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NICKEL AND IRON CONCENTRATIONS IN HAIR AND NAIL OF SOME KANO INHABITANTS

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ABSTRACT

Nickel and iron concentrations in hair and nail analysis were determined by Flame Atomic Absorption Spectrophotometer (AAS). The mean nickel concentration in hair and nail were 0.51±0.40µg/g and 0.79±0.41µg/g respectively while the mean iron concentration in hair and nail were 0.71 ±0.38 and 2.02 ± 1.07µg/g respectively. A progressive increase in nickel concentrations in hair and nails with age indicated no significant difference when their means were compared suggesting that nickel in hair and nails originate from a common source. Comparing the mean nickel concentrations in hair with that of nails, a significant difference was indicated in the two tissues ($p \leq 0.05$). Human hair and nails are hence 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.

Keyword: Nickel, iron, hair, nail, determination, Kano, inhabitants

INTRODUCTION

The milk, urine, saliva and sweat measure the components that are absorbed but excreted. The blood measures the component absorbed 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 can be used to monitor the toxic trace metal levels (Katz, 1979; Bland, 1985; Barrett, 1985). Hair and nails are recording filaments that can reflect metabolic changes of many elements over long periods of time which may furnish post nutritional events (Strain et al., 1972; Ryabukin, 1978; Wolf, 1982; Hambidge, 1983; Klevay et al., 1997). This simple painless test may help to monitor how well our bodies are responding to our diets and environment (EPA, 1979;Foo, 1993; Foo et al.,1993). Millions of people are having health problems that seem to have no cure that can be uncovered by simple hair analysis. Many toxic problems in the body with trace metal hair analysis can be used to know where one stands and how well one's body is doing as the tests are not for any type of infection. It only shows trace heavy metal levels (Johnson, 2002; Kleavay et al., 1997; Durak et al, 1990).

The advantages of hair and nail tissues analysis for trace metal concentrations are that samples are easily and non-invasively collected with minimal cost, they are easily stored and transported to the laboratory for analysis, the samplings are simple and painless and the mineral concentrations are not subjected to rapid fluctuations due to diet or other variables and hence reflect a long term nutritional status. Sample collection is non-evasive, stable at room temperature and analytical methods of analysis are easy as their concentrations in hair and nail are high compared to other measurements (Bord and

Anderson, 1984; McCain,2003). With progress in measuring and understanding 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 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, Creason et al., 1975).

Nickel in hair and nails correlate with chronic exposures and ingestion. Hair is sensitive to external contamination with nickel. Some shampoos and many hair perm dye bleach products place nickel into the hair (Laker, 1982, Fosmire, 1985; Gammelgaard et al, 1990). In blood, nickel binds to albumin, globulins and acids and is deposited in leukocytes (EPA, 1979). In cells, it binds to mitochondrial and cyosolic proteins. In so doing, it can displace zinc and copper, there by activating, inhibiting or deregulating enzymes (Sky-peck, 1990). A nickel exposure may hypersensitize the immune system resulting in inflammatory responses to many environmental substances to which there was formerly little or no response (Smith et al., 1998). Possible symptoms of nickel excess include weakness and fatigue, nausea and headache (Smith et al., 1998).

The interest in iron is due to the fact that it is an essential metal needed by all cells in small amount, but toxicological considerations are important in terms of accidental acute exposures and chronic iron overload due to idiiopathic haemochromatosis or as a consequence of excess dietary iron or frequent blood transfusion (Jacobs and Worwood, 1981). Biological monitoring of iron adequacy is a problem faced by clinicians and experimental nutritionist, for example low blood iron or anaemia, may suggest that iron intake is inadequate, also anaemia a primary symptoms of low dietary iron, can arise if iron metabolism is impaired (Dallham et al., 1982). An example of extraordinary tolerance of man to iron overload is the malnourished Bantu tribesman in South Africa who have developed a disorder called *Bantu sidenosis*, which estimates that 200mg of iron per day are consumed (MacDonald et al., 1963). The total iron content of the human body varies with age, sex, nutrition and state of health (Wells and Awad, 1992). Hair iron may not be reflective of iron status but rather a marker for external contamination. Elevated levels of hair iron may be found in smokers, X-ray technicians and individuals with certain forms of cancer (Creason et al, 1975; Smith et al., 1998). This paper reports the determination of nickel and iron in human hair and nails with a view to their use as index for screening tests.

MATERIALS AND METHODS

Nickel and iron were determined from various subjects resident in Kano for at least six months. 350 hair and 300 nail samples were collected from subjects in the age range of 1-55years. Nail samples were collected in polyethylene containers. Hair samples were cut at the root of the occipital area of each subject. Surface contamination and grease were removed by washing the hair samples in detergent and distilled water after which the samples were kept in an alcohol–ether mixture for 45mins and dried at 60ºC for 72hr. 1.0g of each sample was digested in $10cm^3$ concentrated HNO_3 and the resulting solution was evaporated to dryness and redissolved in 0.1M nitric acid. Trace metal concentrations were determined by Flame Atomic Absorption on a Buck Model 210 VGP Spectrophotometer attached to IBM personal computer. The result of the absorbance of each sample was the

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average of ten 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 66MHZ 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 described procedures (O'Mahony, 1986).

RESULTS AND DISCUSSION

The frequency distribution pattern for the age of the donors is as shown in Fig.1. The distribution is multimodal with a mean age of 27.51±16.5 years. The frequency distribution pattern for nickel in hair is as shown in Fig.2. The distribution is multimodal and is skewed towards high frequency of low concentrations with a mean and standard deviation of $0.51 \pm 0.40 \mu g/g$. Fig. 3 represents the frequency distribution pattern for nickel in nails. The distribution pattern is multimodal and is skewed towards high frequency of low concentrations with a mean and standard deviation of $0.79 \pm 0.41 \mu g/g$. The observed mean in these studies is higher than the reference level of 0.40µg/g reported by Hull (2003). Comparing the frequency distribution patterns for nickel in hair with the level in nails (Fig.4), indicates multiple points of interception existing between them and a significant correlation exist between the nickel in hair and nail ($p<0.01$) as shown in Table1. Comparing the mean concentrations of nickel in hair and nails (Table 2) indicated no significance difference ($p>0.05$). Nickel concentration in hair and nails with respect to age is as shown in Fig. 5. Nickel appears higher in the adolescent.

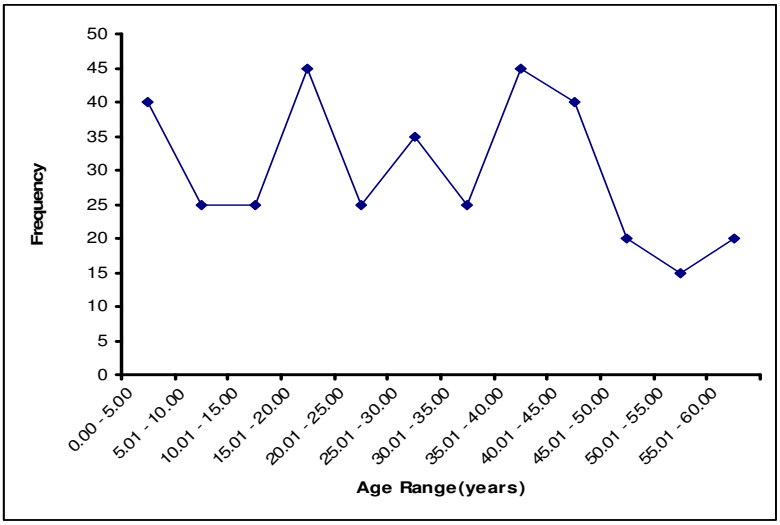

Fig.1: Frequency Distribution Pattern for Age (years) of Donors

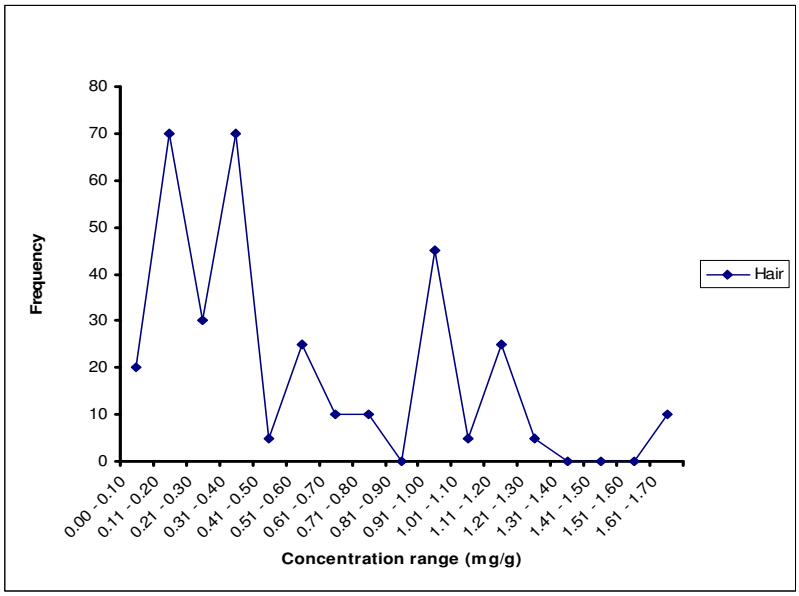

Fig. 2: Frequency Distribution Pattern for Nickel concentration in Hair

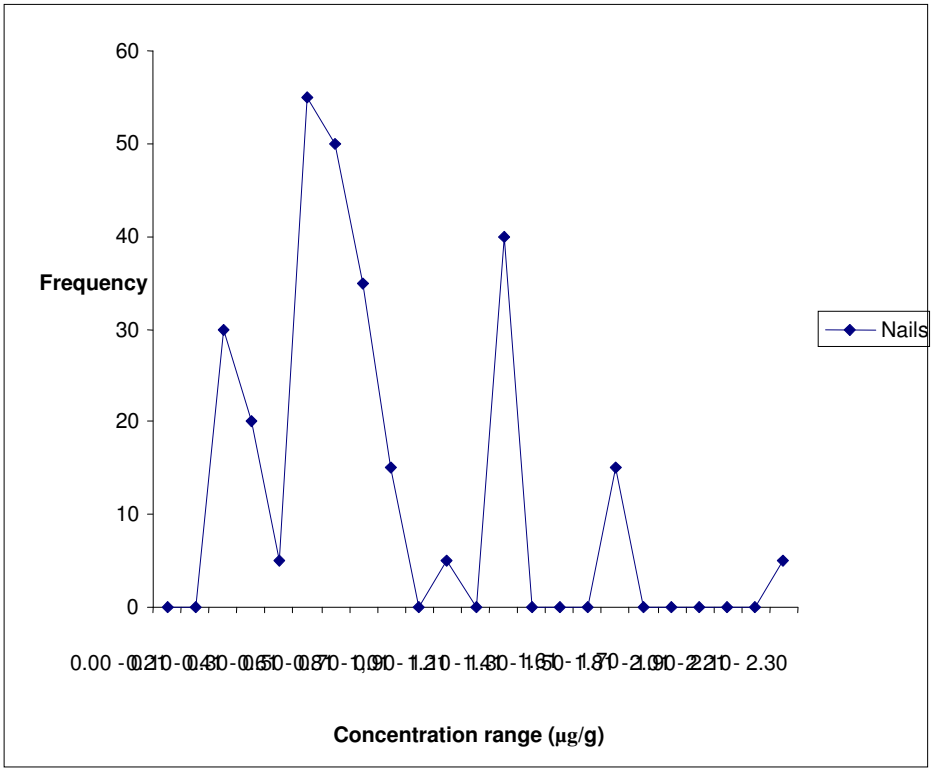

Fig.3: Frequency Distribution Pattern for Nickel concentrations in Nails

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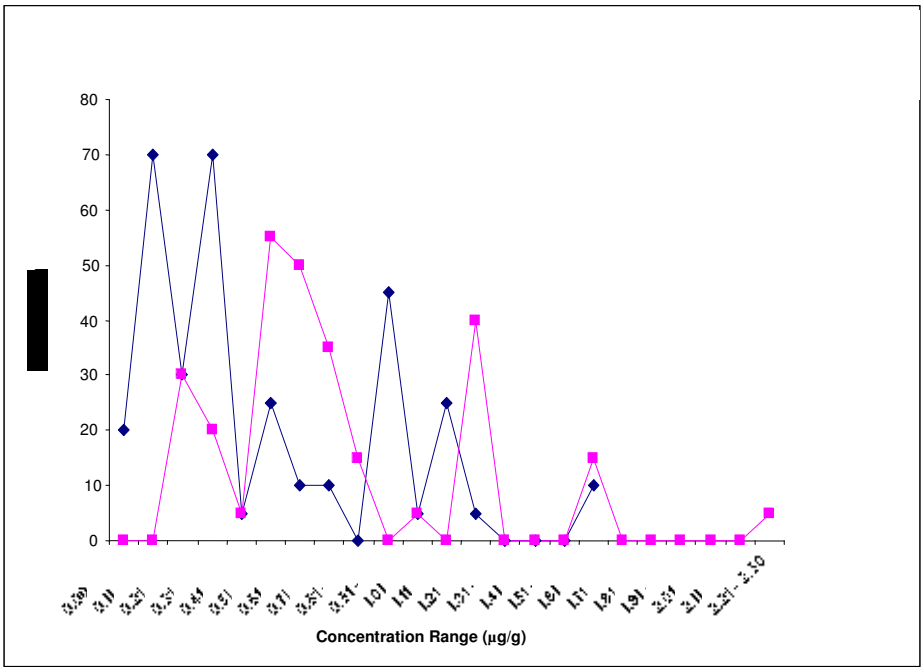

Fig 4 Frequency Distribution Pattern for Nickel concentrations in Hair and Nails

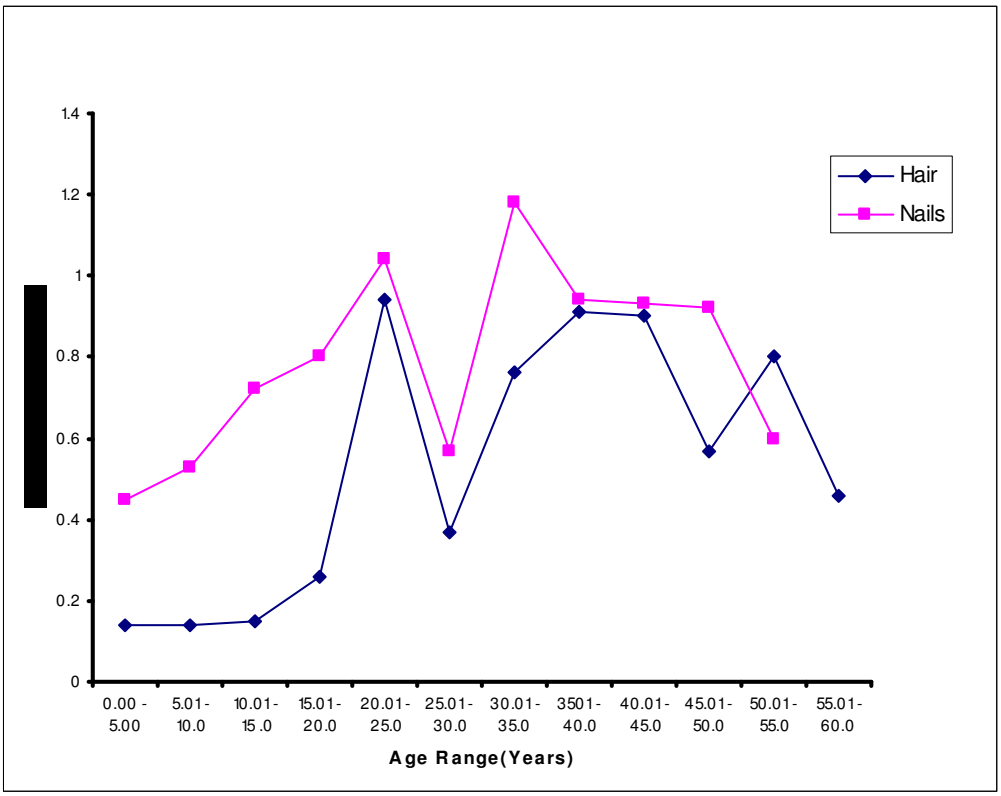

Fig. 5. Nickel concentration (µg/g) in Hair and Nails with respect to age

Table1: Parametric Correlation Coefficients Nickel in Hair and Nails

	Hair	Nails
Hair Pearson correlation	1	.580**
Sig. (2-tailed)	.	.000
N	350	300
Nails Pearson Correlation	.580**	1
Sig. (2-tailed)	.000	.00
N	300	300

** Correlation is significant at the 0.01 level

Table 2: Analysis of variance for Nickel concentrations in Hair and Nails

Source of variation	SS	Df	MS	F	P-valve	F crit
Between Groups	2.026408	1	2.026408182	12.465893	0.0006106	3.929011
Within Group	17.556707	108	0.162556195			
Total	19.58248	109				

Sources of nickel in adolescents include ear piercing and dental braces (Julie et al., 2001; Mortz, 2002). Rich food sources of nickel include chocolate, oatmeal, peas and nuts (Wilson and Wilson, 1998; Mortz, 2002) taken among these age groups. Other sources of nickel include butter, hydrogenated vegetable oils, margarine, imitation whip creams, cigarette smoking, tea, batteries, wire and electrical parts (Ross and Marion, 2001).

The frequency distribution pattern for iron in hair is as shown in Fig.6. The distribution is multimodal and is skewed towards high frequency of low concentration with a mean and standard deviation of $0.71 \pm 0.38 \mu g/g$. The iron level in hair ranged within 0.23-1.66µg/g and 0.3-8.00µg/g in nails (Fig.7). The frequency distribution pattern for iron in nails is multimodal and is skewed towards high frequency of low concentrations with a mean and standard deviation of $2.02 \pm 1.7 \mu g/g$. The mean concentration of iron in nails is thrice its concentration in hair. The major source of iron in nails is manicuring (Owen, 2006). Other sources of iron include meat, fish, poultry, fruits, vegetables, dry beans and nuts (Mckinley, 2003). Iron in hair is significantly correlated with that in nails ($p<0.01$) as shown in Table 3. However, the mean concentration of iron in hair is significantly different from that of a nail ($p>0.05$) as shown in Table 4. Iron concentration in hair and nails with respect to age is as shown in Fig.8. There is a progressive increase in iron concentration with age. Though iron in hair increased with age, the pattern appeared linear when compared with that of nails. These data are in agreement with values earlier reported (Weber et al., 1990; Hashem and Utham, 2001). From the levels of iron obtained, it is reasonable to believe that iron is playing some physiological roles such as in the respiratory organs where it plays special functions in man. Iron concentration in hair and nails with respect to age is as shown in Fig. 8. There is a progressive increase in iron concentration with age.

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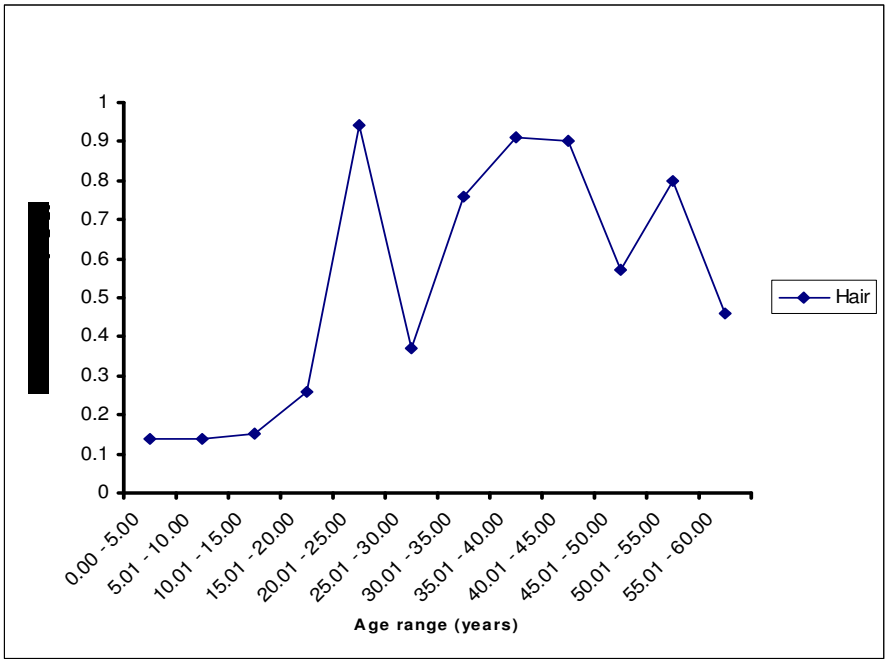

Fig. 6: Frequency Distribution Pattern for Iron concentrations in Hair

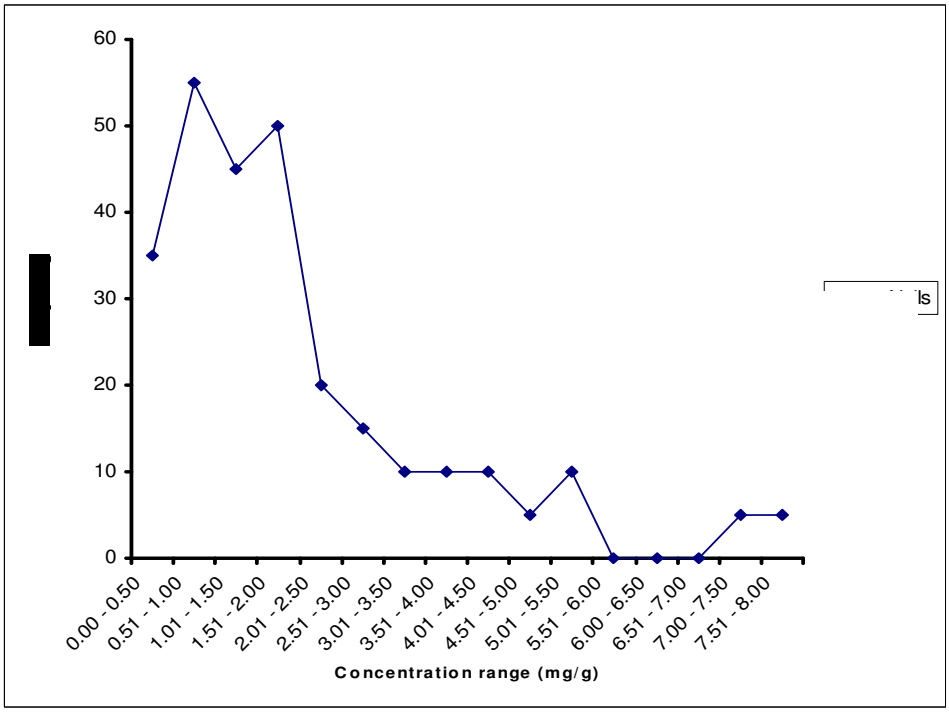

Fig. 7: Frequency Distribution Pattern for Iron concentrations in Nails

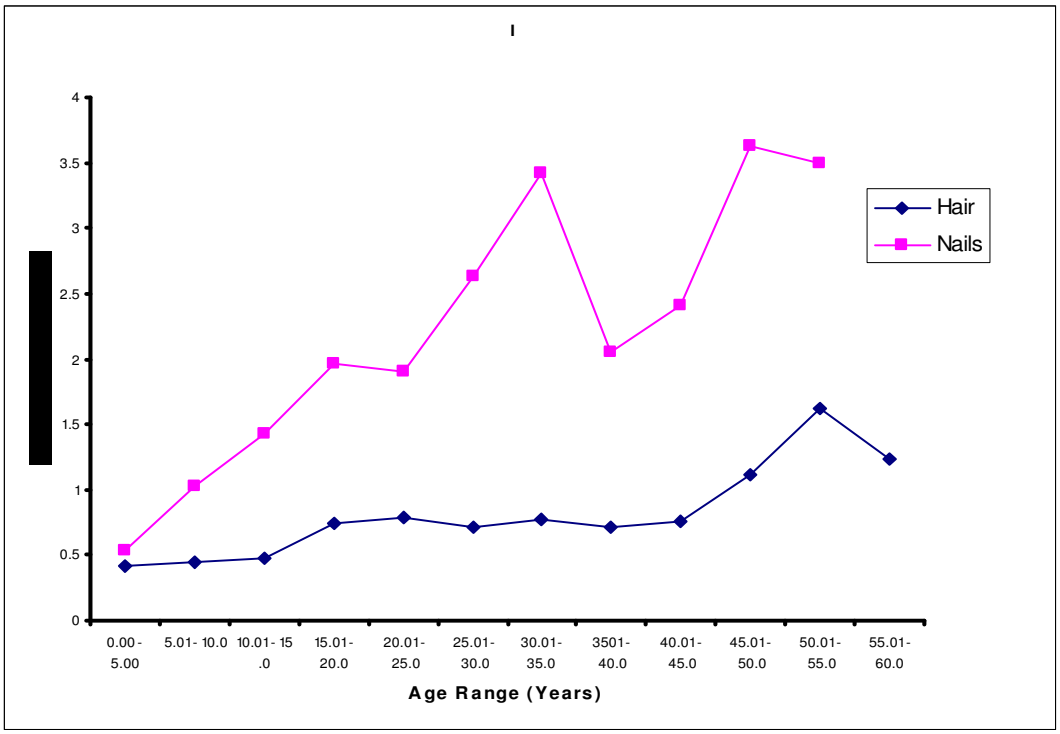

Fig. 8: Iron concentration (µg/g) in Hair and Nails with respect to age

Table 3: Parametric Correlation Coefficients for Iron in Hair and Nails

	Hair	Nails
Hair Pearson correlation	1	.588**
Sig. (2-tailed)	.	.000
N	350	300
Nails Pearson correlation	.588**	1
Sig. (2-tailed)	.000	.
N	300	300

** Correlation is significant at the 0.0 1 level

Table 4: Analysis of variance for Iron in Hair and Nails

Source of variation	SS	df	MS	F	P-valve	F crit
Between Groups	49.9434	1	49.9434036	32.8074395	9.2798-08	3.9290115

Though iron in hair increased with age, the pattern appeared linear when compared with that of nails. These data are in agreement with values earlier reported (Weber et al., 1990; Hashem and Utham, 2001).

Conclusion

Human exposure to toxic trace elements has been the focus of increasing attention among researchers, formulators and managers of health and nutrition policies due to its damages to health. The nickel and iron levels in hair and

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nails vary and may be affected by various factors (Siedel et al., 2001). Age was observed to be a factor influencing their levels.

The values of the two elements investigated revealed sex dependence. Males have higher amount of iron than females because women of fertility age are subject to iron loss during menstruation, pregnancy and lactation (Underwood, 1971). Hair colour, nutritional status, geographic, racial/ethnic and ecological can have a significant impact on the levels of these elements in hair and nails (Sandra and Silva, 2002); but no correlation with any of these factors was observed, since the samples were collected from the same geographical location.

Comparing hair and nails as points of excretion the latter appear superior to the former. The former enables monitoring of elements accumulated over a time span up to several months. They are easily sampled, handled and transported, and less prone to post – sampling contamination because of higher elemental concentration. Therefore human hair and nails are recording filaments that 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 essential micro – elements have been reported corresponding to hair concentrations of the elements (Maugh, 1978; Hopps, 1974; Casey and Hambidge, 1980).

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