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# Environmental Pollution Effect in Children, In view Of Achieving the Millennium Development Goals: Lead Poisoning in Developing Countries- Nigeria in Focus

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**Abstract:** *Lead poisoning in children is a possibly preventable health problem associated with environmental pollution. Millions of children, pregnant women and unborn babies (foetus) around the globe are the most severely affected by this environmental hazard. Adults are equally affected by this dangerous heavy metal but the deadly impact is acute and rapidly manifested in children. Several factors have been shown to be responsible for these health problems especially in developing countries where there is negligence to reduce the risk exposure to lead. Keeping focus to achieving the Millennium Development Goals (MDG's) in which the protection and promotion of maternal and child health is one of the key targets. Studies have shown that millions of lives are lost due to lead poisoning unexpectedly. Lead poisoning has become a public health concern and should be tackled with all sense of urgency especially in resource poor countries.*

## I. Introduction

Lead is a metal that is found everywhere in the environment (soil, water and air) majorly as a result of human activities over thousands of years (Warniment *et al.*, 2010). It has been used for different purposes such as in house construction, for decoration (paints), and even as a food additive (medicinal herbs) and gasoline. It also has been a known health risk for centuries. Hippocrates is thought to have written the first case report of lead poisoning in 600 BC (Aub *et al.*, 1926). Lead has been known to be a cumulative toxicant (Babajide, 2011).

Lead poisoning also known as plumbism, is a clinical condition in humans and animals caused by increased levels of the heavy metal lead in the body. Lead interferes adversely with the body processes and is toxic to delicate organs and tissues including the brain, heart, bones, intestines, kidneys, and reproductive nervous systems. It interferes with the development of the nervous system and is therefore particularly toxic especially among young children (Needleman, 2004). The amount of lead in the blood and tissues, as well as the time course of exposure, determines toxicity. Lead poisoning may be acute (from intense exposure of short duration) or chronic (from repeat low-level exposure over a prolonged period), but the latter is much more common. Diagnosis and treatment of lead exposure are based on blood lead level (the amount of lead in the blood), measured in micrograms of lead per decilitre of blood (μg/dL). Lead exposure among children is associated with developmental problems including impaired cognitive function, reduced intelligence, impaired hearing, and reduced stature; no toxicologically safe blood lead level (BLL) has been identified (Canfield *et al.*, 2003; Jusko *et al.*, 2008). High BLLs, lead can cause convulsions, coma, and death (Needleman, 2004). Evidence confirms that commonly encountered blood lead concentrations, even those less than 10 μg/dL, may impair cognition, and there is no threshold yet identified for this effect (AAP, 2005). The Centers for Disease Control and Prevention (CDC) currently designates a blood lead level of 10 μg per dL (0.48 μmol per L) or higher as abnormal and requiring follow-up and intervention (CDC, 2009). Even blood lead levels lower than 10 μg per dL can affect cognitive development (Needleman *et al.*, 1990); Canefied *et al.*, 2003) Thus, a current dilemma is the nearly impossible task of eliminating all lead exposure in children.

Lead poisoning is one of the most serious environmental health threats to children and is a significant contributor to occupational disease. The World Health Organization estimates that 120 million people are over-exposed to lead (approximately three times the number infected by HIV/AIDS) and 99% of the most severely affected are in the developing world (SanFrancisco, 2011).

### Lead poisoning still a public health concern in developed countries

Even though there has been significant reduction in the prevalence of lead poisoning among children in developed countries like USA, yet it is reported that children in their hundredths of thousands are victims of lead poisoning with elevated blood lead levels (Warniment *et al.*, 2010). This problem has been largely due to airborne lead from lead paint in old houses and leaded gasoline which has been phased out (AAP, 2005). Though lead poisoning still persist but commonly among the poor and low level educated people including the impoverished and immigrants in developed countries like in the United State who live in old houses because of lack of resources are most at risk with high blood lead levels (Brudevold *et al.*, 1956; Bellinger, 2005).

**Sources Of Lead Exposure**

Lead in the environment has multiple sources, including petrol, industrial processes, paint, solder in canned foods and water pipes. It can affect human health via a number of pathways, including air, household dust, street dirt, soil, water and food (European Commission Bristol, 2013). Deciding which of these is responsible for exposure can be complicated, and will vary depending on the populations group and location to some extent. Lead-containing petrol has been a major source of lead pollution and is a significant contributor to the lead burden in the body in the countries where it is still used. Most top soils in inhabited parts of the globe are to some extent contaminated with lead. Industrial emissions are also important sources of lead contamination of the soil and ambient air, and lead may also be ingested from atmospheric air or flaked paint that has been deposited in soil and dust, raising blood lead levels (European Commission Bristol, 2013). In addition, food and water may also be important media of baseline exposure to lead (Tong *et al.*, 2000).

Among developing countries, major sources of childhood lead poisoning include lead mining, smelting, paint, leaded gasoline, battery recycling, and traditional medicines (Falk, 2003; Meyer *et al*., 2008).

**Table 1. Sources of Lead Content and Type of Pollution.**

| **Sources of lead content** | **Common uses** | **Type of pollution** | **References** |
|---|---|---|---|
| Paint | Decoration | Air/soil/dust | Gilbert, 2006 |
| Gasoline | Additives in fuel | Air/soil | Mielke and Reagan, 1998 |
| Lead/ore mining /smelting | Colours/ Jewellery | Air/soil/water | Sanborn, 2002; Watt, 2009 |
| Toys | Children play | Hand to mouth | CNN, 2007 |
| Battery recycling | Recycled for use | Air/soil/water | Manay,2008; Brodkin *et al*,2007 |
| Herbal medicines | Medicinal se/tea | Food/water | Rossi,2008; Karri, *et al.*,2008 |
| Electronic devices | Recycled for use | Air | Babajide, 2011 |
| Cans (solder) | Canned food | Food | Patrick, 2006 |
| Water pipes | Water supply | Water | Brown *et al.*,2012 |
| Eye cosmetics<br><br>Kohl- English (surma- arabic)<br><br>(tiro- Yoruba tribe) (kajal- India) | Beauty | Dust | Nasidi *et al.*,2012 |

## II. Vulnerable Groups To Lead Poisoning

**Children**

Children are more at risk to lead poisoning because their smaller bodies are in a continuous state of growth and development (Landrigan *et al.*, 2002). Lead is absorbed at a faster rate compared to adults, which causes more physical harm than to older people. Furthermore, children, especially as they are learning to crawl and walk, are constantly on the floor and therefore more prone to ingesting and inhaling dust or soil that is contaminated with lead (Woolf *et al.*, 2007).

Children are particularly at risk from adverse effects of lead exposure because:

i. Intake of lead per unit of body weight is higher for children than for adults
ii. Young children often place objects in their mouths, resulting in the ingestion of dust and soil and, possibly, increased intake of lead
iii. Physiological uptake rates of lead in children are higher than in adults
iv. Young children are developing rapidly, their systems are not fully developed, and so they are more vulnerable than adults to the toxic effects of lead (European Commission Bristol, 2013).

Apart from the developmental effects peculiar to young children, the health effects experienced by adults are similar to those in children, although the thresholds are generally higher (ATSDR, 2007).

In adults, occupational exposure is the main cause of lead poisoning. Occupations such as lead mining, smelters, plumbers, fitters, battery manufacturers /recyclers and auto mechanics. Parents who are exposed to lead at workplace sometimes carry lead dust home on clothes or skin and expose their children.

**Foetus**

A foetus developing in the womb of a woman who has elevated blood lead level is also susceptible to lead poisoning by intrauterine exposure, and is at greater risk of being born prematurely or with a low birth weight (Chisolm *et al*., 1956). Lead crosses the placenta, and the blood lead concentration of the infant is similar to that of the mother (Graziano *et al.,* 1990). The source of lead in the infant's blood seems to be a mixture of approximately two thirds dietary and one third skeletal lead, as shown by studies that exploited the differences in lead isotopes stored in the bones of women (Gulson *et al.,* 2003). Although lead appears in human milk, the concentration is closer to plasma lead and much lower than blood lead, so little is transferred. Since infant formula and other foods for infants also contain lead, women with commonly encountered blood lead concentrations who breastfeed their infants expose them to slightly less lead than if they do not breastfeed (Gulson *et al.,* 1998).

**Pregnant Women**

A pregnant woman's elevated blood lead level can lead to miscarriage, prematurity, low birth weight, and problems with development during childhood (Bellinger, 2005). A foetus may be poisoned in uterus if lead from the mother's bones is subsequently mobilized by the changes in metabolism due to pregnancy; increased calcium intake in pregnancy may help mitigate this phenomenon (Cecil *et al* .,2008)

**Routes of Entry of Lead poisoning**

Lead exposure can majorly occur through inhalation, ingestion and sometimes through the skin. And these can result in high blood lead levels in children. The absorption of lead is higher in children than in adults.

**Inhalation:** Contaminated lead dust can pollute the air and be inhaled through the nose into the respiratory tracts.

**Ingestion:** Growing children and crawling infants usually play with bare hands and pick things that are not food from the sand or soil that may be contaminated with lead and put into the mouth (Bellinger, 2004). About 50% of ingested lead is absorbed in children (Binns *et al.,* 2001).

**Skin Contact:** Lead contained in paints, food gasoline and aviation fuel can penetrate through the skin (Patrick, 2006).

**Signs and symptoms**

According to Warniment *et al*. (2010) classified blood lead levels in children into three levels; as follows

**Low Levels:** Children with a blood lead level of less than 10 µg per dL.

**Moderate Levels:** Children blood lead level measured as greater than 20 µg per dL (0.97 µmol per L) once, or greater than 15 µg per dL (0.72 µmol per L) twice.

**High Levels:** Children blood lead levels of 45 µg per dL (2.17 µmol per L) or greater.

The known symptoms of lead poisoning in children are loss of appetite, abdominal pain, vomiting, weight loss, constipation, anaemia, kidney failure, irritability, lethargy, learning disabilities, and behavioural problems (Landrigan *et al.,* 2002). Slow development of normal childhood behaviours, such as talking and use of words, and permanent intellectual disability are both commonly seen (Chisolm *et al.,* 1956). At extreme higher blood lead levels, lead could cause coma, seizures, impaired muscular coordination and even death.

**Reasons Why Lead Levels Have Persisted In Developing Countries**

Lead is still allowed in products in many developing countries (Brudevold, 1956). In all countries that have banned leaded gasoline, average blood lead levels have fallen sharply (Flora *et al.,* 2010). However, some developing countries still allow leaded gasoline (NEPHTN, 2010) which is the primary source of lead exposure in most developing countries (Bellinger, 2008). Beyond exposure from gasoline, the frequent use of pesticides, leaded paints in developing countries adds to the risk of lead exposure and subsequent poisoning (Jones *et al.,* 2009). Poor children in developing countries are at especially high risk for lead poisoning (Bellinger, 2008). Of

North American children, 7% have blood lead levels above 10 µg/dL, whereas among Central and South American children, the percentage is 33 to 34% (NEPHTN, 2010). About one fifth of the world's disease burden from lead poisoning occurs in the Western Pacific, and another fifth is in Southeast Asia (NEPHTN, 2010).

Childhood lead poisoning is typically more severe in developing countries due to inadequately controlled industrial emissions, unregulated cottage industries, and cultural practices such as folk medicines containing lead (National Referral Centre for Lead Poisoning Prevention in India).

**Case study of Nigeria**

Although Nigeria switched to unleaded gasoline by the end of 2003, Nigerian children might also be exposed to the lead that remains in the soil from years of use of leaded gasoline. In addition, lead contamination resulting from gold mining has caused many child deaths in Nigerian villages (Zamfara state) where artisanal gold ore processing takes place (CDC, 2010; Dooyeama *et al.*, 2012).

The environmental and health impacts of small-scale gold production are often overlooked. Gold mining and processing are known to cause air and water pollution from arsenic, mercury, and cyanide. Gold processing can also cause mercury poisoning in workers because of direct exposure to liquid or vaporized mercury during ore processing (Swenson *et al*., 2011). Although lead pollution is not commonly associated with gold mining, studies of small-scale gold mining sites in the Migori gold belt (Kenya) have demonstrated lead, mercury, and arsenic pollution of multiple gold processing sites; recorded soil lead levels ranged from 16 to 14,999 ppm (Ogala *et al.,* 2002; Odumo *et al*., 2010). A study in Ecuador demonstrated lead, manganese, and mercury pollution of river water near the surveyed small-scale gold-mining sites; approximately 40% of adults from the affected communities had BLLs > 20 µg/dL (Betancourt *et al.*, 2005).

**Table 2. Lead Pollution In The Different Parts Of Nigeria**

| PLACE | POLLUTION TYPE/SOURCE | QTY LEAD (Pb) (ppm) |
|---|---|---|
| Calabar | River sediment | 20 |
| Ibadan | Surface Water | 0.05 |
| Lagos | Soil | 67.5 - 426 |
| Nnewi | Soil | 746 |
| Osogbo | Soil | 92.0 |
| Nigeria | Herbal Medicines | 27 |
| Niger Delta | Water | 0.03 - 0.06 |
| Niger Delta | Fish | 0.03 |
| Nigeria | Beverage | 0.11 |
| Nigeria | Sachet water | 0.04 |
| Kano | Vegetables | 13.19 |
| Ogun | Fish | 3.40 |
| Awka | Drinking water | 0.01 |
| Awka | Vegetables | 1.74 |
| Awka | Food crops | 0.10 |
| Nigeria | Syrups | 0.88 |
| Zamfara State | Soil | ≥ 1000 |

Plumley et al., 2013

**Diagnosis:** Screening for blood lead levels (BLLs) using venous sampling is the major instrument in the diagnosis of lead poisoning. Laboratories that perform blood lead testing are required to meet federal proficiency standards with an error range of ± 4 µg per dL (0.19 µmol per L) or ± 10 percent, whichever is greater (CDC, 1997; Binns *et al.*, 2007). As a result, a blood lead level of 8 µg per dL (0.39 µmol per L) could be reported as any value ranging from 4 to 12 µg per dL (0.19 to 0.58 µmol per L) and remain within the range of the proficiency standards.

**Treatment:** Treatment is dependent on the severity of the lead poisoning in children. If the child's BLL is ≤ 10 µg per dL, the child basically needs to be screened, nutrition rich in iron, environmental education to parents and caregivers. And by all possible means reduce much further the blood lead levels.

If the child's BLL is measured as ≥ 20 µg per dL (0.97 µmol per L) once, or greater than 15 µg per dL (0.72 µmol per L) twice. The child should be medically evaluated, the case appropriately managed by carrying out environmental investigation inside and outside the home.

If the child's BLL is measured above 45 µg per dL (2.17 µmol per L) the case should be medically evaluated, chelation therapy is recommended (Rogan *et al.*, 2001; CDC, 2002).

Chelation therapy is usually done with succimer (Chemet), but dimercaprol (Bal in oil) can also be used. Succimer is preferred because it can be administered orally and is better tolerated. Children treated with chelating agents should be monitored closely during and after treatment (CDC, 2002).

Children with levels higher than 70 μg per dL (3.38 μmol per L) should be hospitalized immediately for treatment under direct medical supervision (CDC, 2002). Remediation of contaminated soil: Efforts should be made by environmental authorities to clean up the environment may be through soil remediation of any suitable method.

**Prevention**

Prevention of lead exposure could be achieved at the individual level; removing lead-containing items such as piping or blinds from the home, and personal hygiene (washing of children hands after play). Government policies such as laws that ban lead in products, reduce allowable levels in water or soil, or provide for cleanup and mitigation of contaminated soil, etc.

**Nutrition:** Studies have shown the relationship between iron deficiency and lead poisoning (Wolf *et al.,* 2003; Zimmermann *et al.,* 2006). This information is helpful in order to provide iron rich diets to children that need it so as to reduce the accumulating lead in the body. Calcium has an important role to play in interfering with the absorption of lead in the body by binding to the lead and inhibiting absorption. Calcium supplements or intake of milk and yoghurt to meals and snacks is recommended.

**Education:** Government, private, local and international health and environmental agencies should sensitise and create awareness on risk exposures of lead poisoning to households, factories, industries and oil refineries. Screening exercise is another way of prevention where children and population at high risk of lead exposure are screened to ascertain their blood lead levels.

## III. Conclusion

Lead poisoning is one of the greatest environmental threats to children. There is no safe or normal blood lead level in humans. Therefore the government and relevant environmental authorities especially in developing countries should ensure that lead based commodities that are of potential environmental hazard are phased out. Similar to what is done in developed countries, also there should be standards for lead limit in the water, soil and air which should be monitored and maintained in compliance with international standards. More so, at the long run there are also economic implications if a reasonable population of children are severely affected by this environmental hazard. The outcome could be poor academic performance due to low intelligence quotient that can result in poor performance, and low productivity at work place. Regulatory and enforcement groups should be established to help in addressing this sort of public health issues.

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