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Fingernails as Biological indices of Metal Exposure in Kassala State Inhabitants Using X-Ray Fluorescence (XRF) Technique

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Abstract

This paper deals with the quantitative determination of Pb, Zn, Cu and Fe concentrations in nails of male and female of Kassala State inhabitants . The levels of Pb, Zn, Cu and Fe in fingernails, assayed by X-Ray Fluorescence (XRF) spectroscopy. All the obtained mean values of concentrations of four elements shows that Pb were high level in Kassala, Zn high level in Hameshkoreb, Wad elhelaw and Telkok, Cu were level in Shamal eldelta ,Fe high level in Telkok.

Keywords: Human Finger nail , Metal Exposure; XRF, Kassala.

المستخلص

في هذه الدراسة تم جمع عينات من الأظافر من قطاع من سكان ولاية كسلا بغرض تقييم بعض العناصر متمثلة في (الرصاص،الخارصين، النحاس و الحديد) واستخدمت في الدراسة مطيافية أشعة إكس المتفلورة و قد توصلت الدراسة إلي أن متوسط تركيز الرصاص أعلي في محلية مدينة كسلا،Zn أعلي في كل من همشكوريب،ود الحليو وتلكوك اما النحاس أعلي تركيزاً في محلية شمال الدلتا ،الحديد أعلي تركيزاً في محلية تلكوك.

Introduction

Metal determination in human tissues is the most common application of biological monitoring for screening, diagnosis and assessment of metal exposures and their risks. Various biopsy-materials may be used. Industrialization, urbanization, mining operations, increased vehicular traffic and use of fertilizers and pesticides in agriculture have resulted in increased metal contamination in our environment. Not only the occupationally exposed workers (high-risk population group) but the community at large (low-risk population group) may suffer due to increased metal pollutants in the environment.

Though certain essential trace elements are required in trace amounts for various physiological processes; but, at higher concentrations, these micronutrients tend to be toxic and derange various physiological processes, leading thereby to diseases. Therefore, it is important to determine the

metal concentrations in humans to monitor and assess their impact on human health . Among various biopsy materials; blood, hair, nail ,teeth and other body fluids may be used as bio indicators for this purpose. Unlike blood that gives transient concentrations, nails can provide a continuous record of trace element concentrations of the body (Wilhelm and Hafner 1991). They can be easily sampled and analyzed for accumulated toxic and essential metals in the tissue. Studies on nails as bioindicators have been reported by (Vance *et al* (1988), Hayashi *et al* (1993), Oluwole *et al* (1994) and Chaudhary *et al* (1995). However, studies on correlation of nail-metal levels with different parameters, as well as with various health disorders are scarce .As a continuation of our earlier studies (Mehra and Juneja 2003a,b,c, 2004), here we report the nail-trace metal levels (Pb, Fe, Cu and Zn) in different age groups of subjects with varying personal habits to the hazards of trace metals in their occupational environment. For this study, we have used fingernails as biopsy material.

Materials and Methods

The Study Area:

The state of Kassala is located to eastern part of Sudan, between latitudes $14° 45^-$ and $17° 15^-$ N, and longitudes of $34° 40^-$ and $37°$ E, in an area $42330 Km^2$.The state is consisting of eleven localities', the study has covered the most populated localities which are below in the table(1)

Table (1): The study area (localities)

NO	Locality	Distance from Kassala
1	Kassala town	-----
2	Refi Kassala	25 Km
3	Refi Aroma	49 Km
4	Refi Shamal Eldelta	70 Km
5	Refi Wad Elhelaw	140 Km
6	Telkok	115 Km
7	Refi Hameshkoreb	190 Km

Kassala town is the capital of the state it is located at latitude $15° 27^-$ N and longitude $36° 24^- E$ and at distance of $625 Km$ from Khartoum.

Eritrean hills in east and river Nile and Red sea states in the north and Khartoum and Gedaref states in the west and south.

The Gash seasonal river which flows, divides the town into eastern and western residential areas, from June to October. The area has mainly two climatic seasons, rather prolonged and generally hot (April-September) with rain fall (May- September) and a relatively short winter generally cool and dry with low humidity (November-March).

The average temperature $33℃ – 47℃$, account of population (2,636,3000) account (2010).

Aroma town is located to the north-west to Kassala at latitude $15° 27^- N$ and longitude $36° 24^- E$ and at distance of about $70 Km$ from Kassala town, climatalogical properties are the same as Kassala but it varies with a dusty climate most of the year. The others localities climate like Kassala typically.

Sample Collection and Measurement:

In this paper the element minerals in the human hair and fingernails(350 samples) from inhabitants of Kassala state eastern Sudan were a ssessed by performing X-Ray Fluorescence spectroscopy (XRF) analysis.

A sequential X-Ray Fluorescence(XRF) portable spectrometer with dispersal of the wave lengths with a rhodium lamp(PHILIPS MODEL PW2400)was used program parameters of XRF for qualitative and quantitative analysis.

Statistical analysis:

Statistical Package for Social Science (SPSS),software program was used for data analysis. The values of metal levels in nails are presented as arithmetic mean in (%)with

standard deviation and tabulated to illustrate concentration profile over each group. The statistical significance of mean values between different groups .

Results

Table (2):(Mean±SD) Concentration(%)Nail: Male

Area	Pb	Zn	Cu	Fe
Kassala Town	0.035 ± 0.03	0.0646 ± 0.05	0.0667 ± 0.05	0.6485 ± 0.39
Refi Kassala	0.033 ± 0.02	0.0600 ± 0.05	0.1013 ± 0.06	0.6010 ± 0.22
Aroma	0.02 ± 0.01	0.0608 ± 0.03	0.0593 ± 0.03	0.5795 ± 0.36
Shamal eldelta	0.01 ± 0.00	0.0667 ± 0.03	0.1283 ± 0.07	0.6160 ± 0.30
Wad elhelaw	0.02 ± 0.01	0.0750 ± 0.05	0.0913 ±0.05	0.4010 ± 0.30
Telkok	0.02 ± 0.01	0.0783 ± 0.06	0.0450 ± 0.03	0.7510 ± 0.51
Hameshkoreb	0.028 ± 0.02	0.0814 ± 0.04	0.0689 ± 0.04	0.5030 ± 0.22

Table (3):(Mean±SD) Concentration(%)Nail: Female

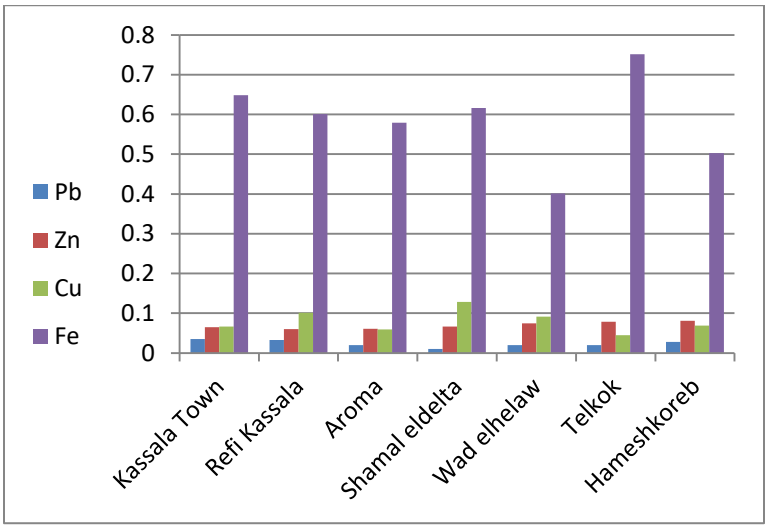
Area	Pb	Zn	Cu	Fe
Kassala Town	0.03 ± 0.02	0.1036 ± 0.13	0.1027 ± 0.06	0.5494 ± 0.31
Refi Kassala	0.02 ± 0.01	0.0654 ± 0.05	0.0779 ± 0.05	0.4516 ± 0.23
Aroma	0.03 ± 0.02	0.0521 ± 0.04	0.0667 ± 0.04	0.6625 ± 0.28
Shamal eldelta	0.04 ± 0.02	0.0757 ± 0.05	0.0856 ± 0.05	0.4750 ± 0.27
Wad elhelaw	0.02 ± 0.01	0.0375 ± 0.03	0.0717 ± 0.05	0.6040 ± 0.18
Telkok	0.04 ± 0.02	0.0500 ± 0.02	0.0856 ± 0.04	0.4680 ± 0.27
Hameshkoreb	0.023 ± 0.02	0.0700 ± 0.06	0.0613 ± 0.06	0.6040 ± 0.26

Table (4):(Max&Mini) Concentration(%) Male

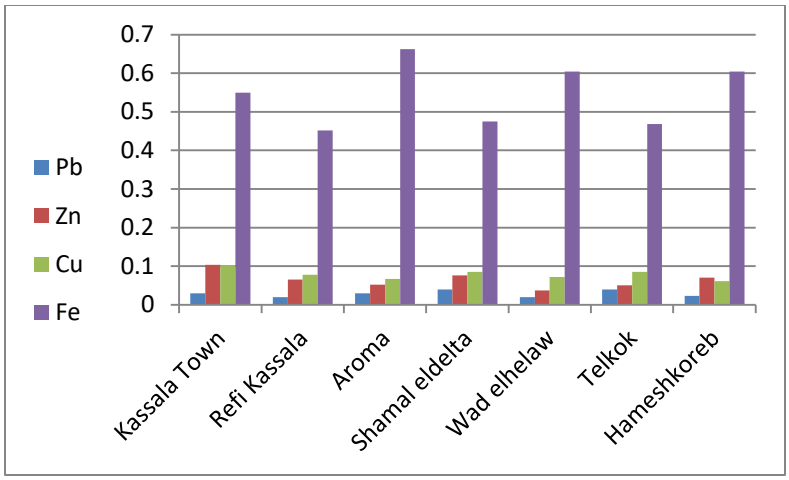
Area	Zn		Cu		Fe		Pb	
	Max	Mini	Max	Mini	Max	Mini	Max	Mini
Kassala Town	0.17	0.02	0.18	0.02	1.73	0.08	0.11	0.01
Refi Kassala	0.17	0.01	0.21	0.02	0.90	0.24	0.08	0.01
Aroma	0.12	0.02	0.11	0.01	1.80	0.17	0.05	0.01
Shamal eldelta	0.09	0.02	0.24	0.07	1.12	0.21	0.01	0.01
Wad elhelaw	0.16	0.01	0.19	0.03	1.08	0.07	0.03	0.01
Telkok	0.19	0.03	0.09	0.01	1.79	0.10	0.05	0.01
Hameshkoreb	0.13	0.03	0.14	0.01	0.80	0.10	0.05	0.01

Table (5):(Max&Mini) Concentration(%) Female

Area	Zn		Cu		Fe		Pb	
	Max	Mini	Max	Mini	Max	Mini	Max	Mini
Kassala Town	0.47	0.01	0.21	0.04	1.21	0.09	0.07	0.01
Refi Kassala	0.15	0.01	0.15	0.01	0.93	0.09	0.05	0.01
Aroma	0.13	0.01	0.15	0.01	1.41	0.21	0.08	0.01
Shamal eldelta	0.16	0.02	0.18	0.02	1.01	0.21	0.06	0.01
Wad elhelaw	0.06	0.01	0.15	0.02	0.83	0.26	0.04	0.01
Telkok	0.08	0.02	0.14	0.02	0.91	0.21	0.06	0.02
Hameshkoreb	0.16	0.01	0.18	0.00	1.01	0.26	0.06	0.01



Graph (1):Mean Concentration(%) Male



Graph (2):Mean Concentration(%) Female

Discussion

The results of the quantitative analyses of fingernails for Pb, Fe ,Cu and Zn are given in table(2) for male and table (3) for female and also table(4,5) were shows the max and mini concentration percentage of this four elements according to the area , male and female The samples analyzed were categorized according to their personal residence. The results shows that the high concentration of this four elements in finger nail was Fe and the second were Cu and Zn ,the last Pb .Fe high concentration in male than female and also Cu but Pb equals in both gender On the other side Zn was high levels in female than male.

Conclusion

Analysis of Zn, Cu, Fe, and Zn in human finger nails has been carried out to ascertain accumulation of exposure metals. The mean concentrations of exposure metals showed that all the 200 nails samples, high mean concentration was Fe and the second was Cu and Zn but Pb shows minimum level in all samples .

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