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Lead intoxicated children in Kabwe, Zambia

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ABSTRACT

Kabwe is a lead contaminated mining town in Zambia. Kabwe has extensive lead contaminated soil and children in Kabwe ingest and inhale high quantities of this toxic dust. The aim of this paper is to analyze the health impact of this exposure for children. Health data from three existing studies were re-analyzed. Over 95% of children living in the most affected townships had high blood lead levels (BLLs) > 10 μg/dL. Approximately 50% of those children had BLLs ≥ 45 μg/dL. The existing data clearly establishes the presence of a severe environmental health crisis in Kabwe which warrants immediate attention.

1. Introduction

Kabwe is the fourth biggest town and capital of the central province of Zambia. The town has a long history of mining, which operated for more than 90 years and produced large quantities of lead (Pb) and zinc (Zn) until closure in 1994.

Lead is a toxic substance and chronic exposure causes serious adverse health effects. The pathways of exposure are mainly ingestion of Pb contaminated soil and dust, but inhalation as a route of entry can also be significant. Pb can cause acute and chronic intoxication. High exposure can cause severe colic-like abdominal pains, neurological symptoms, seizures, encephalopathy and finally death (World Health Organization, 2010).

Infants are at higher risk due to specific risk behaviors such as playing on bare soil, relevant hand to mouth activity and thus their oral uptake is greater compared with adults (World Health Organization, 2010). While high blood Pb levels (BLLs) have been associated with extensive adverse effects, evidence of low BLLs causing serious negative health effects is extensive and conclusive. The negative effect of Pb exposure during pregnancy to the fetus and during early childhood on the regular development of the brain has enormous adverse implications (Advisory Committee on Childhood Lead Poisoning Prevention, 2016; Needleman et al., 1990).

The CDC Reference Level for Pb is 5 μg Pb/dL blood (https://www.cdc.gov/nceh/lead/acclpp/blood_lead_levels.htm). Between 5 and 44 μg Pb/dL, actions to lower the body burden are recommended In the former "Kabwe lead poisoning management protocol" a Pb level of 20 μg Pb/dL was considered as minimum level for individual follow up (Project Technical Committee - Zambia Consolidated Copper Mines Investments Holdings, 2006). The medical intervention level for children is 45 μg Pb/dL. Children with confirmed Pb encephalopathy need to be hospitalized and treated individually (Advisory Committee on Childhood Lead Poisoning Prevention, 2016; Thurtle et al., 2014). Data from a large treatment survey in Nigeria indicates that oral chelation treatment with Chemet® (succimer, DMSA) is both safe and effective (Thurtle et al., 2014). However, chelation therapy without environmental intervention may prove futile since re-exposure will likely occur.

2. Environmental assessments

Lead contaminated soils in Kabwe pose a serious environmental hazard. In 2003–2006, the "Copperbelt Environment Project" analyzed over 1000 soil samples for Pb in various townships. The results showed,

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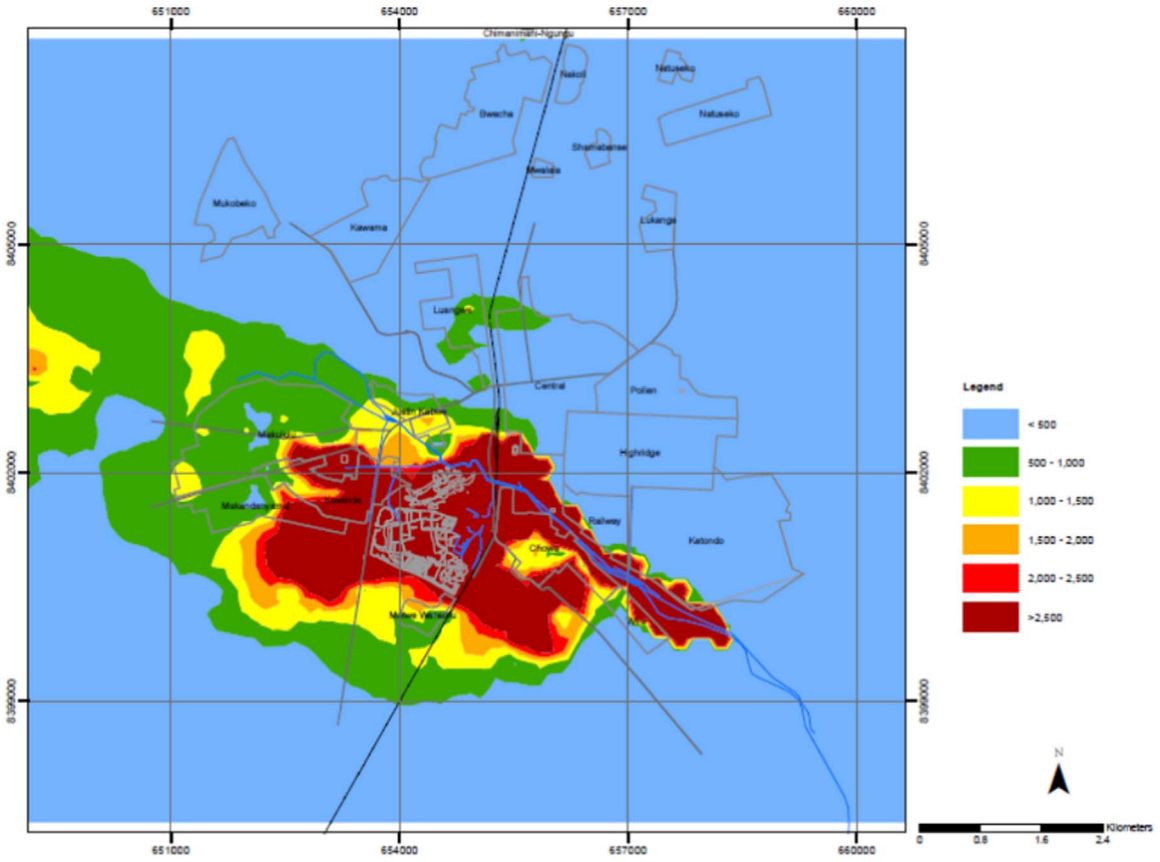

Fig. 1. Interpolated distribution of Pb in soil in the KSDS survey area based on district and township survey (Water Management Consultants Ltd, 2006).

that the soil "over a substantial area is highly contaminated with the metal". "Median Pb concentrations of soil in townships in the vicinity of the mine inducing Kasanda (3008 mg/kg), Makandanyama (1613 mg/kg), Chowa (1233 mg/kg), Mutwe Wansofu (1148 mg/kg), Makululu (870 mg/kg) and Luangwa (507 mg/kg) were recorded. All exceeded levels generally regarded as acceptable by international authorities with respect to residential areas" (Water Management Consultants Ltd, 2006).

The most affected townships are immediately adjacent to the former Kabwe mining complex and homes downwind from the smelter and the tailings (see Fig. 1).

Regrettably, the situation appears to have changed little in recent years as shown from work done by Pure Earth (formerly Blacksmith Institute) in 2014. Data shows townships close to the mining area are still polluted with Pb levels in soil well above recommended levels for residential areas. Soil samples analyzed with an Innov-x Delta series X-ray fluorescence by Pure Earth found median soil concentrations of 3212 mg/kg in Chowa, 6162 mg/kg in Kasanda, and 2286 mg/kg in Makululu (Caravanos et al., 2014; Office of Solid Waste and Emergency Response, 1994; Pure Earth, 2015). Citywide, surface soil Pb concentrations ranged from 139 mg/kg to 62,142 mg/kg, with a geometric mean concentration of 1470 mg/kg. Of the 339 soil tests, 86 readings (25.4%) were > 400 mg/kg.

This overview of results shows that the Pb contamination of soils in Kabwe is serious with townships close to the mining area being highly contaminated. Lead is not the only contaminant of concern in Kabwe; the different assessments showed high levels of cadmium (Cd) and Zn in the surrounding mining area and adjacent townships (Tembo et al., 2006; Water Management Consultants Ltd, 2006).

The aim of this paper is to analyze whether the high lead exposure has a health impact on children in Kabwe.

3. Health assessments

Presently, there are three information sources on childhood BLLs in Kabwe; (1) data from the Copperbelt Environment Project; (2) data from projects of Pure Earth and (3) data from a University of Zambia with collaborators from Hokkaido University, Japan. A summary of BLL data is provided below.

3.1. Copperbelt environment project

Commissioned by the Government of the Republic of Zambia, funded by World Bank, the "Copperbelt Environment Project" performed the Kabwe Scoping and Design Study (KSDS) from 2003 to 2006. One of the aims of the KSDS was to update health and environment data for Kabwe. A specific aim was to reduce the geometric mean of BLLs substantially below 25 μg/dL for children in Kabwe. In the KSDS report, data from approximately 2500 participants are presented. Children were recruited by study nurses from the different townships. BLLs were especially elevated in children 0–7 years old. Nearly all children were above the reference level of 5 μg/dL and in some highly exposed townships over 50% of the children had BLLs at which medical treatment was warranted (see Table 1 (Water Management Consultants Ltd., 2006)).

The survey showed that the geometric mean BLLs in townships closer to the mining sites were higher. As shown in Table 1, the geometric mean BLLs of children aged 0–7 years in the surrounding townships were: Chowa 31.7 μg/dL, Kasanda 32.8 μg/dL, Makandanyama 38.2 μg/dL and Makululu 31.3 μg/dL (Water Management Consultants Ltd, 2006). The BLLs were in the range, where negative health effects are likely. Children aged 8–16 years and adults as well had increased BLLs, although lower than levels in children aged 0–7 years.