TRACE METAL LEVEL OF HUMAN BLOOD FROM DARETA VILLAGE, ANKA, NIGERIA


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ABSTRACT

The trace metal levels of blood obtained from some people in Dareta Village (a mining community) were determined. About 33 males of various age groups ranging from 1 to 40yrs were recruited for the study. The trace metals studied include Zn, Pb, Cd and Cu. These metals were analyzed using graphite furnace Atomic Absorption spectrophotometer(Shimazu AA-6800). The mean trace metal concentrations and their ranges were Zn, 8.42(5.21-14.44) mg/l; Pb 1.13 (0.25-2.65) mg/l; Cd 0.052(0.01-0.098) mg/l and Cu, 0.67 (0.15-2.178) mg/l. The levels of these metals were higher than acceptable limits, except for copper which is within safe limits. These metals could bioaccumulate and thereby pose a long term effect on man. These effects have been extensively discussed.

KEY WORDS: Human blood, Trace metals, Mining community, Bioaccumulation, Males

INTRODUCTION

Toxic metals are natural components of the environment, but human activities in mining, industry and agriculture, have been responsible for the wider diffusion of these elements. The most ubiquitous presence of some metal pollutants facilitates their entry into the food chain and thus increases the possibility of them having toxic effects on humans and animals. Increasing pollution has given rise to concern on the intake of harmful metals in humans. These metals enter the human body through inhalation and ingestion. The intake through ingestion depends on food habit.

Trace amounts of heavy metals occur naturally in soil. However, exploitation of land for mineral extraction, manufacturing industry and waste disposal has resulted in the inputand accumulation of large quantities of heavy metals. Unregulated inputs of metal contaminated materials into the natural environment pose a range of both short- and long-term environmental risks. These heavy metals may find their way into the human body through food, water, air or absorption through the skin (Shibko, 1972; Goyer, 1996). Some of these metals bioaccumulate (Nriagu, 1979; Luckey et al, 1975; Babalola et al, 2007). Heavy metals which have received the most attention both in terms of sources and effects are those which are considered either (or both) as essential or toxic or show a high geochemical abundance, these include: zinc, iron, copper, molybdenum, lead, mercury and cadmium (Martin and Coughtrey 1982, Hawkes, 1997, Anetoret al, 2002).

Zinc is distributed widely throughout the body, and is deposited relatively slowly in the skeleton, where it is bound for long periods. Approximately 98% of the zinc in normal human plasma is protein bound. The principal carrier protein is albumin which binds about 80-85% of plasma zinc; approximately 15% is bound to 2-acroglobulin, less than 2% to retinol-binding protein and less than 1-2% of Zinc is free or ultrafilterable (Giroix and Henkin 1972; Chivers, 1984; Foote and Delves 1984). Zinc is found in high concentrations in the choroid plexus, prostate, kidney, liver, lung, spleen, and brain (particularly the cerebellum and hippocampus) and may have long term effect (Durdanaet al, 2007).

Exposure to lead occurs from breathing air, drinking water, and eating foods that contain Lead. Inhalation of Lead fumes or of fine Lead particles is the most important route of absorption in the working environment and general atmosphere. Chronic low-dose Lead exposure exerts subtle neuropsychiatric, reproductive and renal effects and children are particularly susceptible.

Death from Lead poisoning has occurred in children at blood Lead levels of 1.25 mg/L or higher. Lead poisoning in childhood is a chronic disease and currently it is accepted that even very low blood levels of Lead may induce developmental deficits (Gilman et al, 1990, Garrettson1990).

The Lowest Observe Adverse Effect Level (LOAEL) of Lead for children (causing developmental toxicity) is 0.1mg/L in blood. This level is associated with diminishing IQ score in children (Sax and Lewis 1989; ATSDR 1990). Acceptable daily intake (ADI) and other guideline levels provide maximum tolerable weekly intake of Lead: adults, 3 mg per person or 50 µg/kg body weight; children 25 µg/kg body weight (FAO/WHO, 1987). Lead interferes with the haem biosynthetic pathway, producing haematological effects, and competes at the molecular level with calcium. The central nervous system and kidneys are particularly sensitive to lead. The central and peripheral nervous systems are affected; gastrointestinal structures are also damaged; and there is strong evidence of effects on the reproductive system. Lead also may have a role as a cofactor in carcinogenesis (Goyer 1990; ATSDR 1990;
**MATERIALS AND METHOD**

For the investigation, 33 clients (all males) were recruited for the study. Their ages ranged from 1-40 years. About 5ml of venous blood were collected from each of the subject using disposable pyrogen free needle and syringe (Beckton-Dickinson, Dublin, Ireland). The blood samples were transferred into heparinized test tube containing lithium heparin (Vacutainer system Inc., Rutherford, New-Jersey) and kept frozen at -20 °C until analyzed. The frozen blood sample were retrieved and left on the bench overnight to digest the blood (using micropipette) into clean test tube. To this, 5 ml of conc. nitric acid and 5ml of perchloric acid were added and left on the bench overnight to digest the blood samples (Babalola et al., 2007). The solution was later made up to 25ml with distilled deionized water and analyzed for trace metals using Shimadzu Atomic Absorption Spectrophotometer model AA-6800. Standard solutions of each of the metals were aspirated to calibrate the AAS before the aspiration of the sample.

**RESULTS AND DISCUSSION**

The average concentration of zinc, lead, cadmium and copper of human blood analyzed from the 33 respondents (all males) from Dareta village is presented in Table I.

<table>
<thead>
<tr>
<th>Metals</th>
<th>Concentration (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc</td>
<td>8.986 ± 2.0 mg/l</td>
</tr>
<tr>
<td>Lead</td>
<td>1.36 mg/l</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.072 mg/L</td>
</tr>
<tr>
<td>Copper</td>
<td>0.0495 mg/l</td>
</tr>
</tbody>
</table>

**Zinc values in human serum of 1.09 to 1.3 mg/l was reported (Vallee, 1963), similar to those of iron; whole blood zinc, 8.8 ± 2.0 mg/l; and red cell zinc, 14.40 ± 2.70 mg/L. The normal or therapeutic value in blood is 0.68 to 1.36 mg/l and, in the CSF, 20 to 60 µg/kg/litre. From Fig I, the mean Zn concentration in blood is 8.986mg/l; this value is far above the normal therapeutic value in blood. Those in the age range between 11 to 20 years had the highest Zn concentration of 10.103mg/l, while those in the age range between 1-10 had the lowest concentration of 7.90mg/l. The high zinc concentration in the age range between 11 to 20 years may be attributed to active involvement of the age group in the mining processes without wearing necessary protective gears.

From Fig II, the average lead level in blood is 1.321mg/l. The highest average concentration of 1.72mg/l was found in the age range 31-40, while the lowest average concentration of0.94mg/l was found in the age range 0-10. Most of the adult in this study work in the mine field and may have been exposed to lead dust. The children could have been exposed to lead from the dust that rises from the crushing mills scattered all over Dareta village and from playing with contaminated sand.

Cadmium is extremely poisonous and toxic to humans. In recent times whole blood cadmium concentration is the best measure of exposure. Whole blood levels above 10µg/l indicate significant exposure. Several studies (Roelset et al., 1981; Roelset et al., 1983) have revealed that in cadmium-exposed populations renal dysfunction is present when the concentration of urinary cadmium exceeds 10µg cadmium/g creatinine. From this study (Fig III), average cadmium blood concentration is 0.0495mg/l, with the adults (31-40 yrs) having average concentration of 0.072mg/L and the children (1-10 yrs) having concentration of 0.05mg/l which is still higher than the significant exposure concentration of 10µg/l. These high cadmium levels also may be attributed to the engagements of adults at the mine fields without necessary protective gears. Cigarette smoking is another important source of cadmium exposure (Majidet al., 1999). Dust from the grinding mills and intake through food may be responsible for the high levels of cadmium in children. Cadmium poisoning can result in lung damage, reduction of sperm count, kidney damage etc (Ibeto and okoye, 2009).

Copper is an essential trace element. In humans, it’s essential for the proper functioning of organs and metabolic processes. However, acute or chronic exposure to copper results in copper induced toxicity. Liver is the target organ of copper induced toxicity. Other target organs include bone and the central nervous system. The allowable limit of copper for blood is between0.75-1.5mg/l (Yasminet al., 2010). In Table I, the mean concentration of copper was found to be 0.750mg/L which is within the WHO allowable limit. From Fig IV, the highest average concentration of 0.984mg/l was observed in the range 31-40 years of age and the lowest average concentration of 0.572mg/l was observed in the age range 1-10 years.
Table I: Average Trace Metal Concentration (in mg/l) of Human blood of people from Dareta Village

<table>
<thead>
<tr>
<th>Age (Yrs)</th>
<th>Pb ± SD</th>
<th>Cd ± SD</th>
<th>Zn ± SD</th>
<th>Cu ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (1-10)</td>
<td>0.94±0.53</td>
<td>0.05±0.03</td>
<td>7.90±2.35</td>
<td>0.572±0.36</td>
</tr>
<tr>
<td>B (11-20)</td>
<td>1.12±0.144</td>
<td>0.04±0.04</td>
<td>10.10±0.81</td>
<td>0.721±0.31</td>
</tr>
<tr>
<td>C (21-30)</td>
<td>1.50±0.07</td>
<td>0.04±0.04</td>
<td>8.52±3.69</td>
<td>0.724±0.77</td>
</tr>
<tr>
<td>D (31-40)</td>
<td>1.72±0.48</td>
<td>0.07±0.02</td>
<td>9.42±2.93</td>
<td>0.984±0.63</td>
</tr>
<tr>
<td>Mean</td>
<td>1.32±0.56</td>
<td>0.05±0.03</td>
<td>8.99±2.46</td>
<td>0.750±0.44</td>
</tr>
</tbody>
</table>

Fig I: Concentration of zinc in human blood from Dareta village

Fig II: Concentration of lead in human blood from Dareta village
Fig III: Concentration of cadmium in human blood from Dareta village

Fig IV: Concentration of copper in human blood from Dareta village
CONCLUSION

From this present study, high levels of Cd, Pb, and Zn were recorded in the blood of the sampled population. Only copper was within the world health acceptable limits, though the age range between 31-40 had average concentration of 0.984mg/l. The continuous bioaccumulation of these metals may increase their possibility of having toxic effects on humans and animals. To ameliorate these problems, a comprehensive study of the level of heavy metals in the ground water, streams, soils in and around Dareta village be carried out so as to carry out a remediation of the environment. The natives need to be educated on the effect of bioaccumulation of these metals. Modern mines should be built to tap these minerals.

ACKNOWLEDGEMENTS

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REFERENCES


www.reuters.com/article/idUSTRE6534JE20100604