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Cobalt and Zinc in Toenails of Some Kano Inhabitants

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ABSTRACT: Quantitative determination of Co and Zn concentrations in toenails of 42 volunteers with a mean age of 25.01 ± 11.46 years and resident in Kano for at least six months were assayed by atomic absorption (AAS). .Significantly high levels of Co and Zn were present in the toenails of some individuals with a mean Co of 75.72 ± 24.67µg/g and 108.51 ± 61.40 µg/g for Co and Zn respectively. With respect to age there was increase relation in zinc concentrations with age with approximate average of 18% in its concentrations with each decade but no such uniform pattern for the cobalt concentrations.
Keywords: Cobalt, Zinc, toenails, Kano, Nigeria.

INTRODUCTION

Toenail is a biological specimen that is easily and non invasively collected with minimum cost, easily stored and transported thus making toenail an attractive bio-monitoring substrate (Hayasi *et al*., 1993; Oluwole *et al*., 1994; Chaudhary *et al*., 1995; Vance *et al*., 1988). Since trace elements are excreted in toenails many have suggested it for assessing their exposure, particularly in developing countries where specialized laboratory services may be unavailable and resources are limited (Schumacher *et al*., 1991). The ability to distinguish between endogenous trace metals namely absorbed into the blood and incorporated into the toe nails matrix, exogenous and those derived from external contamination is a problem. During the wash step it is assumed that exogenous trace metals are removed, whereas endogenous ones are not. Another issue is the variation in the metal concentration profile among various subpopulations according to age, sex, and toenail (Wolfsperger *et al*., 1994). Thus it is difficult to establish reference ranges because confounding factors may impose restrictions on the interpretation of individual results.

Man may be exposed to cobalt by breathing, drinking and eating food when cobalt is widely dispersed in the environment. Skin contact with soil or water containing cobalt also enhances exposure. It is found in phosphate fertilizers, tobacco smoke and in burning of coal oil (ATSDR, 2003; Soliman *et al*., 2006).

Cobalt is beneficial to man because it is part of vitamin B_{12}, essential for health. It is used to treat anaemia in pregnant women because it stimulates the production of red blood cells (ATSDR, 2003). Other health effects caused by high concentrations of cobalt are vomiting and nausea, vision and heart problems and thyroid damage (ATSDR, 2003). Cobalt is a possible carcinogen since animalsô studies has shown that cobalt causes cancer when placed directly into muscles or under skin but did not cause cancer in animals that were exposed to it in the air, food or drinking water (ATSDR, 2003).

The need for zinc in human nutrition was demonstrated with the discovery of metabolic process in which this mineral acts as an enzymatic factor (Guthrie and Picciano, 1995). Zinc participates as a component of various proteins, hormones and nucleotide (Guthrie and Picciano; 1995). Zinc deficiency is a public health concern. The extent of the problem is unclear because there is no well established method to assess the zinc status of an individual. Physiological signs of zinc deficiency include depressed growth, anorexia, diarrhoea, parakeratotic and impaired testicular development, immune functions and cognition function (Nielsen, 2002). Pathological signs of zinc deficiency include dwarfism, delayed puberty, failure to thrive, impaired wound healing and increased susceptibility to infectious disease (Nielsen, 2002). Low zinc status increases the susceptibility to osteoporosis and to changes caused by the presence of excessive reactive oxygen species or free radicals (Nielsen, 2002).

The adult human body possesses approximately 1.5 to 2.0g of zinc of which 80% is found in bones, muscles, liver, skin, ocular retina, hair and nails (Krebs *et al*., 1995). It is found in the pancreas, kidney and other body fluids such as prostrate and sperm (Krebs *et al*., 1995). However, long term high doses of zinc causes digestive problems, decreased cholesterol and defects in immune system function. Zinc concentrations in hair, nails, plasma, blood cells and urine excreted is reduced in the presence of severe deficiency (Gibson, 1989). when in short supply the following activities maybe decreased viz plasma alkaline phosphates, liver, retina and testes alcohol dehydrogenase and connective tissues, thymodine kinase, pancreatic carboxyl peptidase A and liver nuclear DNA -dependent RNA-polymerase (Hambidge and Krebs, 1987, Miller *et al*., 1979). It is associated with taste and small acuity, wound and burn healing (Hambidge and Krebs, 1987). This study was aimed to investigate cobalt and zinc in toenails of inhabitants residents in Kano and at identifying the sources of exposure contributing to the concentrations of these elements

MATERIALS AND METHODS

Sample Collection

The collected toenail samples were washed using the standard procedure (IAEA, 1997). Volunteers were asked to wash their feet with water and soap devoid of metal contamination, followed by drying with clean towel or tissue paper to remove any external contamination. Using clean stainless steel scissors toenail samples were collected from the toes. Respondents provided toenail clippings and completed questionnaires regarding age and gender. Toenail samples were washed, hot-block digested, and analyzed for Co and Zn. For subsequent analysis, each nail sample was sealed in plastic cover till it was rewashed, dried, digested and converted into water-clear solution.

Sample Treatment

The procedure involved 6 steps of washing each sample in a clean beaker in an ultrasonic bath, with 25cm^3 portions successively, water, acetone, 1% detergent solution, water, water, acetone, water, decanting the wash liquid after 10-minute wash (Gammelgaard *et al*., 1991; Kucera *et al*.,1996). After washing the samples were air dried and kept in a plastic container.

Analysis

The concentrations of metals were assayed by Flame Atomic Absorption on a Buck Model 210 VGP Spectrophotometer with air acetylene flame. A series of standards were prepared in deionised water for instrumental calibration by diluting commercial standards containing 1000mg/dm^3 of the metals concentration.The main instrumental parameters like band width, lamp current and wavelength for estimation of metals by AAS were set-up separately for each metal (Mehra and Juneja, 2005).

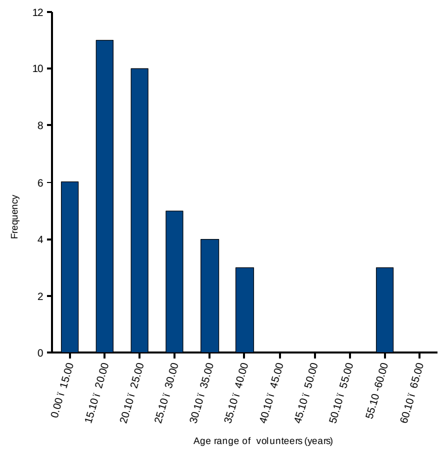
Each sample (0.5g) was digested in 10cm^3 concentrated HNO_3 and the resulting solution was evaporated to dryness and redissolved in 0.1M nitric acid. The result of the absorbance and scattering were compensated for by deuterium hollow cathode lamp. De-ionised water was digested as blank using the same procedure previously described (Ayodele and Abubakar, 1998; Ayodele and Abubakar, 2001; Ayodele and Bayero, 2008, 2009).

Statistical Analysis

All statistical computations were on the PC 486 66MHZ microcomputer using the integrated statistical package for windows from Umstat Ltd. (London) or dedicated micro instructions for Excel spread sheets from Microsoft. The approach enabled the advantages of the various computational and graphical facilities of both types of software's to be used with the ability to read different file formats. The analysis of variance (ANOVA) was carried out according to described procedures (O'Mahony, 1986).

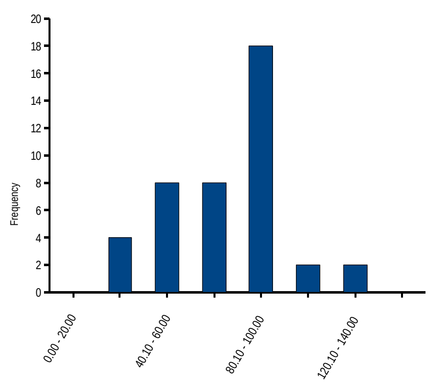
RESULTS AND DISCUSSION

The frequency distribution pattern for the age of donors is as shown in Figure1.The distribution is multimodal with a mean age of 25.01 ± 11.46 years. The frequency distribution pattern for cobalt in toenail is as shown in Figure 2.The distribution is multimodal and is skewed towards low frequency of high concentration with a mean and standard deviation of 76.53 ± 26.77µg/g while the frequency distribution pattern for zinc



in toenails (Figure 3) is multimodal and is skewed towards **Figure 1:** Frequency Distribution Pattern for the age of Donors (Years)

(a)



(b)

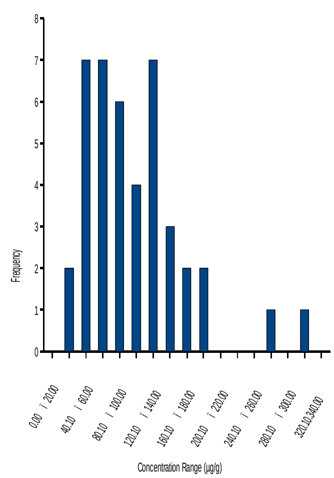


Figure 2: Frequency Distribution pattern for Cobalt **(a)** and Zinc **(b)** in toenails (µg/g)

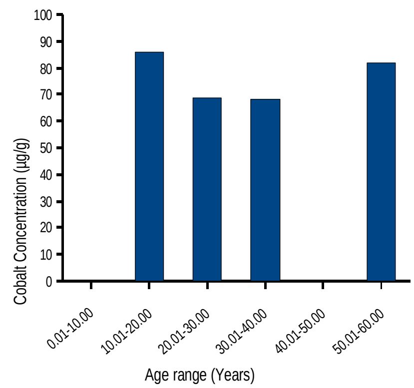
low frequency of high concentration with a mean and standard deviation of 108.51± 61.40µg/g. Pearson parameric correlation showed a significant correlation between the cobalt and zinc contents in toenail Table 1. The analysis of variance (ANOVA) revealed that the mean cobalt concentration in toenail is significantly different from that of zinc.

Table1: Parametric Pearson correlation coefficients for cobalt and zinc in toenails

	Cobalt	Zinc
Cobalt	1	923**
Zinc	923**	1

**Correlation significant at the 0.01 level (1-tailed); N=42

(a)



(b)

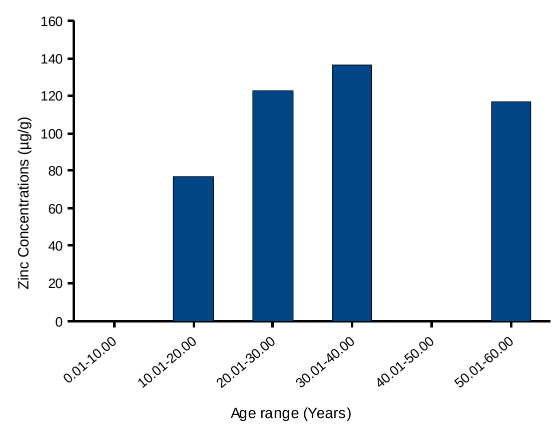


Figure 3: Cobalt **(a)** and zinc **(b)** concentrations with respect to age

Cobalt and zinc concentrations in toenails with respect to age are as shown in Figure 3. There was no ordered pattern for cobalt in toe nails but a progressive increase in Zn concentrations in toenails with age indicating that the metal may be playing some physiological functions during the formative years. There was increase relation in zinc concentrations with age with approximate average of 18% in its concentrations with each decade of age (Guallar *et al*., 2005). Toenails can record the level and changes of elements in the body over a long period of time (Saiki *et al*., 1998; Khuder *et al*., 2008) Changes in the elemental composition of toenails therefore depend on alterations of external and internal media of the human body, and is considered that toenails of healthy individuals contain each element and are potential indicator of both external and internal long-term exposure to pollutants. The idea of toenail analysis is inviting, since it is painlessly removed, normally discarded, easily stored and transported to the laboratory for analysis. The analysis is simple and painless,s trace metal concentrations are not subjected to rapid fluctuations due to diet or other variables and therefore reflect a long term nutritional status. Samples are stable at room temperature, analytical methods are easy because metal concentrations in toenails are relatively high (Borel and Anderson, 1984).

CONCLUSION

Evaluation of cobalt and zinc in human tissues such as toenails has proved useful in studies pertaining to body exposures. It can be suggested as indexes to evaluate environmental exposures to toxic trace metals (Nord *et al*., 1973; Flynn, 1977). Trace elements profiles of human toenails may be linked to an individual identity in the same way a hair and fingerprints (Bates and Dyer, 1965) since this tissue after a rapid growth remains somewhat isolated from the metabolic activities of the human body trace elements accumulated in it to reflect largely its exposure. Toenails are useful biomarkers for exposure to contamination. This study has confirmed that a factor such as age is important and should be considered when investigating the potential exposure of human populations to environmental metal concentrations. However, in using these measures, it is necessary to demonstrate that washing in contaminated water causes minimal external contamination. Toenail metals are better surrogate because of the improved correlations with environmental concentrations compared with hair. Diet, metabolism and exposure to environmental contaminants all contribute to trace element concentration in nails. The observed associations between concentrations in toenails are reflective of a combination of factors .This study provides insight into the association between trace element status and disease, establishing a basis for future investigations.

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