identified elevated BLLs (⩾10 μg/dL) on follow-up testing among 39 of 92 African refugee children who received both screening and follow-up testing after resettlement in Manchester in 2004 (CDC, 2005). These elevated BLLs on follow-up testing demonstrate that this population is at risk for lead exposure after resettlement.

The predominant source of lead poisoning for children in the US is from exposure to lead-based paint hazards in housing built before 1950 (CDC, 2002). Twenty-nine percent of homes in NH were built before 1950 (US Census Bureau, 2002). Certain refugee children were placed in older houses on arrival in Manchester and therefore are at risk for lead exposure in these homes. Malnutrition might also contribute to increased lead absorption among this vulnerable population (Mahaffey et al., 1986).

The objectives of this study were to (1) confirm that refugee children who arrived in Manchester during fiscal year 2004 had higher BLLs than nonrefugee children who live in the same city, (2) describe the characteristics of refugee children who had an elevated initial screening BLL on arrival in NH, (3) identify risk factors that are associated with elevated BLLs after resettlement, and (4) identify risk factors that are associated with an increase between initial screening BLL (BLL1) and follow-up BLL (BLL2).

2. Materials and methods

This study was reviewed and approved by the Institutional Review Board of Centers for Disease Control and Prevention (CDC).

2.1. Study setting

This study was performed in Manchester, NH, which has a population of approximately 107,000 (US Census Bureau, 2000). Of the 556 African refugees who resettled in NH in 2004, a total of 471 (85%) were resettled in Manchester. Of these 471, a total of 196 (42%) were children aged <16 years.

2.2. Study populations

A refugee child was eligible for participation in the study if he or she was an African refugee aged <16 years who had resettled in Manchester during October 1, 2003–September 30, 2004, and who had two blood lead tests separated by ⩾4 weeks: a screening BLL (BLL1) and a follow-up BLL (BLL2), both performed during January 1–December 31, 2004.

The comparison cohort consisted of all nonrefugee children who had a screening BLL in 2004 as recommended by the state (NH Department of Health and Human Services, 2005) and who lived in Manchester. These children were identified through the NH CLPPP blood lead surveillance database.

2.3. Data collection

2.3.1. BLLs of refugee children

A trained health department nurse, using a portable blood lead analyzer, obtained all screening capillary samples at the local health department to minimize contamination. The health department maintains a Clinical Laboratory Improvement Amendments certification for this equipment. Follow-up venous samples were obtained by the children's healthcare providers and submitted to laboratories for testing, performed in accordance with state-approved laboratory methods. All BLL results were entered into a database at NH CLPPP.

2.3.2. BLLs among nonrefugee children

Samples were collected by the children's healthcare providers and submitted to laboratories for testing. All results were routinely reported to NH CLPPP. All refugee and nonrefugee BLL data were abstracted from the NH CLPPP database.

2.3.3. Questionnaire

We conducted household interviews by using a pilot-tested questionnaire to collect risk factor data. The questionnaire was developed in collaboration with CDC staff trained in cultural anthropology and familiar with the participating refugee populations. CDC translated the questionnaire and consent forms into the families' native languages.

The questionnaire consisted of 47 yes/no, true/false, single-best-answer, and open-ended questions, some of which were based on CDC's recommended lead exposure risk questionnaire and on a questionnaire created for a different study (CDC, 1997; Dalton et al., 1996). The questionnaire contained family demographic questions, and questions regarding behaviors of the family and the child. The questionnaire required ⩽30 min to administer per child.

2.3.4. Household visits

We presented the objectives and methods of the study to refugee parents with the assistance of trained interpreters before scheduling interviews. On the day of the interview, interpreters read an informed consent form to parents of eligible children in their native language. If eligible children aged ⩾7 years were present at the time of the interview, a consent form was read to them in their native language.

Through a trained interpreter, investigators administered the questionnaire to the child's parent in face-to-face interviews performed at participants' homes. An interpreter was present for all interviews with refugee families, regardless of the parents' ability to communicate in English.

2.3.5. Assessment of lead hazards

All interviewers attended a 2-h training conducted by lead specialists from NH CLPPP, in which the interviewers learned how to identify exterior elements (e.g., missing structural elements or loose and peeling paint) that made a building at high risk for exposing children to lead. The interviewer completed a visual inspection outside the home by using a validated tool (personal communication, Jonathan Wilson, National Center for Healthy Housing, 2005). If children had moved since BLL2 testing, the interviewer completed an inspection of the buildings in which these children lived at the time of BLL2.

We also reviewed and incorporated results from home inspections performed by NH CLPPP staff. NH CLPPP had performed these inspections as part of the routine investigation when any child is identified with a BLL⩾20 μg/dL. These inspections were performed to identify lead hazards, defined as a surface containing lead paint with one of the following elements: peeling, chipping paint, a surface that creates friction, or a chewable surface.

2.4. Data analysis

Descriptive analyses summarized the characteristics of the study population, including demographics, building inspection, parental knowledge regarding lead poisoning, and use of traditional cooking pots, jewelry, or traditional medicines.

To confirm that refugee children had higher BLLs after resettlement than nonrefugee children, we compared BLL1 and BLL2 of refugee children with routine screening of nonrefugee children BLLs. To examine the association between refugee status and BLL, we used a linear mixed model. This model allows adjustment for age and season by including relevant indicator terms in the model, and accounts for the possible correlation of BLL of children living in the same household by including appropriate random effects (Laird and Ware, 1982). We included interaction terms between refugee status and age, and refugee status and seasonality.

We conducted three separate multivariate linear mixed models to assess factors associated with BLL1, BLL2, and the proportional change between BLL1 and BLL2. Log of BLLs was used because BLLs follow a log-normal distribution. In the first model, we used log of BLL1 as the dependent variable in assessing factors associated with BLL1. Behavioral risk factors were not evaluated for association with BLL1 because BLL1 was drawn shortly after arrival in NH, and we considered behavioral risk factors to be not applicable until after they had lived in NH for some time. In the second model, we used log of BLL2 as the dependent variable to assess factors associated with BLL2. In the third model, we used the difference between log of BLL1 and log of BLL2 as the dependent variable to assess factors associated with the proportional change between BLL1 and BLL2. For all three models, we considered household variation, or clustering of children with elevated BLLs within households, and adjusted for age and seasonality (summer season [June–August] or nonsummer season). Age at the time of BLL1 was categorized into three groups (<2 years, 2–5 years, and ⩾6 years [the SAS code used defines children in the older age group as ⩾6 years]). These age categories are consistent with children achieving developmental milestones related to risk for lead exposure. Time interval between BLL1 and BLL2 was also considered for the models that assessed risk factors associated with BLL2 (model 2) and proportional change between BLL1 and BLL2 (model 3). We included only age at the time of BLL1, because the age category at the time of BLL2 was the same, except for one child. In these models, we accounted for the length of time between measurements by including linear splines (Greenland, 1995).