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Environmental factors associated with blood lead among newcomer women from South and East Asia in the Greater Toronto Area

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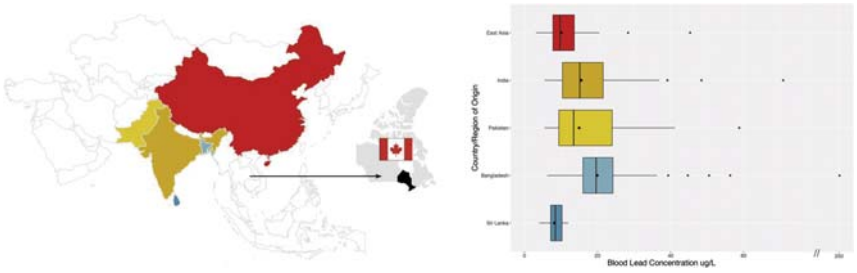
HIGHLIGHTS

- Blood Pb concentrations of newcomer women varied by country of origin.
- Findings corroborate case reports of Pb exposure through cosmetic products.
- The transnational Pb exposures suggest the need for improved enforcement globally.
- Assessment of potential lifetime Pb exposure is important in newcomers.

GRAPHICAL ABSTRACT



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ABSTRACT

Background: Newcomers bring with them histories of environmental exposure in their home countries and may have different sources of lead (Pb) exposure compared to other residents of their adopted country.
Aims: To describe past and current factors associated with Pb exposure and blood Pb among South and East Asian newcomer women of reproductive age in the Greater Toronto Area (GTA), Ontario, Canada.
Methods: In collaboration with public health units and community organizations a community-based research model was utilized by recruiting peer researchers to assist in all aspects of the study. Blood samples were taken and phone interviews were conducted. Canadian Health Measures Survey (CHMS) cycles 1, 2, and 3 data was used to contextualize the distribution blood Pb levels. Multiple regression was applied to log-transformed blood lead measurements, using a hierarchical model building process.
Results: In total, 211 participants were recruited from Bangladesh, China, India, Pakistan and Sri Lanka. The distribution of the blood Pb varied by country of origin, and higher blood Pb values were found above 75th percentile compared to the CHMS. Distal factors significantly influencing blood Pb concentrations related to life history, such as duration of stay in Canada (RR = 0.91; 95% CI 0.86–0.97), living near agricultural fields (RR = 0.78; 95% CI 0.62–0.93), and country of origin. Proximal factors with significant contribution were use of cosmetics, traditional remedies, and smoking cigarettes.
Recommendations: Different past and current exposures may be important in various newcomer populations, informing international stakeholders, public health agencies, and primary care practitioners to adapt health education and exposure reduction programs to consider pre- and post-migration factors.

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1. Introduction

Lead (Pb) has been implicated in many adverse health outcomes, including neurotoxic effects (O'Halloran and Spickett, 1992; von Stackelberg et al., 2015), anemia, and kidney diseases (Buser et al., 2016; Goyer, 1990). The neurodevelopmental effects of Pb have resulted in development of public health interventions to prevent fetal, neonatal, and early life exposure to Pb, with a particular focus on women of reproductive age (Curren et al., 2014; CDC, 2010).

While public health interventions in many high-income countries have generally reduced exposure to Pb over the last century, several studies have pointed to higher concentrations of blood Pb in lower- and middle-income (LMIC) countries coming from a variety of sources and accompanied by a substantial associated economic burden of illness (Attina and Trasande, 2013). For example, a systematic review on emerging economies showed greater exposure to heavy metals in LMIC countries compared to the United States (US) (Horton et al., 2013).

In certain populations, exposure through cosmetic products and traditional remedies has been reported (Chui et al., 2013; Janjua et al., 2008; Lin et al., 2012; Patel et al., 2011; Saper et al., 2004), as have a variety of dietary sources (Jin et al., 2014), and *pica* behavior (Thihalolipavan et al., 2013). There has been a concern about the transnational effect of these atypical sources in North America and Europe among immigrants (Cerci, 2007; Gorospe and Gerstenberger, 2008; Hore et al., 2016), as well as for the contamination of imported spices, which has prompted several company recalls (USFDA, 2016). Case reports have documented exposure through cosmetics or traditional products (e.g. sindoor, surma, kohl, as well as medicinal products), food, and spices purchased in other countries and brought to the US, UK, and Canada for personal use (Gorospe and Gerstenberger, 2008; Health Canada, 2011; Parry and Eaton, 1991). Therefore, it has been recommended that past and present exposure to Pb through these atypical sources be considered in case management for immigrants and refugees (Health Canada, 2013). In Canada, higher blood concentrations of Pb have been recorded among foreign-born Canadians (Curren et al., 2014; Lye et al., 2013). While several US studies demonstrated disparities in heavy metal exposures by ethnicity or race (Belova et al., 2013; Remer Thompson and Boekelheide, 2013), the variation of blood Pb levels in Canada by ethnicity, race, or gender has not been well described or adequately investigated (Chakravartty et al., 2014; Chen et al., 2017).

With diversity in the sources of exposure to Pb across the world, newcomers (immigrants or refugees) to a metropolitan area such as Toronto, ON, Canada (comprising 10% of Toronto's population) may have different sources of Pb exposure than the rest of the population (TPH, 2014). Comprehensive studies of exposures among newcomers are needed to support evidence-informed and culturally-sensitive policies and programs for preventing and mitigating Pb exposure. In particular, policy makers need to know if these policies should focus on shifting the general exposures (average levels) or focus on atypical exposures (tail of the distribution curve) in order to guide the development of effective policies. To investigate the levels of Pb in newcomer populations, the Metals in Newcomer Women (MNW) study was initiated with the aims of (1) describing the distribution of blood Pb concentrations among newcomer women of reproductive age (19–45 years old) from South and East Asia in the Greater Toronto Area (GTA); and (2) modeling the associations of potential sources of exposure with blood Pb levels.

2. Methods

2.1. Study setting and partnerships

The GTA is home to a large population of immigrants. According to the 2006 census, nearly 1 million people who reside in Toronto are immigrants from South, East, and Southeast Asia (Statistics Canada, 2006). From 2001 to 2006, 46% of the immigrants settling in Toronto were from South and East Asia (TPH, 2011), making the Toronto area an ideal location for this study. Partnerships were established with local health units (Toronto Public Health, in collaboration with Peel Public Health, York Public Health), community health centers, and non-governmental organizations (e.g., Access Alliance Multicultural Health and Community Services) to enhance recruitment and reach newcomer populations in Toronto. Ethics approval for this study was received from the Health Canada and Public Health Agency of Canada Research Ethics Board (February 13, 2015), the Health Sciences Research Ethics Board of the University of Toronto (August 19, 2014), and the Research Ethics Board of Toronto Public Health (February 26, 2015). Informed consent was obtained from all study participants.

2.2. Study population

The MNW study recruited newcomer women of reproductive age (19–45 years old) from South and East Asian countries in the GTA for a cross-sectional survey, informed by the principles of community-based research (Israel et al., 1998). Similar to the Canadian census, a newcomer was defined as a woman who came to Canada for the purpose of permanent residency and who had resided in Canada between 1 and 5 years (Statistics Canada, 2010). This criterion ensured that blood Pb would be affected by exposure sources in Canada (at least one year), yet also short enough that exposures related to practices that continued after arrival in Canada would likely persist. We focused on all women of reproductive age, as they would be the group for whom Pb exposure could potentially affect their health over the life course, as well as affecting a fetus or infant.

In accordance with community-based research principles, peer-researchers of South and East Asian origin were hired to assist in all aspects of the study (e.g. recruitment, data collection, analysis, interpretation). The recruitment was open to women from all countries that are geographically located within South and East Asia; however, linguistic fluency and partnerships with local organizations resulted in a focus on the following countries: China, India, Pakistan, Bangladesh, and Sri Lanka. To ensure participants reflected diverse areas in the GTA, recruitment sessions were organized with different community partners. Formal recruitment occurred though presentations at pre-natal nutrition or parenting classes and interested individuals were recruited after those presentations. In the informal recruitment strategy, peer-researchers recruited participants through their networks, including through places of worship and cultural centers. The recruitment took place from February to July 2015.

2.3. Blood sample collection and laboratory analysis

Following participant consent, blood collection through venipuncture was performed by a registered nurse or phlebotomy technician. The blood sample was chosen over other media and tests of body burden of Pb due to convenience and interpretability of this measure. The blood collection process was facilitated by mobile blood collection at community health centers, and by home visits. In some cases, peer researchers accompanied participants to blood collection labs. Whole blood was collected in metal-free sampling tubes and blood samples were stored at 4 degrees Celsius for approximately one month. Batched samples were sent for analysis at L'Institut national de santé publique du Québec (INSPQ) - an accredited commercial lab, which uses a validated method developed specifically for biomonitoring purposes in line with ISO 17025 guidelines. Samples were stored at −20 degrees Celsius until preparation. Blood samples were diluted 20-fold with 0.5% (v/v) NH_4OH (Trace Metal grade, Fisher Scientific, Ottawa, ON, Canada, #A512-P500) and 0.1% (v/v) octylphenol ethoxylate (EMD Millipore Corporation, Billerica, MA, USA, #TX 1568-1). Following dilution, samples were analyzed for Pb (as well as mercury (Hg), and