*J. Appl. Environ. Biol. Sci.*, 1(5)96-100, 2011



ISSN 2090 – 424X
Journal of Applied Environmental and Biological Sciences
*www.textroad.com*

# Status of Trace Metal Levels of Different Age Population of Dareta Village, Anka, Nigeria

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## ABSTRACT

Trace metal determination in human blood have become important to obtain information regarding the health status of individuals since blood is a good indicator of current body burden of metals. In this study the levels of Nickel, Manganese, Cobalt and Chromium were determined in whole blood of people of different age groups ranging from 1-40 years residing in Derata, Anka, Nigeria. Thirty-three blood samples were collected from the subjects and analyzed using Atomic Absorption Spectrophotometer after wet digestion. The trace metal levels in mg/l were 0.166±141, 0.935±0.491, 0.318±141 and 1.321±0.376 for Cr, Ni, Mn and Co respectively. The result obtained indicated no significant difference in metal levels between the age groups except for cobalt. Apart from Manganese, the concentrations were found to be above the maximum allowable limits for these metals in human blood. The health implications of these research findings were also discussed.

**KEY WORDS**: Metal levels, whole blood, allowable limits, health implications, Dareta village.

## INTRODUCTION

Metals are natural components of the earth crust. They cannot be degraded or destroyed [1]. Increase in agricultural, mining and industrial processes have resulted in an increase concentration of metals in air, water and soil. These metals taken in by plants and animals subsequently find their way into the food chain and enter the human body through ingestion. Inhalation and absorption through the skin are the other sources through which they gain access into the human body [2, 3]. Essential metals at trace level play vital roles when present in the human body. Some of them form integral part of several enzymes and are capable of causing serious health problems by interfering with the normal functions when present beyond specific concentration referred to as allowable limits for such metals[(4, 5 & 6]. Both toxicity and necessity vary from element to element [7].

Several studies have investigated the levels of metals in the body and where possible their effect on health using body fluid especially blood, since blood is considered as a good indicator of current body burden of metals. It is therefore important to monitor the exact levels of trace metals in blood using reliable analytical technique [8]. The levels of trace elements in blood vary considerably between global population and the normal range for a typical population was different [4]. It is necessary that ranges of trace element in blood of a normal population be established for different regions.

The main aim of this study is to investigate the levels of trace metals in blood of population of Dareta, Anka, Zamfara State, Nigeria. Zamfara State has a lot of untapped mineral resources. The natives tap these minerals crudely with so many mining mills scattered all over the State [2]. Dareta village is one of such mining fields. Recently, many deaths were recorded amongst children in Anka and Bukuyum local governments of the state [9]. The deaths were attributed to lead poisoning which informs this study. Previous study [2] has shown high levels of lead, Cadmium, and zinc in blood of Derata population. This study investigates the levels of Chromium, Nickel, manganese and cobalt.

Nickel is widely distributed in the earth crust and can be found in air, water and soil. Natural sources includes, dust from volcanic emission and weathering of rocks and soils. But the levels found are usually by far lower than those from occupational situations [10]. Occupational exposures of several million workers Worldwide has been shown to give rise to elevated levels of nickel in blood, urine, and body tissues [1 & 10]. In this case workers are exposed to ambient fumes and dust containing nickel and its compounds. Inhalation therefore is the main route of uptake. The levels of nickel in ambient air is small (about 6-20 $ngm^{-3}$) but levels up to 150ng Ni/ m in air contaminated with anthropogenic sources. In water nickel is derived from solubilisation of nickel compounds from soils, sedimentation of nickel from the atmosphere and from biological cycle. Uncontaminated water contains about 300ngNi/dm3. Farm soils contain approximately 3-1000mgNi/kg. But contaminated soil can reach up to 2400-5300 mg/kg - soils near metal refineries and sludge [10].

Excess manganese exposure is predominantly reported in adults exposed occupationally. Infants are exposed via diet and water [11].

Cobalt is the 23rd most abundant element. Sources of exposure to cobalt includes both natural and anthropogenic. Natural sources are windblown dust, forest fire, sea water spray etc. The anthropogenic sources include burning of

fossil fuels, sewage sludge, mining, fertilizer and industries. The earth crust contains an average cobalt concentration of 20-25mg/kg [12].

Chromium is a mineral that humans require in trace amount, though its mechanism of action in the body and the amount needed for optimal health is not well defined. It's found normally in two forms: (1) Trivalent chromium which is biologically active and found in plants, and (2) Hexavalent chromium, a toxic form that results from industrial pollution [13 & 14]. Chromium is found in rocks, animals, plants, soils and can be liquid, solid or gas. Its compounds bind to the soil and are not likely to migrate to groundwater but are persistent in water sediment. Hexavalent chromium is a known carcinogen. [15].

## MATERIALS AND METHOD

The study was carried out in 33 male subjects, 1-40 years of age who resides in Dareta. About 5ml Venus blood was collected from each subject using disposable pyrogen free needle syringe (Becton-Dickinson, Dublin, Ireland). The blood samples were transferred into heparinised tube containing Lithium heparin (Vacutainer system Inc. Rutherford, New-Jersey) and kept frozen at about – 20$^{o}$C until analyzed. The frozen blood samples were retrieved and allowed to thaw. 1ml of the blood was pipetted into a clean test tube. To this, 5ml of conc. nitric acid and 5ml of perchloric acid were added and left over night on the bench to digest. The solution was later made up to 25ml with distilled deionised water and analyzed for Ni, Co, Cr, and Mn. This procedure was adopted from Babalola [16].

### Analysis

Heavy metal analyses was done using schemadzu Atomic Absorption Spectrophotometer (AAS) model AA 6800 equipped with Zeaman background correction and graphite furnace. Standard solutions of each of the metals were aspirated to calibrate the AAS before aspiration of the samples. Average values of replicates were taken for each determination and were subjected to statistical analysis. The results were presented as mean± S.D.

### Data analysis

Data collected were subjected to statistical test of significance using one way analysis of variance (ANOVA) to assess significant variation in concentration levels of the metals across the various age groups. Statistical analysis was done using SPSS Statistic 17.00 (one-way ANOVA).

### Validation of analytical procedure

In order to check the reliability of the analytical methods employed for trace metals determination, Standard Reference Material, Animal blood coded IAEA-A-13 was also digested and then analyzed following the same procedure.

## RESULT AND DISCUSSION

A standard reference material of animal blood coded IAEA-A-13 was analysed in like manner to our samples. The values determined and the certified values of the elements determined were very close (table 2) suggesting the reliability of the analytical method employed.

Table I: Average Trace Metal Concentration(in mg/l) of different age population of Dareta Village

| Age (Yrs) | Mn± SD | Cr ± SD | Ni ± SD | Co±SD |
|---|---|---|---|---|
| A (1-10) | 0.168±0.157 | 0.826±0.391 | 0.332±0.389 | 0.957±1.473 |
| B (11-20) | 0.163±0.136 | 0.913±0.081 | 0.288±0.350 | 0.443±0.764 |
| C (21-30) | 0.175±0.153 | 1.105±0.177 | 0.153±0.211 | 1.492±1.555 |
| D (31-40) | 0.157±0.105 | 0.897±0.928 | 0.499±0.404 | 2.391±2.40 |
| Mean | 0.166±0.141 | 0.935±0.491 | 0.318±0.141 | 1.321±0.376 |

The results obtained from the estimation of Cr, Ni, Co and Mn in blood samples of Derata population are presented in table I. The trend of these metals was as follows: Co > Cr > Ni > Mn. The subjects were divided into four groups according to their ages. Group A ranged from 1-10 years, group B ranged from 11-20 years, group C ranged from 21-30 years and group D 31-40years.

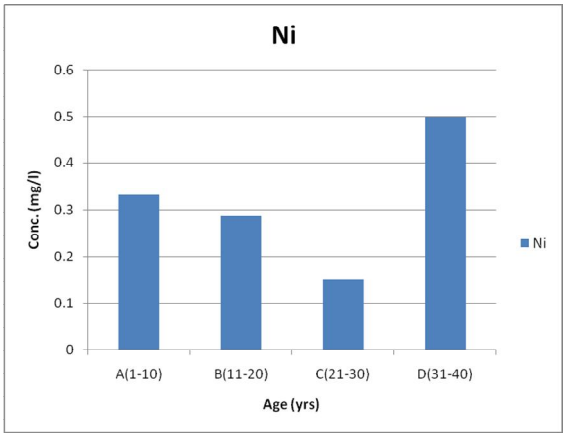


Figure 1. Concentration of Ni in Blood of Different Age Population of Dareta Village

The average concentration of Ni in human blood was found to be 0.318mg/l. The trend of Ni, across the four age groups was a follows: D > A > B > C (Fig. 1). There was no significant difference in Ni levels between the four age groups (P > 0.05). The high concentration of Ni in blood recorded in group D might be due to the active involvement of these group in the mining process without protective gears. They may have been exposed to ambient air or dust containing nickel or its compounds both at the mining fields and at the mills. Dust from the mills scattered around the village and playing on the dust both at home and village square as well as ingestion of contaminated food and water may account for the high Ni levels in group A. A previous study [17] recorded high concentration of Ni in hand dug wells which is the major source of water in Derata village.

Table 1 shows the results of analysis of reference material (animal blood IAEA-A-13) compare to the reference value.

| Elements(mg/L) | Fe | Cu | Pb | Ni | Zn | Ca | Na |
|---|---|---|---|---|---|---|---|
| A Value | 2360 | 4.75 | 0.22 | 1.37 | 14.2 | 292 | 13486 |
| R Value | 2400 | 4.30 | 0.18 | 1.00 | 13.0 | 286 | 12600 |

A Value = Analysed value R Value = Reference value.

Lower mean concentration of Ni (2.3µg/100ml) in blood was recorded for healthy children and 1.8 µg/100ml for children suspected to have lead poisoning in previous studies [18]. Mean values of 0.23ppm and 0.51ppm were also recorded for Ni in blood plasma and red blood cell respectively [19]. The reference value for nickel in blood is between 4.5-28.0µg/L [20]. Nickel is toxic at concentration equal to or greater than 8µg per litre of blood [21]. The concentration of nickel recorded in this study is sufficiently high to cause health problems. Acute effect generally results from short term exposure to high concentrations. Chronic non cancerous effect results from long term exposure to relatively low concentration of nickel. Inhalation of nickel causes cancer of the nose, lungs, throat, stomach and sinuses [10]. Other health effects of nickel exposure include dermatitis, cardio vascular and kidney diseases, asthma and bronchitis. Clinical symptoms include diarrhoea, head ache, visual disturbance and skin rashes at the site of contact [10].

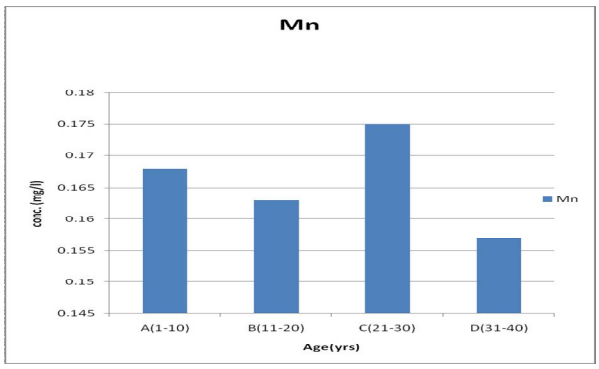


Figure 2. Concentration Of Mn In Blood Of Different Age Population Of Dareta Village

The allowable limits for manganese in human blood is 0.17 – 1ppm [5] for healthy life, but the concentration of manganese in human blood recorded in this study exhibited no deviation from the maximum allowable limits. The mean concentration of Mn was found to be 0.166mg/L (Table I) which is within the limit. The highest mean concentration of 0.175±0.153 was recorded by age group C and the lowest (0.157 ± 0.105) by age group D as shown in figure 2. Higher value (0.408ppm) of manganese in blood was reported [5]. Lower Values of manganese in blood of children were record in previous studies. 1.2µg/100mls was reported for healthy children and 1-8 µg/100mls was reported for children suspected to have lead poisoning [18]. There was no significant difference in manganese level across the four age groups ($p > 0.05$). The primary targets of Mn toxicity are the brain and the central nervous system. Symptoms include impaired neurological and neuromuscular control, mental and emotional disturbances, muscle stiffness and impaired male fertility. Manganese exposure is shown to be teratogenic [11]. Children with high manganese exposure have been associated with learning disabilities and decrease liver functioning [11]. The trend of manganese across the various age group was; C > A > B > D.

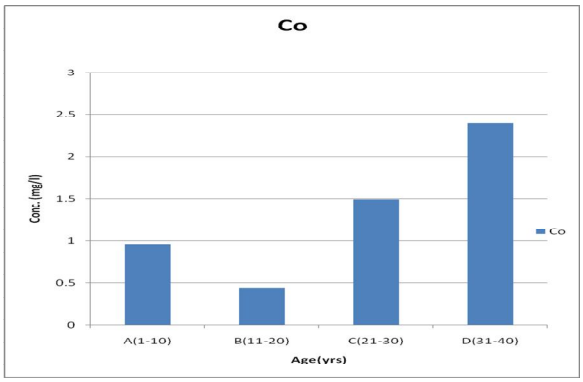


Figure 3. Concentration of Co in Blood Of Different Age Population of Dareta Village

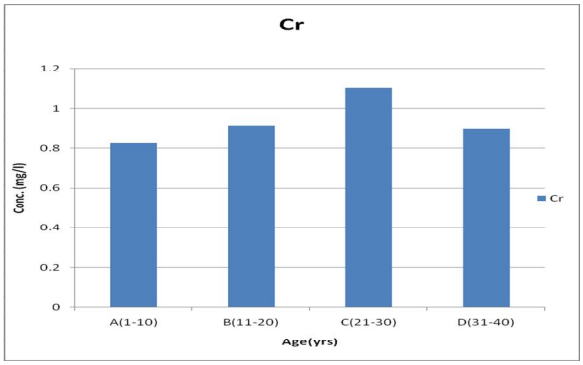


Figure 4. Concentration of Cr in Blood of Different Age Population of Dareta Village

Cobalt is an essential element in the human body. It forms the core of vitamin B12 necessary for the formation of all cells, especially red blood cells. Monitoring cobalt in body fluid is necessary for the control of nutritional deficiency and also to prevent its toxic effects when in excess [22]. In this study, the average level of cobalt was 1.32± 0.376mg/L (Table I). Group D recorded the highest level of cobalt in whole blood, the trend was as follows: D > C > A > B (Fig.3). Age group D and C was actively involved in the mining activities without protective gears and thus may have been exposed. Group A may have been exposed through ingestions (food and water) as well as direct contract as they play both home and village square. A significant difference in cobalt levels was observed across the age groups ($P < 0.05$). In previous studies, lower levels were recorded for

cobalt in blood of children. 0.46ug/100mls was recorded for healthy children and 0.32ug/l100mls for children suspected to have lead poisoning [18]. At concentrations between 0.1 – 1.2ug/L in human serum, cobalt is said to be toxic [21]. It is important to note that even the lowest concentration of cobalt recorded in this study is higher than this value. Cobalt is found to have reproductive and developmental effect in animals. Bronchial asthma, cardiomyopathy, lungs diseases, eye, nose and throat irritation are some of the effects of cobalt toxicity [12].

Chromium levels in blood of the subjects under study were noted above the reference value (2.6 - 45µg/L) for chromium in human blood [20]. The average blood chromium level was found to be 0.935± 0.491mg/l. Group C recorded the highest mean blood chromium levels (1.105 ± 0.177), the trend was as follows: C > B > D > A (Figure 4). No significant difference of chromium levels in blood of group A, B, C, and D was observed, but all the age groups are at risk of chromium toxicity. Average chromium concentrations of 4.13 ± 078 and 3.09 ± 0.83µg/L have been reported in blood of different age groups in Pakistan [4]. Average chromium concentrations of 3.5µg per100 litres and 4.1µg per 100litres have also been reported for healthy children and children suspected to have lead poisoning respectively [18]. Chromium is an important mineral the body must have to function properly. The body stores chromium in the blood and hair. It's responsible for stimulating the activities of insulin in the body and also help controls blood cholesterol levels. The acceptable daily intake of chromium is 50-200µg/day. Low level exposure to chromium can cause skin irritation, and ulceration. Long term exposure can cause kidney and liver damage as well as circulatory and nerve tissue problems (1 &2).

## CONCLUSION

In this study, levels of chromium, Nickel and cobalt of different age groups of Dareta population were found to be sufficiently high to cause health problems. Manganese was found to be within the allowable limit for manganese in human blood. The high level of these metals concentration in children indicates that occupational exposure is not the only route of exposures. The trend of the metals in blood was as follow: Co > Cr > Ni > Mn. A comprehensive study of metal levels in water, soil, crops and air should be carried out by government to ascertain the extent of pollution. Environmental impact assessment should be carried in Zamfara before further exploitation of the abundant solid minerals in the State. Proper enlightenment programs should be carried out to create awareness on the dangers of metal poisoning among the villagers.

**Acknowledgement**

The authors are grateful to Zamfara State Ministry of health for their support and to the Federal Ministry of Science and Technology for sponsoring the study.

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