

The Determination of Heavy Metals Exposure to Environmental in Fingernails of Females in Port Sudan

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Abstract:

The purpose of this study is determining the usefulness of imposed guidelines for exposures to elements level in district of eastern Sudan in Port Sudan city. Elements calcium (Ca), copper (Cu), nickel (Ni), zinc (Zn), and lead (Pb) concentrations in fingernails samples of volunteers females students were collected to determine their levels of contamination in hands fingernails. The samples were measured using graphite furnace atomic absorption spectroscopy (Perkin-Elmer, Spectrophotometer) to analyze the heavy metals in females fingernails of ages 14 to 16 years and children of 4 to 5 years old. Different methods are used for data assessment and source identification such as correlation, principal component analysis, eigenvalue and variance confirming that the sources of Ca, Cu and Zn exposure to environmental from locality contamination such as soil dispersion and underground drinking water, while Ni and Pb are connected to other sources expose by environmental contamination factors.

Keywords: heavy metals, fingernails, females, graphite furnace, environment.

Introduction:

Assessment of fingernails elements content can be used as preferable makers for a long term exposure and as measures of absorption of heavy metal. Nails samples are easily to be collected from volunteers, which is desirable for elements evaluation of human body metals accumulation. Fingernails consists of nail plate, lunula,

eponychim, nail matrix and nails groove growth in front of the finger from horn-like envelope in three to six months is duration to be renew. The fingernails are growth fast in summer than other season, therefore some factors is effecting the growth such as age, sex, season. Nails matrix is forming by nail plate and cells determined the width, thinness and the size of the nails. The nail plate is protecting the soft tissues from injuries and continues to grow and bush older nail plate cells forward (20).

Several substances are penetrated in nails such as water, chemical, toxics position and medical substance, which lead to the infection, peel, break, and dry out. The deep grooves of nails generally form across the front of the fingers that may result from disease. The nails in human tissues are used as biomarkers of toxic metals for environmental monitoring (Nowak, 1993; Chaudary et al., 1995; Agahian et al., 1990; Schegel-Zawadzka, 1992; Das et al., 1995). The elements concentrations in human body are reflected their level in nails during 12- 18 months (Yoshinaga et al., 1990; Nowak and Kozlowski, 1998) (8). The main advantages of nails that reveal the elements exposure in the body are very stable after collection and not required special storage conditions.

Human body consists of calcium and 99% of an amount is deposited in bones and the remainder in the soft tissues. The daily intake of calcium of 800 mg was recommended by USA national research council; though the higher amount than permissible levels may case disorder and relieve the symptoms commonly associated with aging. The lack of calcium can cases certain illness, such as bone pain backaches, tumors of the fingers, and insomnia and brittle teeth with cavities.

Nickels is an essential mineral found in human nutrition and as catalysts are involved in the hydrogenation of edible vegetable oils. The status of nickel oxidation through the interaction with oxygen is changing the position of iron atom with protein (Porwol et al., 1998), (Valentine et al., 1998). The Ni is affecting human body with level in the environment and the duration of exposure, however the level of concentration in the nails reaching less than $1\mu\text{g/g}$ and that an amount is possible attribute to environment pollution, although larger than $8\mu\text{g/g}$ potential stronger(1, 4).

The body tissues is containing copper assists in the formation of hemoglobin and red blood cells by facilitating iron absorption and the upper intestines use approximately 30% of ingested copper (Halliwell and Gutteridge, 1984). Its moves in the blood stream after ingestion in an intestine 15 minutes time and store in the tissues mainly in liver, kidneys and brains, in addition to bones and muscles which consists over 50% of the total copper in the body. Dietary intake of the copper is 2. 5 to 5 mg per day as recommended by the national council of USA or 5 to 20 μ . mol per day (Shike, 1983, Shenkin, 1988). However, the possibility of toxicity occurs genetic disorder that results from abnormal copper metabolism(19).

Human body is enclosed an amount of zinc need in the liver, pancreas, kidney, bones, skin, hair, and fingernails, although a small amount is absorbed in intestine. The USA national council is recommended 15 mg per day of zinc as dietary intake, which highs amount may interfere with copper affecting incomplete iron metabolism. On the other hand, basis on a rise of copper kidney concentration, the content of latter in liver as well as activity of some copper dependent undergoes transient changes and also is endorsed to stabilization of Cu-Zn (Parat et al 1997).

Lead in human body is highly toxic at only tolerate 1 to 2 mg and that enter the body through the skin and the gastrointestinal tract. The accumulation of lead in the body is stored in bones and soft tissues, but acute high quantity can attacks the central nervous system and cause a possible of hyperactivity in children (19). Lead concentration in nail is used as biomarker for toxic effect exposure in human; however that reflect current body burden as a function of recent and past exposure which is reviewed elsewhere (Sakai 2000). Human nails can be used as data record to develop a diagnostic program for toxics elements, particularly as serving program for specific groups (17).

Therefore, the present work is supporting the connections between ingestion of elements in human body and secretion of these elements into nails, which reflects the levels in the body. The elements contents in human nails substance were determined the elements composition and provide data for long term assessment. The trace elements in nails are utilized as a tool for monitor elements level in the mineral metabolism in the human tissues. Therefore, hands fingernails and feet nails are disposable parts from human body can be used as a valuable properties and data record for individuals. The elements level in nails and the appropriate selection of these elements reflect primary prevention activities of people which have critical importance for health care management purposes and public health decision making.

Materials and Methods:

Port Sudan is main harbor of Sudan and a district semi-arid part of the province on the red sea coasts surrounding from the west with the series of hills and mountains. Fingernails samples of high school female's students were collected for investigation, besides the children fingernails samples were used as control data for comparison. The graphite furnace atomic absorption spectroscopy is superior sensitivity and detection limits instrument based on electro-thermal atomizer system that provides thermal energy to produce free ground state atoms. The sample in the furnace is heated to high temperature and that break the chemical bonds and then the excited atoms absorb radiation energy at wavelength characteristic of the element of interest. Thus, the atomic concentration of selected element is linearly proportional to an amount of light energy absorbed. Determination of element concentration is obtained by plotting a curve of the relation between intensities and concentrations after calibrating the instrument with standard of known quantity.

The samples were collected and store in container to prevent any further contamination. A sample was diluted using nitric acid HNO_3 and then a small amount of approximately 20 micro liters injected in the graphite furnace. The nails samples were cleaned manually and all visible dirt on the surface removed, followed by using nonionic detergent (triton X-100), then was washing with water-acetone solution as recommended by the International Atomic Energy Agency (IAEA, 1985)(8). The nails sample is bathing in deionized water five times and drying for 30 minutes in an oven at 110°C (Rita Meha and Meenu Juneja, (2005). Therefore, the heavy metals do not affect with washing procedures to remove the external contaminants due to strong complex with the groups, which is essentially influence their concentration in the

nails sample (Chen et al., 1999), Mikasa et al (1988)(8). Digestion of 10 ml of nails samples were prepared of 6:1 ratio of a mixture of nitric acid and concentrated perchloric acid that kept overnight and then heated at 160 – 180 °C to obtaining crystalline dry and then diluted with 0.1 Normality of nitric acid solution. The standards solutions were prepared in series of samples as a reference concentrations using metal powder with content of 1000 ppm of the metal (1, 4, and 19).

Results and Discussion:

The accuracy of measurement of metals in nails is indication of closeness of the agreement of result associated with a measurement and the comparison of the data and the interval of values which can be determined. The figure (1) shows the elements average concentration of female's students and children. The children samples are used as reference samples which show the lowest elements concentration compared to females nails samples under investigation. The elements of Ca, Ni and Zn of the fingernails of female's students are showed the highest concentration compared to children elements nails contents, in addition to the elements of Cu and Pb both does not exist among children nails elements concentration. These elements variations are related to the ages and the absence of Cu and Pb in children's finger nails, which appear in female's samples are possible to be related to some exposure contamination among the student's females (19). Therefore, in the figure (1) a considerable amount is present in fingernails elements average value of the student's females compared to children control fingernails, which is probably related to expose contamination.

The nails metals concentrations in ng/ml were tabulated to illustrate and assess the statistical data level using various methods such as correlation analysis, principal component analysis and eigenvalue. The elements correlation of fingers nails of the female's students are shown in the table (1). Ca in fingernails is highly correlated with Cu and in good correlation with Zn, although Ni is highly correlation with Pb.

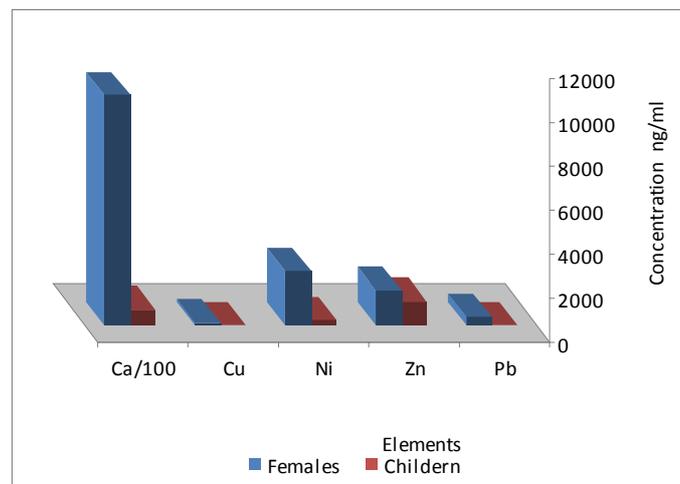


Fig. (1) Fingernails element concentration of females and children.

Table (2) shows the principal component analysis and in columns (1, 2) component matrix and coefficient matrix both are confirmed that Ca, Cu and Zn connected to one group that reveals high values, while Ni and Pb are indicating negative values, which likely to be connected to other source of contamination exposure (1, 4). These two categories elements according to correlation analysis and principal component analysis are possible to be impact with environmental contamination related to locality such as soil, underground drinking water and type of food used.

Table. 1. Pricipal component analysis data of female's fingernails

Elements	Component Matrix	Coefficient Matrix	Communalities, Extraction
Ca	0. 843	0. 196	0. 710
Cu	0. 928	0. 216	0. 862
Ni	-0. 968	-0. 225	0. 937
Zn	0. 985	0. 229	0. 971
Pb	-0. 903	-0. 210	0. 816

Table. 2. Correlation of fingernails elements concentration.

Elements	Ca	Cu	Ni	Zn	Pb
Ca	1				
Cu	0. 982	1			
Ni	-0. 680	-0. 805	1		
Zn	0. 739	0. 852	-0. 997	1	
Pb	-0. 531	-0. 680	0. 982	-0. 963	1

The communalities extractions are indicated higher quantities of Ni and Zn and very good values for Cu, Pb and Ca. The analysis for a t-test from particular set of data is comparing the means in relation to the variation in the data shows a significant value at 95% confidence interval of the difference, which is suggesting a variation in individual variability of nails contents. The total of extraction sums of squared loadings is 4. 296 accumulated to high value of 85% variance that indicates high variation among the student's girls, which is supposed to be influence with some attribute to elements contamination. Additionally, the statistical assessment of fingernails elements are an indication of quantities variation among the females, which is related to the undertakings of each body potential to be contaminated exposure between different individual. A comparable result was obtained in other literature (1, 16).

Conclusion:

Consequently, it is concluded that the variation of Ca, Cu and Zn concentration level in fingernails can be attributing to geographical area pollution such as soil and

underground drinking water. Even though the concentration of Ni and Pb is significantly high may be affected with other environmental contamination factors. These elements above the permissible levels are a valuable data for fitness history of individual that can be used as earlier revealed of some diseases.

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