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Review article

What are the blood lead levels of children living in Latin America and the Caribbean?

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ABSTRACT

Introduction: Information on the prevalence of lead exposure is essential to formulate efficient public health policies. Developed countries have implemented successful public policies for the prevention and control of lead poisoning. In the United States, Canada, Japan and the European Union, for instance, periodically repeated prevalence studies show that blood lead levels (BLLs) in children have decreased overall. Although BLL of Latino children in the U.S. have also dropped in recent years, the geometric mean remains higher than that of white children. Little is known about lead exposure in children in Latin America and the Caribbean (LAC). In this review, we responded to two questions: What is currently known about lead sources and levels in children in LAC? Are there public policies to prevent children's exposure to lead in LAC?

Method: We conducted a literature review covering the period from January 2000 to March 2014 in the PubMed and Lilacs databases to obtain English, Portuguese and Spanish language studies reporting the prevalence of BLLs in children aged 0–18 years living in LAC countries. No specific analytical method was selected, and given the scarcity of data, the study was highly inclusive.

Results: Fifty-six papers were selected from 16 different LAC countries. The children's BLLs found in this review are high (≥10 μg/dL) compared to BLLs for the same age group in the U. S. However, most studies reported an association with some type of "lead hot spot", in which children can be exposed to lead levels similar to those of occupational settings. Only Peru and Mexico reported BLLs in children from population-based studies.

Conclusions: Most BLLs prevalence studies carried out in LAC were in areas with known emission sources. The percentage of children at risk of lead poisoning in LAC is unknown, and probably underestimated. Thus, there is an urgent need to establish public health policies to quantify and prevent lead poisoning, specifically by prioritizing the identification and control of "hot spots".

Contents

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1. Introduction

Lead is a neurotoxin that causes serious damage to the human brain. A large body of scientific evidence shows an association between lead exposure during childhood and impaired cognitive function in children (Bellinger, 2004; Needleman, 2004; Lanphear et al., 2005; Hornung et al., 2009; Mazumdar et al., 2011; Dickerson et al., 2016; Blackwoicz et al., 2016; Wagner et al., 2016). Early lead exposure may also be a risk factor for neurocognitive impairment in adulthood, adult mental retardation (Carpenter and Nevin, 2010; Nevin, 2009), low economic productivity (Grosse et al., 2002; Schwartz, 1994), delinquency and violent offences (Needleman et al., 2002; Dietrich et al., 2001; Wright et al., 2008; Olympio et al., 2010; Mielke and Zahran, 2012). An assessment of neurobehavioural outcomes showed no evidence of a threshold under which lead levels are not associated with harmful effects (Chiodo et al., 2007); no level of lead exposure is considered safe (Canfield et al., 2003; Lanphear et al., 2005).

The levels of lead considered tolerable for children have dropped repeatedly over the last three decades. In 2012, the United States (U.S.) Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended eliminating the term "blood lead level of concern", based on evidence of the adverse health effects on children with levels <10 μg/dL. Instead, the ACCLPP recommended the adoption of a "reference value" based on the 97.5th percentile of the blood lead levels (BLLs) distribution in children aged 1–5 years in the U.S., which is currently 5 μg/dL. The ACCLPP also recommended that the Centres for Disease Control and Prevention (CDC) focus on implementing primary prevention strategies and providing guidance using the best available evidence to respond to children with BLL above the reference value.

The U.S. has implemented successful public policies for the prevention and control of lead contamination. Data on the ethnicity of children associated with BLLs is available from national surveys, which provides a useful overview of the situation of Latino children when compared to other ethnic groups. For example, Jones et al. (2009) assessed the trends in children's BLLs based on national surveys conducted during a 16-year period in the U.S. Data from 1- to 5-year-old children surveyed in Phase I (1988–1991) and Phase II (1991–1994) of the Third National Health and Nutrition Examination Survey (NHANES) were compared with those collected during the survey period from 1999 to 2004. A decline of 84% indicated that the prevalence of high BLLs (≥10 μg/dL) dropped from 8.6% in 1988–1991 to 1.4% in 1999–2004. Between 1988–1991 and 1999–2004, the BLLs geometric means (GM) declined among non-Hispanic blacks (5.2 to 2.8 μg/dL), Mexican Americans (3.9 to 1.9 μg/dL), and non-Hispanic whites (3.1 to 1.7 μg/dL). However, the BLLs found in non-Hispanic black children are still higher than in Mexican American and non-Hispanic white children. BLLs were distributed as follows: 92.6% were <5 μg/dL, 6% ranged from 5 to 10 μg/dL and 1.4% were ≥10 μg/dL. Multivariate analysis indicated that living in old houses, poverty, younger age and being non-Hispanic black are still major risk factors for elevated BLLs. The authors concluded that children's BLLs have decreased in the U.S., even among populations that historically face high risks of lead poisoning. To maintain the progress achieved and eliminate remaining disparities, efforts should be directed toward screening children at high risk to identify and control sources of lead (Laborde et al., 2015).

More recently, Raymond et al. (2014) evaluated the prevalence of BLLs in 1- to 2-year-old children using data from the 2002 to 2010 CDC's Child Blood Lead Surveillance (CBLS) System to determine the proportion of U.S. children 1 to 2 years of age who tested for lead and data from the 1999 to 2010 National Health and Nutrition Examination Survey (NHANES) to examine the prevalence of BLLs ≥ 5 μg/dL and ≥10 μg/dL. The NHANES data from the period between 2007 and 2010 showed that 3.1% of children aged 1 to 2 years had BLLs ≥ 5 μg/dL. BLLs higher than 5 μg/dL were found for 7.7% of the non-Hispanic black children and for 1.6% of the Mexican-American children aged 1 to 2 years (95%CI: 0.7–3.0). The poverty level influenced BLLs in those children: 6.0% of children living in a household with a poverty-to-income ratio of <1.3 had BLLs ≥ 5 μg/dL, while only 0.5% of children living in a household with poverty-to-income ratio of ≥1.3 presented BLLs ≥ 5 μg/dL. Children living in pre-1950s housing were 10 and 4 times more likely to show BLLs ≥ 5 μg/dL compared to children living in post-1978 housing during NHANES 1999–2002 and 2007–2010, respectively.

The largest minority group of children in the U.S. is Latino, representing >12 million, i.e., 1 out of every 6 children (Carter-Pokras et al., 2007; U.S. Census Bureau, 2006). Nearly one-third of all children living in poverty are Latinos living in inner city areas and agricultural/rural communities, where they are routinely exposed to environmental contaminants (Ramirez and De La Cruz, 2002).

Childhood lead poisoning remains a serious concern in the U.S., disproportionately affecting ethnic minorities. Deteriorating lead-based paint in homes is the most common source of lead exposure among children (CDC, 2000). According to a study by Carter-Pokras et al., 1990, Puerto Rican and Mexican American children may present a higher probability of elevated BLLs than non-Hispanic white children in the U.S. because of their greater likelihood of living in older housing and inner cities. The exposure of Mexican-American children may be higher than the general population because of the use lead-containing folk medicines and lead-glazed pottery, and consumption of lead-contaminated candy from Mexico.

Japan and several countries in Europe present additional examples of developed countries that have been required to address the exposure of the population to lead. Lead concentrations from different sources, such as air and food, have tremendously decreased in Japan since the 1970s (Yoshinaga, 2012). BLLs for Japanese children between 1 and 14 years are relatively low, with a GM of 1.07 μg/dL (Yoshinaga et al., 2012). Since 2011, the country's Ministry of the Environment has been conducting a large-scale birth cohort study called "Japan Environment and Children's Study" (JECS), in which mother-child pairs are followed and studied until the children reach the age of 13 years. The study