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Full Length Research Paper

Lead and zinc concentrations in hair and nail of some Kano inhabitants

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The advantages of hair and nail tissues analysis over other biological samples are that trace metal concentrations in them are not subjected to rapid fluctuation due to diet, air and water hence a long term stable nutritional status. Lead and zinc concentrations in hair and nail samples were determined by flame atomic absorption spectrophotometer (AAS). The mean zinc concentration in hair and nail were 0.695 ± 0.33 mg/g and 0.640 ± 0.52 mg/g respectively while the mean lead concentrations in hair and nail were 0.384 ±0.34 and 0.463 ± 0.364 mg/g respectively. A progressive increase in zinc concentrations in hair and nails with age indicated no significant difference when their means were compared suggesting that zinc in hair and nails originate from a common source, comparing the mean lead concentrations in hair with the nails a significant difference is indicated in the 2 tissues (p ≤ 0.05). Human hair and nails are therefore recording filaments that can reflect metabolic changes of many elements over long periods of time and hence furnish a print out of post nutritional event as dietary levels of some of the essential micro-elements.

Key words: Lead, zinc, hair, nail, AAS, Kano, Nigeria.

INTRODUCTION

The results of analysis of human milk, urine, saliva and sweat reflect some of the components that are absorbed but excreted from the body. The blood contains components absorbed and temporarily in circulation before excretion and/or storage (EPA, 1980). The hair, nails and teeth tissues in which trace minerals are sequestered and/or stored and can be used to effectively monitor the highest priority toxic trace metals (Barrett, 1985; Afridi et al., 2006a, b; Kazi et al., 2008). Hair and nails are re-cording filaments that can reflect metabolic changes of many elements over long periods of time which may fur-nish post nutritional events (Strain et al., 1966, 1972; Hambidge, 1982; Klevay, 1997).

Analysis of trace and heavy metal in hair and nail is a simple laboratory test which helps to monitor how well bodies are responding to our diets and environment (EPA, 1979).

The advantages of hair and nail tissues analysis over other diagnostic samples are, trace metal concen-trations are not subjected to rapid fluctuation due to diet, air and water hence a long term stable nutritional status. Sample collection is non-evasive, stable at room tempera-ture, analytical methods of analysis are easy as their concentrations in hair and nail are high compared to other measurements (Borel and Anderson, 1984; Bord and Anderson, 1984). With progress in measuring and under-standing the specific functions of macro, trace and toxic elements in human physiology, it has become evident that the action of each element may be potentiated or reduced by the presence of another. This may be why the ratio between the concentrations of any given element in body chemistry is decisive as to whether or not deficiencies or toxicities may occur. Therefore the requirement and the nutritional adequacy of a particular element depend on others already present in the body chemistry (Hill and Matrone, 1970). Zinc is important in human physiology and its deficiency leads to poor growth, hypogonadism and reduced immunity. In children it is associated with autism, dyslexia, apathy, lethargy irritability and childhood hyper-activity. In adults it has been linked with the development of both senility and Alzheimer's disease (Tuormaa, 1995).

Zinc an essential element in animal nutrition is required in amounts less than 100 mg/kg in the dry matter (Hambidge et al., 1987; Underwood, 1977; Hill et al., 1987; Neathery et al., 1973). Zinc is an essential component of carbonic anhydrate (Todd et al., 1934; Hove et al., 1940). It is an indispensable component of over 200 enzymes or proteins (Hambidge et al., 1987). When in short supply the

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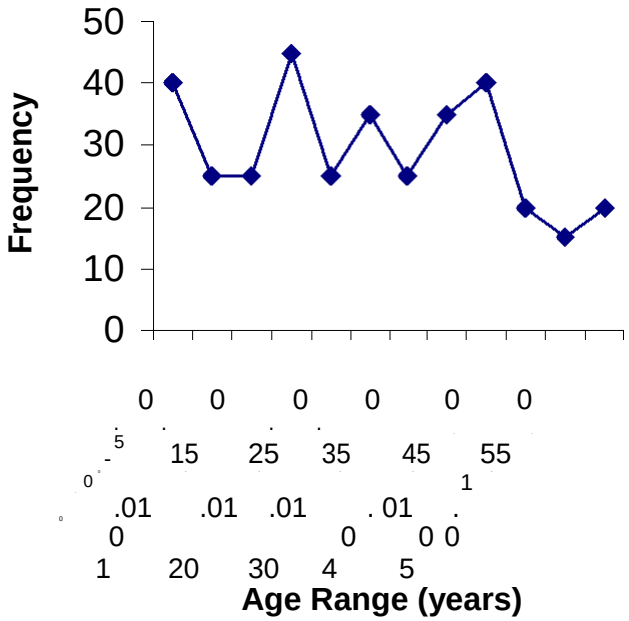

Figure 1. Frequency distribution pattern for AGE (years) of hair and nail donors.

following activities may be decreased, viz plasma alkaline phosphates, liver, retina and testes alcohol, dehydrogenate and connective tissue, thymodine kinase, pancreatic carboxyl peptidase A and liver nuclear DNA-dependent RNA-polymerase (Hambidge et al., 1987; Miller et al., 1979).

Zinc is involved in nucleic acid and protein metabolism and in the fundamental processes of cell differentiation and replication. It is chemically bound in crystalline insulin. It plays a role in the production, storage and release of several other hormones as well as in the effectiveness of recaptor sites and end organs responsiveness (Hambidge et al., 1987). It is essential for maintaining normal growth, reproduction and lactation performance (Miller et al., 1979). It is associated with taste and smell acuity and wound and burn healing. It is essential to the integrity of the immune system as it plays a role in stabilization of cell membranes and microtubule polymerization (Hambidge et al., 1987).

Lead an ubiquitous element in biological samples does not possess any evidence suggesting its importance in normal metabolic processes in man. It has been implicated in red cell survival and in the synthesis of globin (Boeckx, 1986). Its level in human hair and nails are yet to be deter-mined accurately (Tuormaa, 1994).

Realizing that toxic metal excesses and trace mineral deficiencies are associated with all forms of reproductive failures, the hair tissue analyses before conception has been advocated for (Barnes and Bradley, 1994; Bradley and Bennett, 1995). This paper reports the determination of lead and zinc in human hair and nails.

MATERIALS AND METHODS

Lead and zinc were determined from various volunteered subjects resident in Kano over a 6 month period. 350 hair and 300 nail samples were collected from subjects in the age range of 1 - 55 years. Nail samples were collected in polyethylene containers and were washed in 1% solution of TRITONX-100 in de-ionized water in an ultra sonic bath and on drying were stored in small plastic tubes (Iyengar, 1984). Hair samples were collected from each subject as close to the scalp as possible (Kucera et al., 1996). To eliminate grease and surface contamination the hair samples were rinsed with acetone (Kucera et al., 1996) and by washing each sample in detergent and distilled water (Nowak, 1998; Martin et al., 2005) after which they were kept in an alcohol ether mixture for 45 mins and dried at 60°C for 72 h. 1.0 g of each sample was digested in 10 cm^3 concentrated HNO_3 and the resulting solution was evaporated to dryness and redissolved in 0.1 M nitric acid. Trace metal concentrations were determined by flame atomic absorption on a model 210 VGP spectrophotometer attached to IBM personal computer. The result of the absorbance of each sample was the average of 10 sequential readings. Background light absorption and scattering were compensated for either by deuterium hollow cathode lamp or by tungsten/halogen lamp. Distilled water was digested as blank using the same procedure previously described (Ayodele and Abubakar, 1998; Ayodele and Abubakar, 2001)

Statistical analysis

All statistical computations either were on the PC 486 66 MHZ microcomputer using the integrated statistical package for windows from Umstat Ltd. (London) or dedicated micro instructions for the 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 analyses of variance (ANOVA) were carried out according to the procedures described by O'Mahony (1986).

RESULTS AND DISCUSSION

The frequency distribution pattern for the age of hair and nail donors is as shown in Figure 1. The distribution is multimodal with a mean age of 27.51 ± 16.5 years. The frequency distribution pattern for zinc in hair and nail is as shown in Figure 2. This is multimodal for zinc in hair with a mean and standard deviation of 0.695 ± 0.33 mg/g whilst the frequency distribution pattern for zinc in nails of the sampled is bi modal and is skewed towards low frequency of higher concentrations with a mean and standard devia-tion of 0.64 ± 0.52 mg/g. The observed trends for zinc in hair and nails with respect to age of donors are as shown in Figure 3. Table 1 shows the maximum, minimum, mean, standard deviation and number of samples for zinc in hair and nails. Figure 3 summarizes zinc concentrations in hair and nails with respect to age of their donors. A progressive increase in zinc concentrations in hair and nails with age indicated no significance difference indicated when the mean zinc in hair was compared with that of the nail ($p < 0.05$). Our results are in agreement with several other authors who reported varying concentrations of these me-tals in hair and nail samples (Tables 2 and 3).

From the zinc levels in hair and nails it is reasonable to believe that zinc in human tissues may be playing some physiological roles (Vivoli et al., 1990). It is also reasonable to suggest that zinc in hair and nails originate from a number of sources, such as the air, water and food we con-

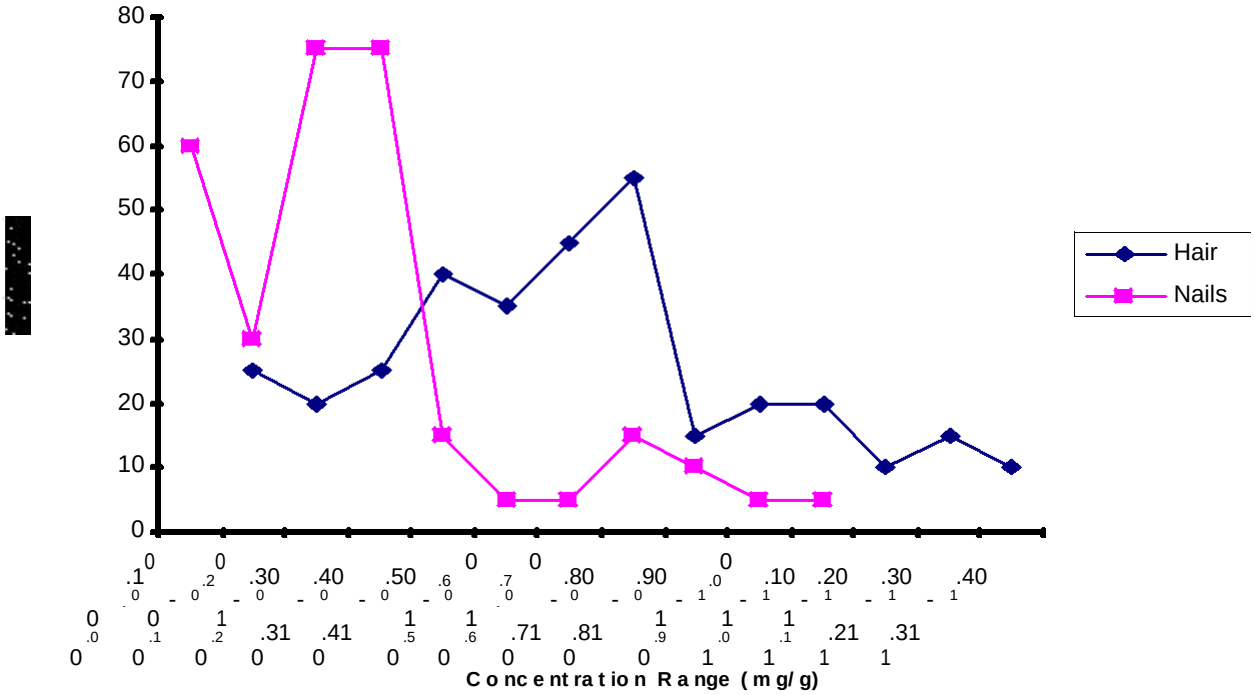

Figure 2. Frequency distribution pattern for zinc (mg/g) in hair and nails.

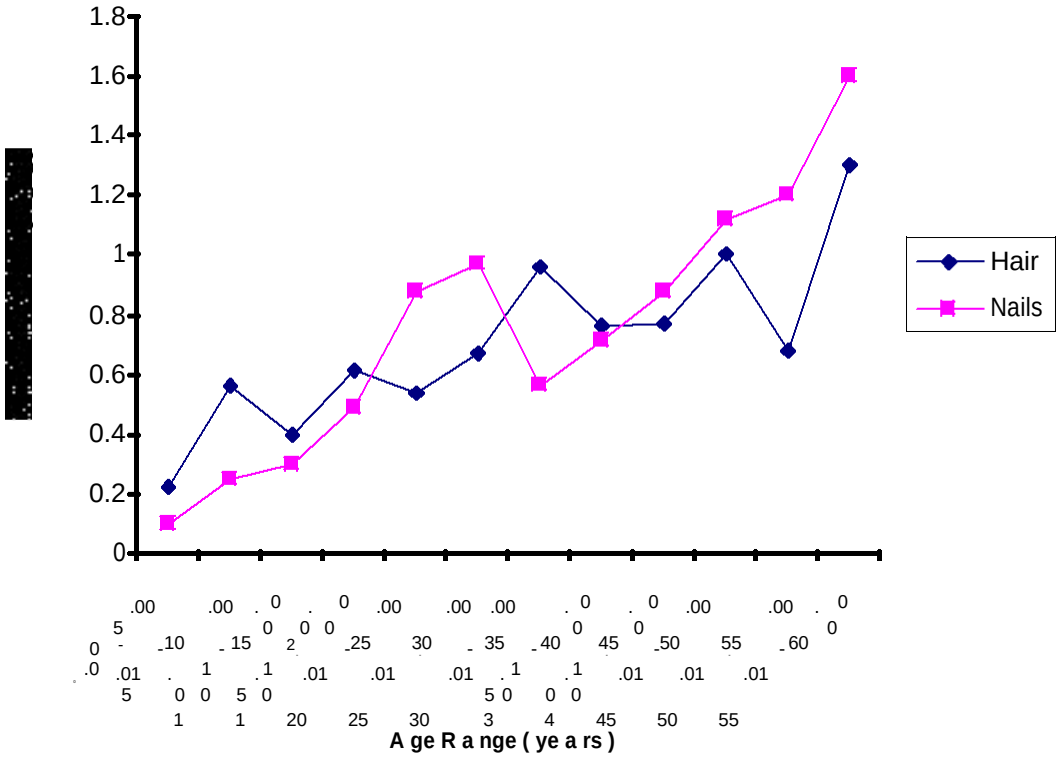

Figure 3. Zinc concentration in hair and nails with respect to age.

sume (Strain et al., 1972; Maugh, 1978; Casey and Hambidge, 1980). These high concentrations of zinc secreted than could possibly be received from water, confirm the suscipicion that there may be other sources since

Table1. Lead and Zinc concentrations (mg/g)in hair and nails.

Concen.	Lead		Zinc	
	Hair	Nails	Hair	Nails
Maximum	1.48	1.35	1.33	1.90
Minimum	0.05	0.05	0.12	0.05
Mean	0.384	0.463	0.695	0.640
Std.Dev	0.34	0.364	0.33	0.52

Table 2. Results of zinc concentrations in hair and nails from different countries

Country	Mean	Units	References
Austria	174	µg/g	Ryabukin (1978)
Germany	129 (Hair)	µg/g	Wilhelm et al (1991)
	108 (Nails)	µg/g	
New Jersey (USA)	205	µg/g	DeAntonio et al (1982)
Brazil	151- 168	µmol/g	Sandra et al (2002)
Saudi Arabia	121-247	µg/g	Imran et al (2003)
India	140.6±6.0	Ppm	Sukumar and Subramanian (2003)
India	110.29-286.59(nail)	µg/g	Mehra and Juneja (2005)
Turkey	21.40 – 176.96	Ppm	Ulvi et al (2003)
Poland	156.48± 74.5	mg/kg	Chojnacka et al(2005)
Poland	173-189	mg/kg	Chojnacka et al(2006)
Nigeria	57.7-510 (Hair)	µg/g	Nnorom et al(2005)
Nigeria	0.695±0.33 (Hair)	mg/g	This study
	0.640 ±0.52 (Nail)	mg/g	

Table 3. Results of lead concentrations in hair from different countries.

Country	Mean	Range	Units	References
Austria		0.97-44.9	Ppm	Fergusson (1990)
Canada	10.1	0.5-25	ppm	Fergusson (1990)
Canada	16.90	0.5-35	ppm	Fergusson (1990)
Canada	6.3±0.90	10-350	ppm	Ferguson (1990)
India		10.40-67.00	µg/g	Sukumar and Subramanian (2003)
Indonesia	131.7±93.40		µg/g	Pirsaraei (2007)
Iran	21.1±13.20		ppm	Pirsaraei (2007)
New Zealand	14.50	14.42-48.30	µg/g	Fergusson (1990)
			µg/g	Boris (1994)
Russia	6.55-16.20	6.41-7.37	µg/g	Boris (1994)
		6.55-16.2		
Saudi Arabia	1.046±1.39		mg.kg	Imran et al (2003)
U.S.A		7.6-107.1	ppm	Ferguson(1990)
Poland		1.42-2.17	ppm	Chojnacka et al (2005)
Poland		8.64-129.42	mg/kg	Chojnacka et al (2006)
India			µg/g	Mehra and Juneja (2005)
Nigeria	0.384±0.34 (Hair)	9.1-194.5	µg/g	Nnorom et al (2005)
Nigeria	0.464±0.364 (Nail)		mg/g	This study
			mg/g	This study

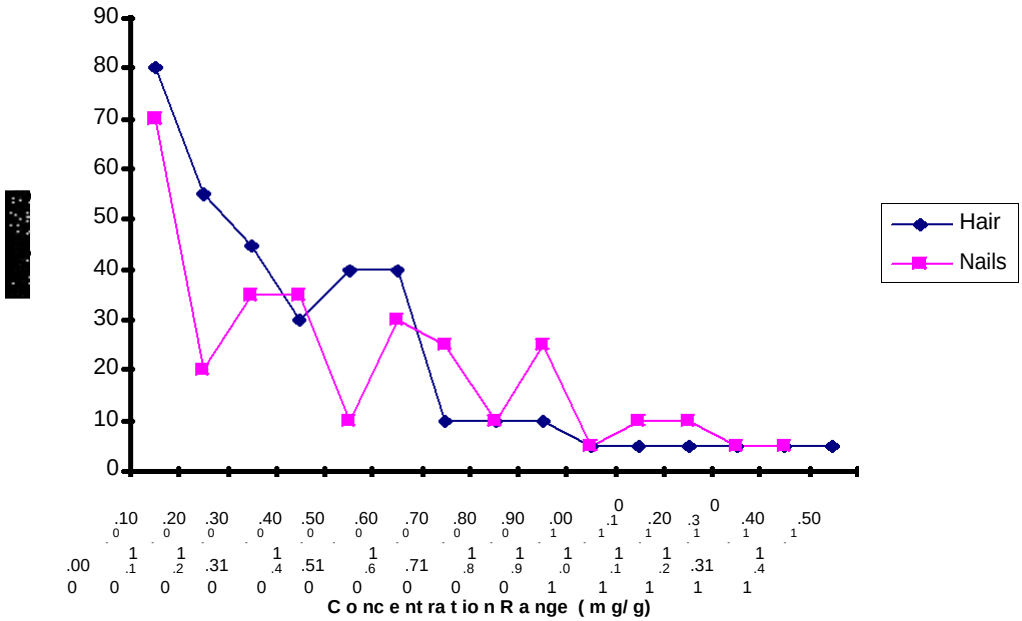

Figure 4. Frequency distribution pattern for lead (mg/g) in hair and nails.

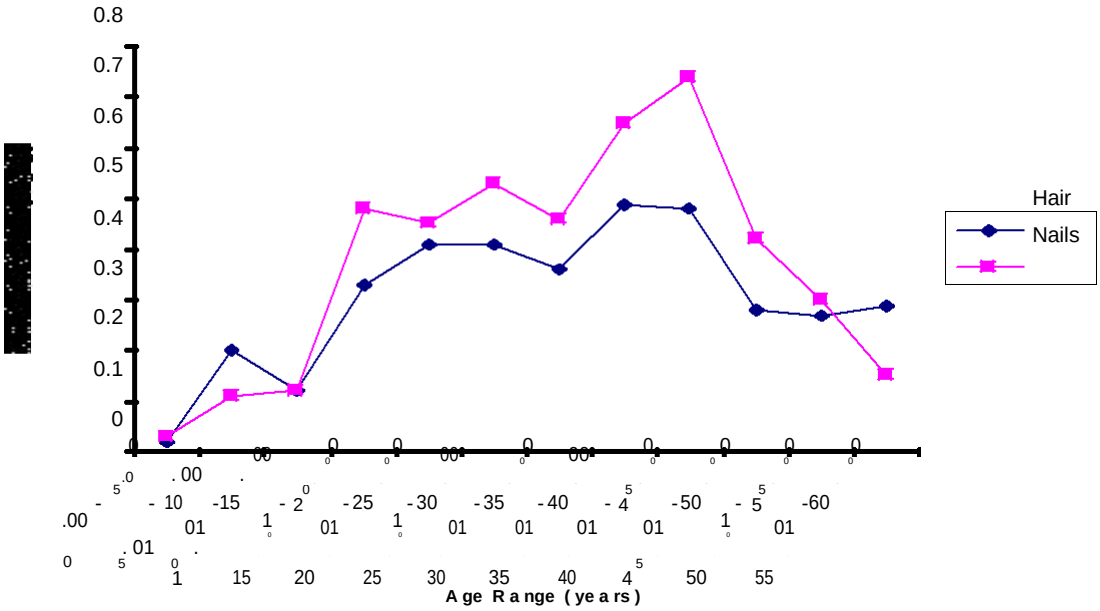

Figure 5. Lead in hair and nails with respect to age.

since the nutritional status of individual may contribute this effect (Calabrase, 1980; Harding-Barlow, 1983; EPA, 1988; Ayodele and Bayero, 2002).

The frequency distribution pattern for lead in hair and nail tissues are as shown in Figure 4. The distributions are both skewed towards low frequencies of high concen-trations with a mean and standard deviation of 0.384 ± 0.34 and 0.463 ± 0.364 mg/g in hair and nail respectively. Lead concentrations in hair and nail with respect to age of donors are as shown in Figure 5. Comparing hair and nails as points of excretion the latter appear superior to the former. Comparing the mean lead concentrations in hair with the nails a significant difference is indicated in the lead concentrations in the 2 tissues ($p \leq 0.05$). It may thus be stated that human hair and nails are recording filaments that can reflect metabolic changes of many elements over long periods of time and hence furnish a print out of post nutritional event (Strain et al., 1972) as dietary levels of some of the essential micro-elements have been reported to correspond to hair concentrations of the elements (Rein-

hold et al., 1966; Strain et al., 1966; Potter et al., 1974; Maugh, 1978; Katz, 1979; Hopps, 1977; Casey and Hambidge, 1980).

Conclusion

Hair analysis provides a cosmetologist, a nutritionist and a doctor an additional diagnosis tool in their respective pro-fessional fields. The cosmetologists use this system to diagnose hair and skin related problems. If and when it is discovered that these problems are related to general health conditions they are referred to the appropriate pro-fessionals.

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