IPEN-ISIP PROJECT

Lead Poisoning in Owino Uhuru Slums in Mombasa- Kenya

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Abstract

This study sought to provide scientific evidence of lead poisoning in Owino Uhuru, a slum area in Mombasa city adjacent to a lead battery recycling factory. Samples were collected from five different sources (i.e. soil, wall and roof dust, effluent water and blood) from the Owino Uhuru slum area. The Metal Refinery EPZ is located 50 m away from the slum. Similar samples were also collected from the Maweni area, slum area found north of Mombasa city and about ten kilometers from the lead-acid battery recycling company to act as the control experiment. These were taken to the lab for lead analysis. The results showed that samples from Owino Uhuru slums had higher lead concentrations except for the blood samples from both locations had below-detection limit lead content. Therefore, the used lead acid battery recycling factory within Owino Uhuru slums was found to have significantly increased lead concentration in the slum's environment which poses environmental health risks especially to children living in the slum.

Key Words: Heavy metals, lead, lead poisoning, blood lead levels, water, soil, dust, Owino Uhuru,

List of Abbreviations

ULABs: Used lead acid batteries

EEIK: Eco Ethics International Kenya

BLL: Blood Lead Level

EPA: Environmental Protection Agency

NEMA: National Environmental Management Authority

IQ: Intelligence Quotient

RBCs: Red Blood Cells

CDC: Center for Disease Control and Prevention

SAICM: Strategic Approach to International Chemicals Management

ISIP: International SAICM Implementation Project

OK International: Occupational Knowledge International

BEST: Better Environmental Sustainability Targets

AAS: Atomic Absorption Spectroscopy

CEHRC: Community Environmental Health Resource Center

EPZ: Export Processing Zone

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Acknowledgement

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1.0. Background

1.1. Introduction

Presently, the anthropogenic contribution of heavy metals into the environment far exceeds the input from natural processes (Nriagu, 1988). Lead is a naturally occurring metal found in small amounts in rock and soil. Lead has been used industrially in the production of gasoline, car batteries etc. In the past, automotive sources were the major contributors of lead emissions to the atmosphere. After leaded motor vehicle fuels were phased out by 2005 in Sub-Sahara Africa, (Mungatana, 2004), the contribution of air emissions of lead from the automotive sector greatly declined. Today, industrial processes, primarily metals processing, account for a large portion of lead emissions to the atmosphere and the highest levels of airborne lead are usually found near industrial operations that process materials containing lead, (U.S. EPA, 2003).

Lead is a commonplace material with widespread usage. It is used in bullets, batteries, fishing sinkers, old toy soldiers, and for decades it was an additive in gasoline, (Anthony, 1990). Lead has no known essential role in living organisms, and is toxic at even low concentrations (Bryan, 1976). Lead is not used in any way in human metabolism, so there is no tolerable amount, (Anthony, 1990).

Lead poisoning can come from a number of sources. Lead poisoning from the recycling of lead-acid batteries is growing in prominence especially in developing countries and those in transition. Lead-acid batteries are rechargeable and are made up of lead plates and sulfuric acid that are contained in a plastic cover. After long and sustained use, the lead plates eventually weaken and are no longer able to store energy; these can be discarded or recycled. The lead in the plastic casing is recycled and used in making other products and new lead-acid batteries which contain almost 80% recycled lead.

The Basel Convention included the Used Lead Acid Batteries, (ULABs) on its list of materials classified as “hazardous waste”. This was due to growing evidence of increase in blood lead levels attributable to disposal of the used lead acid batteries and their components.

The most frequent and common way that people are exposed to lead contamination is through lead particulates from the battery acid. During the breaking process, battery acid can easily leak into the soil or enter ground and surface water systems that are used for bathing and drinking. Lead toxins can also be inhaled during the melting of the lead plates, which allows the metal to enter into the respiratory and circulatory systems. Excess lead dust from this process can also be transported on clothing and can accumulate inside houses on bedding, furniture, and even food. Dry soil that is contaminated with lead particulates also poses the hazard of spreading lead dust throughout a community, where it can easily be inhaled or touched.

Lead can enter the body by breathing it in as a dust or vapor, by ingesting it when eating, and to a lesser extent, by absorption through the skin, (EPA, 2003). The latter is common in factory workers when they don’t use appropriate personal protective gears while at work. Young children are particularly at risk of lead exposure because of typical hand-to-mouth behavior. Dust from factories can settle in their playground or the floor of the house. Children, of course, live on the floor and put everything into their mouths, (Anthony, 1990). This way they can be exposed when they ingest any lead contaminated dust material.

Lead accumulates in every tissue of the body and affects almost all the body systems more so the RBC’s. The maximum acceptable level of lead in blood is 10 μg/dl, (CDC, 1991). Lead poisoning is the most serious environmental health threat to children and one of the most significant contributors to occupational disease, (Ok International,2011). Accumulation of lead higher than the acceptable standards has numerous effects in human health. The effect depends on the age and the level of exposure. Lead causes symptoms ranging from the loss of neurological function to death depending upon the extent and duration of exposure. Other effects include; brain damage, reduction in bloods ability to carry oxygen, decreased blood production, male infertility, nerve damage, and increase in blood pressure. Children are particularly vulnerable because at that age, they have smaller body masses and their growing bodies absorb more lead, moderate lead exposure is responsible for a significant decrease in school performance, lowering IQ scores, and is linked with hyperactive and violent behavior. Lead poisoning an also affect the unborn child in pregnant women.

Lead battery production and recycling are now the most significant source of lead exposures. Average exposure levels in children residing near battery plants in developing countries are four times the current level of concern established by the World Health Organization (WHO) and the average worker blood lead levels (BLLs) in these plants in developing countries are approximately twice the recommended level, (Ok International, 2011).

This process usually involves breaking the ULABs open by hand or with an axe, which can lead to direct dermal contact with lead. Pieces of the broken batteries are then left on the ground where they are exposed to the elements and can possibly spread toxins to people through dermal contact. Once the batteries are broken open, parts of the battery must be melted in order to recover the secondary lead. Lead-oxide, which accounts for 40 percent of the lead weight in each battery and is a particularly bio-available form of lead, is often improperly disposed of and left out in the open.

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The growth in demand for lead batteries by the vehicle, telecommunications, and solar industries around the world has led to the lead battery recycling industries in Kenya which has grown at a rate that sufficient environmental controls have lagged behind. This has led to hundreds of violations of emission standards and thus, widespread environmental contamination and lead poisoning in the vicinity of battery production and recycling facilities

The success of recycled lead, the market for extracting and reselling used lead has grown substantially, particularly in low- and middle-income countries where there are no proper regulations on lead recycling. Unregulated recycling industries and informal methods of extracting lead – often conducted in homes or backyards – can lead to high levels of environmental lead contamination.

The city of Mombasa is one of the major urban areas along the Kenya Coast that has in recent times seen considerable industrial development and population increase. Some of the industries however, cause serious environmental and human health degradation. In particular, the Metal Refinery Export Processing Zone; an industry which manually extracts lead metal from used car batteries. There is poor waste handling facilities and inadequate use of personal protective equipment exposing them to lead dust. It is anticipated that the workers in this factory have higher blood lead levels, (Kiaka, 2010). The factory is located in close proximity with Owino Uhuru Slum. The residents have experienced severe cases of lead poisoning. This was ascertained through medical diagnosis of three children from the slum by the Public Health Department; their blood lead levels were measuring as high as 23 μg/dl, 17 μg/dl and 12 μg/dl, (Kiaka, 2010). These levels are very high compared to the WHO standards.

The study was prompted by the unavailability of comprehensive scientific information specific for Owino Uhuru slums within Mombasa on the risk of lead poisoning for the people of Owino Uhuru slums. This would inform actions responding to root, underlying and manifest causes of excessive lead exposure and poisoning.

The specific objectives of the study were

i. To find out the environmental lead content in Owino Uhuru slums
ii. To investigate the blood lead levels among humans and livestock in Owino Uhuru area in Mombasa city.

These objectives are geared towards contributing to the attainment of the Better Environmental Sustainability Targets (BEST) Standard 1001 objectives which include to reduce lead exposures in communities where lead batteries are manufactured or recycled; to reduce lead exposures and improve the health status of workers in lead battery manufacturing facilities that are occupationally exposed to lead and other hazardous materials and; to increase adoption of sustainable practices in order to reduce the environmental impact of lead battery manufacturing/recycling by encouraging efforts to minimize waste, lower emissions, reduce energy and water consumption, and encourage environmentally sound recycling.

This is a continuation of EEI-K actions aimed at promoting research, education and awareness in response to the fears expressed by community members, government agencies, civil society organizations (CSOs) on the extent of lead poisoning suffered by the residents of Owino Uhuru slums from the factory's activities. This is particularly evidenced by the brief closure of the factory by the National Environmental Management Authority (NEMA) and public health officials in 2011 following environmental public concerns voiced by community members.

2.0. Methods

2.1. Study area

The study area was in the western side of the coastal town of Mombasa. Mombasa has a warm tropical climate. The amount of rainfall depends essentially on seasons and is influenced mainly by large-scale pressure system of the Western Indian Ocean and monsoon winds. The rainiest months are April and May, while in January to February the rainfall is minimal.

2.2. Sampling and analysis

Samples were collected from five different sources from the Owino Uhuru slum area. The Metal Refinery EPZ is located 50 m away from the slum. Similar samples were also collected from the Maweni area, a slum found north of Mombasa city and about ten kilometers from the lead-acid battery recycling company to act as the control experiment. The soil samples were selected randomly from a marked up study area adjacent to the lead-acid battery recycling company. The same applied to the roof and wall dust samples from the houses in the study area in Owino Uhuru slums. The Soil and dust samples were then delivered in self sealing plastic bags to the laboratory for lead testing. This was with special reference to the standard sampling methodology according to the Community Environmental Health Resource Center (www.cehrc.org, 2006). The soil and dust samples were digested and run into the Atomic Absorption Spectroscopy (AAS) machine to analyze lead element following the Shimadzu AA6300 standardized analytical method (Shimadzu, 2002).

Blood samples were also sought from two individuals (humans) and a male duck within the study area in Owino Uhuru slums. The blood samples were filtered by Whatman Grade 4 Filter Paper and analyzed. This was with regard to standard Filter Paper (FP collection-based) Blood Lead Testing (Moyer et al, 1999) procedure. Near factory effluent samples were also collected and delivered to the lab by the help of capped glass bottles. The effluent water samples were centrifuged before running them into the AAS machine.

3.0. Results and Discussion

3.1. Environmental lead content

The lead content within the Owino Uhuru slum study area, adjacent to the lead-acid battery recycling factory, ranged from 7.933 mg/L to 25.024 mg/L as compared to those in the Maweni area, ten kilometers away from the factory, which averaged at 2.695 mg/L. there was also more lead content within the dust in Owino Uhuru slums mostly ranging from 45.586mg/L to 207.840 mg/L. in Maweni, the lead content was disportionately lower with most samples having lead below the detection limit. The highest lead content in the dust samples from Maweni was 16.701mg/L.

3.2. Blood lead levels

From the analysis of all the blood samples, blood lead levels were found to be below the detection limit. This was common for both the samples from Owino Uhuru slums near the lead-acid battery recycling factory and the more distant maweni slums. This means there was no detectable differences in blood lead levels in the two areas.

The above information is summarized in table 1 below:

Sample	Owino Uhuru area	Maweni area
Soil	17.768 mg/L	2.695 mg/L
Roof dust	22.534 mg/L	Below detection limit
wall dust	121.643 mg/L	9.564 mg/L
Blood	Below detection limit	Below detection limit
Effluent water	6.823 mg/L	Below detection limit

Table 1: Summary of the analysis results of lead metal content Owino Uhuru slum and Maweni slums

Chart representation of this would be as below:

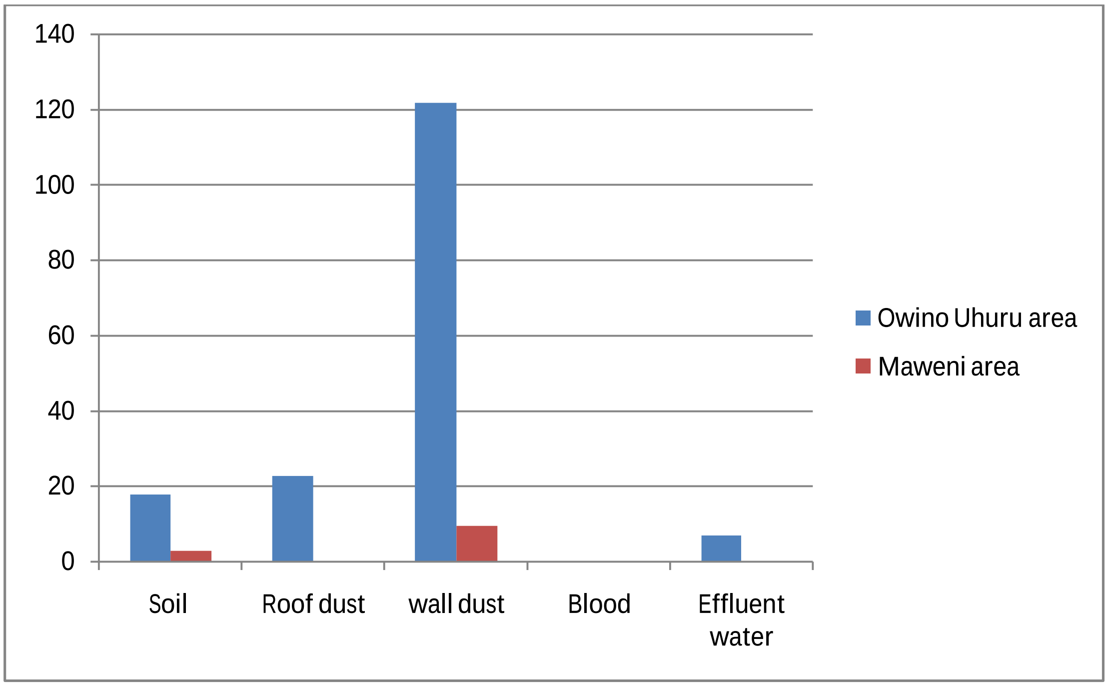

Chart 1.0 Lead metal content Owino Uhuru and Maweni slums

3.3. Discussion and Recommendations

From the above, we can infer that there are consistently more lead concentrations in the environment i.e. the soil, water and wall dust within the areas proximal to the lead-acid battery recycling factory as compared to the more distant Maweni slums. This can be attributed to the factory processes which result in lead leakages in to the nearby places which include the very populous slum. However, from the blood samples from humans and livestock, there wasn't any detectable consistent difference between those from the Owino Uhuru slums and those from Maweni in terms of blood lead levels. This means that the disparities in environmental lead content between the two areas in this study has not as such translated into significant variance in blood lead levels of the people living in the two areas and their livestock.

Importantly, it's important to take cognizance of the global debate on the extent of environmental and health impacts of lead poisoning with regard to blood levels. Many countries including USA, Canada, and Germany have revised their lead goals and intervention levels following emerging information. The World Health Organization (WHO) has accepted that neurobehavioral damage can occur when blood lead levels are below 5 µg/dL. In 2010, the WHO also concluded that a previously established tolerable intake of lead in a person's diet – 25 parts per billion, per week – was no longer acceptable based on its effect on neurological development in children and hypertension in adults. To date, there is no tolerable level of lead in dietary sources.

This implies that even humans and livestock blood with blood lead levels below detection limits are still susceptible to the risks associated with lead poisoning. There is therefore need to continually research and generate new knowledge to inform new standards and policies.

There is need to continually effect lead reduction in industrial working practices and litigation. Programs aimed at addressing this issue should target homes especially those vulnerable to irresponsible lead waste disposal and other sources of pollution. Investigations and periodic audits in such industrial areas, as provided by the law, need to be enforced and up scaled. Other individual-level behavioral measures need to be embraced to reduce the risk of lead poisoning. These include encouraging hand washing and wet mopping of dust reduce the lead burden attributed to dust, and allow an individual to regain a sense of control. This calls for substantive investment in education of the at-risk communities.

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Appendix 1.0: Study Area

Map 1.0: Owino Uhuru Slums