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Lead exposure from aluminum cookware in Cameroon

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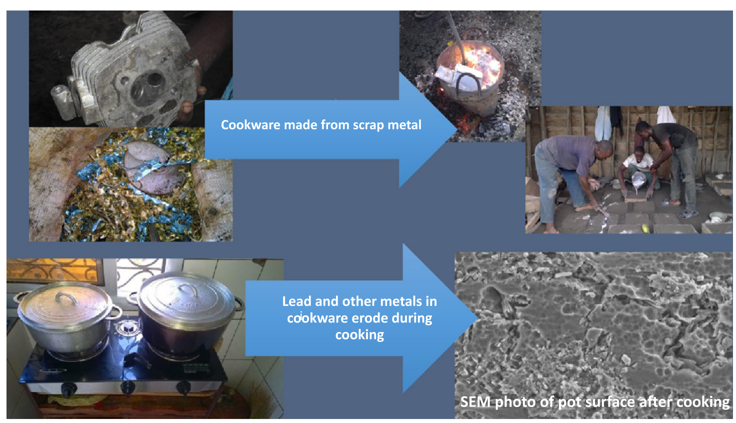
HIGHLIGHTS

- Cookware is manufactured in Cameroon from scrap aluminum including car parts.
- Twenty-nine cookware samples were evaluated for their potential to leach lead.
- Boiling extractions to simulate the effects of cooking released significant lead.
- Potential lead exposures per serving are estimated as high as 260 μg.
- Artisanal aluminum cookware may be a major contributor to lead poisoning.

GRAPHICAL ABSTRACT



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ABSTRACT

Blood lead levels have decreased following the removal of lead from gasoline in most of the world. However, numerous recent studies provide evidence that elevated blood lead levels persist in many low and middle-income countries around the world at much higher prevalence than in the more developed countries. One potential source of lead exposure that has not been widely investigated is the leaching of lead from artisanal aluminum cookware, which is commonly used in the developing world.

Twenty-nine samples of aluminum cookware and utensils manufactured by local artisans in Cameroon were collected and analyzed for their potential to release lead during cooking. Source materials for this cookware included scrap metal such as engine parts, radiators, cans, and construction materials. The lead content of this cookware is relatively low (<1000 ppm by X-ray fluorescence), however significant amounts of lead, as well as aluminum and cadmium were released from many of the samples using dilute acetic acid extractions at boiling and ambient temperatures. Potential exposures to lead per serving were estimated to be as high as 260 μg, indicating that such cookware can pose a serious health hazard. We conclude that lead, aluminum and cadmium can migrate from this aluminum cookware during cooking and enter food at levels exceeding recommended public health guidelines. Our results support the need to regulate lead content of materials used to manufacture these pots. Artisanal aluminum cookware may be a major contributor to lead poisoning throughout the developing world. Testing of aluminum cookware in other developing countries is warranted.

Abbreviations: GFAAS, graphite furnace atomic absorption spectrometry; ICP, inductively coupled plasma spectrometry; MADL, maximum allowable dose level; PTTIL, provisional tolerable total intake level; PTWI, provisional tolerable weekly intake; SEM, scanning electron microscopy; XRF, X-ray fluorescence.

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1. Introduction

In recent decades lead has been removed from gasoline in all but a few countries resulting in a substantial decrease in blood lead levels. However, evidence suggests that elevated blood lead levels persist in many low and middle-income countries around the world at much higher prevalence than in the more developed countries. Recent research from India (Kalra et al., 2013), China (Li et al., 2014; Xie et al., 2013), South Africa (Naicker et al., 2013), the Democratic Republic of Congo (Tuakuila et al., 2013), Thailand (Swaddiwudhipong et al., 2013) and Saudi Arabia (El-Desoky et al., 2013) indicate that blood lead levels among young children are many times higher than levels reported in the U.S. or EU despite progress from earlier decades.

Lead accounts for 674,000 deaths annually (Lim et al., 2012) and is a risk factor for attention-related behaviors, learning disabilities, and criminal behavior. Lead toxicity in low- and middle-income countries costs $977 billion annually (Attina and Trasande, 2013). There is no identified threshold for toxicity (Lanphear et al., 2005; Wigle and Lanphear, 2005). The continued prevalence of high blood lead levels in children after the phase-out of leaded gasoline is therefore of great concern from a public health perspective.

Evidence suggests that it may be increasingly difficult to identify a single source of exposure to account for the current exposure scenario and to provide relief to millions of exposed individuals. To address this next phase of the global lead poisoning epidemic it is necessary to identify significant exposure sources that contribute to the patterns observed in recent studies from emerging market countries so that appropriate responses can be developed. One known source repeatedly cited has been contaminated food (Bergkvist et al., 2010; Xie et al., 2013), but little direct evidence is available to explain how lead has entered the food supply. Although some reports link lead contamination of soil to these exposures, many other sources may also play a contributing role (Bergkvist et al., 2010; Ritchie and Gerstenberger, 2013).

In addition to some more prominent exposure sources including industrial emissions, lead in paint, and contaminated water supplies, many consumer products have been shown to contain lead in significant concentrations (Weidenhamer and Clement, 2007; Weidenhamer, 2009). While conducting education and outreach programs in Cameroon around the need to control lead levels in new paints (Gottesfeld et al., 2013), several participants raised concerns about the lead content of locally available cooking pots.

An investigation was subsequently launched to determine whether lead may be entering the manufacturing process of locally made aluminum pots. In visiting a number of artisanal cookware manufacturing facilities, we discovered that the raw material used is scrap metal including used car and motor bike engine parts, waste aluminum and computer components (Fig. 1). These inexpensive pots, which are not anodized, are widely used throughout Cameroon. Lead introduced through aluminum cookware may be a significant source of contamination relative to other environmental exposures. Recently other investigators have noted a possible link between the use of inexpensive aluminum cookware and lead absorption (Bergkvist et al., 2010; Swaddiwudhipong et al., 2013).

This investigation was designed to help fill the gap in explaining the potential lead exposures from aluminum cookware. We investigated the levels of lead and other heavy metals that may be released into foods cooked in finished pots obtained from a number of local sources in four cities in Cameroon where artisanal cookware production is prevalent. The results of our investigation are outlined along with recommendations to regulate the lead content of aluminum cookware.

2. Methodology

2.1. Sample collection

Cookware samples were collected from four towns located in four of the ten regions in Cameroon where cookware production is concentrated: Kumba (4 samples), Douala (6 samples), Ngaoundéré (5 samples) and Yaoundé (11 samples). Sample collection information including potential scrap metal sources and used or new condition of the pot (Figs. 1 and 2) was documented, and all samples were numbered as collected. In addition to the cookware samples, three cooking ladles (Fig. 2, inset) were also collected. To facilitate international shipment of this large number of samples to the analytical laboratory, the ladles and one pot from each location with its lid were sent intact, while 4 × 4 cm pieces were cut from all remaining samples and sent for analysis.

Fig. 1. Some source materials used in the manufacture of artisanal aluminum cookware in Cameroon. (A) Computer hard drive cover; (B) mixed scrap including computer parts; (C) motor bike engine part; and (D) molten scrap being poured into molds for pots.