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Trace element levels in nape of neck hair from local population Latakia –Syria: link to sex and age factors

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The aim of this study was to assess the contents of some trace elements of cadmium (Cd), nickel (Ni), lead (Pb), Cupper Cu and zinc (Zn) in nape of neck hair of male and female volunteers of different ages from Latakia city. The collected samples of hair underwent a series of processes of washing, drying, and digestion then they were analyzed by ICP-MS to determine the levels of trace elements of Ni, Zn, Cu, Pb, and Cd in nape of neck hair of volunteers. It was noticed that values of Pb, Zn, and Ni depend on sex factor that is element levels were higher in female comparing to those of male. But age factor didn't influence on the level of the studied elements except for Pb whereas it was directly proportional to age. It was obvious that the levels of trace elements in nape of neck hair were correlated to gender and age. Therefore hair can be considered a good monitor for different levels of elements in the human body linked to gender and age of person as a source of sample.

Keyword: Zinc (Zn), Cupper (Cu), Nickel (Ni), Cadmium (Cd), Lead (Pb), ICP-MS, Hair analysis, sex, age.

1. Introduction

Scalp hair has been used for long time as monitor for body status. Over 200 years hair analysis has been used for assessment of arsenic (As) levels in human body. It widely spread since 50 years. Researches carried out by NGO over decades affirmed that using hair analysis was one of the potential analyses for bio-monitoring of heavy element traces inside human body [1]. IAEA and EPA programs considered that hair is a reliable noninvasive tool for assessment of high toxic elements such as Lead Pb, cadmium Cd and mercury Hg. These elements accumulate in hair, as well as in blood and urine. Hair can be easily sampled when compared with sucking out blood and breaking bone. Little amount of hair is taken, treated, injected and analyzed. Contrary to human body tissues hair is considered a stable deposit that can be stored and transferred easily without providing adequate physicochemical conditions. And it it's not influenced by environmental changes. On the other hand hair monitors for total body burden neither for specific organ nor for tissue. In addition, hair appears to be superior to blood and urine it comparatively monitors of the levels of elements that accumulated over long periods of time [2]

Hair protein grows at slow rate meanwhile it binds to minerals and salts and when it's analyzed, concentration can be obtained for the specific period. This unique method is distinguished from other ones. Heavy minerals are highly dangerous pollutants due to their toxic impacts that can be accumulated generally in the tissues of living organisms and specifically in - that of human beings [3] Heavy mineral pollution is one of confusing problems for the following reasons: 1- Most of the adverse effects are carcinogenic for living organisms even in very low levels

2-several elements have various sources

3-Many elements tend to accumulate in living organisms; many of them are toxic [1]

Determination of heavy elements accumulated in human body is of great importance in order to link human health to the degree of exposure to these elements. In the last years the determination of element levels in scalp hair has become very common to monitor the degree of exposure to minerals [2, 3]

Every person is almost exposed to toxic elements of environmental pollutants. Toxic elements tend to accumulate due to severe and chronic exposure or even when their levels exceed the threshold of body clearance. Screening elements of scalp hair whether in case of physiological decline of elements or in disproportionate distribution is still invaluable work, hence, it has been considered a vital bio-monitor in terms of environment and health in many countries such as Germany, Italy, USA, Iran, France, Chile, Pakistan, Turkey, India, Slovenia, Korea, Nigeria, Japan, China, and Poland. The findings of the researches done in these countries were relatively different and proportional to the level of environmental pollution of the screened area. This research aims to determine the contents of Pb, Cd, Zn, Ni, and Cu in samples of human nape of neck hair from Latakia using ICP-MS then to correlate sex and age to the concentrations of elements in hair samples since hair analysis appears to be superior to blood and urine for the following reasons:

- The determination of elements and salts levels is time-saving.
- Low cost -analysis requirements
- It's a newly adopted analysis and valuable indicator to environmental pollution, further it reflects the health status of human body and the degree of its exposure to any toxic element or narcotics [3].

2. Materials & Methods

Hair samples were taken from male and female volunteers of different ages from Latakia. In addition samples were also taken from smokers in purpose of comparison.

Hair samples were cut from the nape of neck close to the scalp as strands and directly stored in polyethylene bags [1, 2] The samples were soaked in water, washed using a detergent, double distilled water and acetone respectively. Then samples were then dried at 60 °C for 4 hours using oven [5, 10].

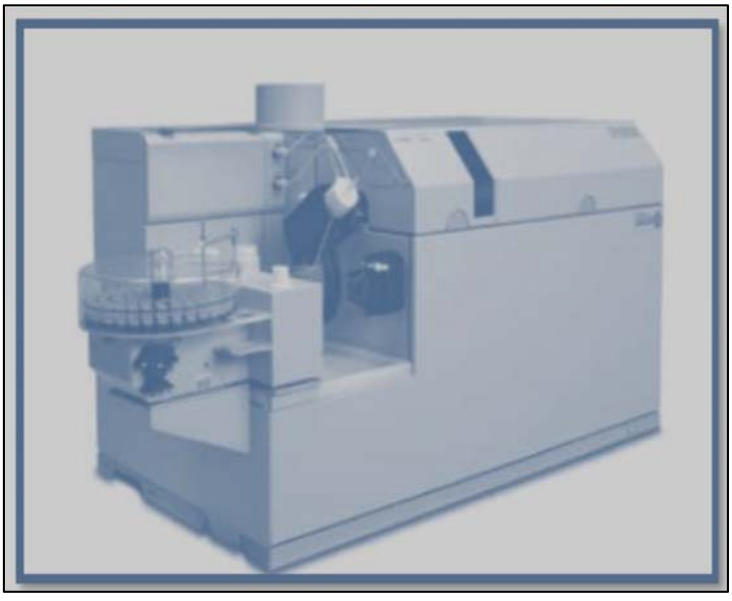

Fig 1: ICP-MS.

0.25 g of the sample was taken and placed in digestion tube and 3 ml of nitric acid were added as well as few drops of H_2O_2. Then the tube was put in the apparatus of digestion this process would take 30 minutes at 90 °C. The content of the tube was then moved to a polyethylene tube

and diluted up to the mark using double distilled water. Thus the sample was ready for analysis Prior to analysis, it's recommended that ICP-MS is ready to run in typical conditions Table 1 shows the parameters that are necessary to initiate the analysis by ICP-MS.

Table 1: operating parameters for ICP-MS

Plasma gas flow rate	15.0 L/min
Aux. gas flow rate	1.0 L/min
Carrier gas flow rate	1.17 L/min
RF power	1300W
Nebulizer	PEEK, Babington-type
Spray chamber	Glass, double pass
Spray chamber temp.	1 °C
ICP torch injector	Quartz, 2.5 mm
Sample uptake rate	0.4 mL/min
Sampler cone	Nickel
Skimmer cone	Nickel
Sampling depth	8 mm

Finally we chose the element analysis program then the sample was put in the allocated vials in order to be analyzed

3. Results and Discussion

The present study concentrates on the determination of Pb, Cd, Zn, Ni, and Cu in human hair. Beside that correlation between element levels and volunteer's age and sex was specifically investigated.

Levels of the studied elements were related to body burden and chronic ingestion of these elements. This type of analysis would reflect the levels of elements in volunteer's body and his or her health status. Heavy metals get in human bodies through many routes:

*via air: factory chimneys release several types of metal oxides that pollute air then into humankinds, animal and plants. On the other hand car exhausts emit Lead oxides resulted from the combustion of tetraethyl Lead (TEL) which is considered the major cause of lead-air pollution.

*via water: industrial wastes poured in sea water which pollute marine organisms when they fished, the toxicants are transferred up the food chain to humans and animals.

*via soil: this a way of minerals transmission that land metal wastes rust when exposed to air moisture. Heavy metals as pollutants dissolve in water and rainfall therefore they reach and contaminate ground water or drinking water and plants thereafter.

The study was conducted on two parallel tracks that involved sex and age factors:

i. Sex factor: hair samples were collected from male and female volunteers from Latakia city
ii. Age factor: the age of volunteers from Latakia city were of different ages.

(i) Sex factor

Samples were collected from 40 male and female volunteers from Latakia city their ages range from 25-35. The study population was divided into two groups of 20 males and 20 females. They were residents of countryside (unpolluted remote areas)

The study samples underwent a series of processes:

1-washing2-drying3-digestion

Thus samples would be ready to be analyzed by ICP-MS. Table2 reveals the findings of elements content.

Table 2: Sex- related Levels of Cd, Pb, Cu, Zn and Ni in nape of neck hair analyzed by ICP-MS

Sex	Number of volunteers	Pb (µg/g)	Cd (µg/g)	Zn (µg/g)	Cu (µg/g)	Ni (µg/g)
Male	20	15.9±0.9	0.5±0.03	195.4±13.8	15.9±0.9	0.5±0.03
Female	20	12.3±0.7	0.5±0.02	208.7±19.3	13.0±0.7	1.6±0.2

It's been noticed from the findings revealed in Table 2 that there were different concentrations of the studied elements among volunteers of different sexes, whereas Pb level was higher for males than for females; it ranged 15.9±0.9 µg/g in males and 12±0.7 µg/g in females. This difference can be attributed to dietary habits of males in comparison to that of females, that is, according to many researches it's obvious that drinking spirits increases the absorbance of Pb. In addition farming and using insecticides play a major role in ingestion of Pb into human body.

Regarding to Zn and Ni, their levels were higher for female than for males and they were recorded as follows 195±13.8 µg/g in males and 208.7±19.3 µg/g in females. Similarly to Ni, its level was higher for males 1.2±0.1 µg/g than for females 1.6±0.2 µg/g. This difference is attributed to female habits of wearing nickel - made jewels and administering zinc-contained drugs.

As for cadmium and copper their levels were not gender-related. But they basically depended on other factors such as environment pollution, dietary habit, drinking water, smoking, alcohol administering, and other various practices. These factors would by turn effect on the levels of elements in hair.

The observed findings were analyzed statistically as shown in figures 2, 3. It's obvious that levels of Cd, Pb, Cu, Zn, and Ni vary in relation to donor sex.

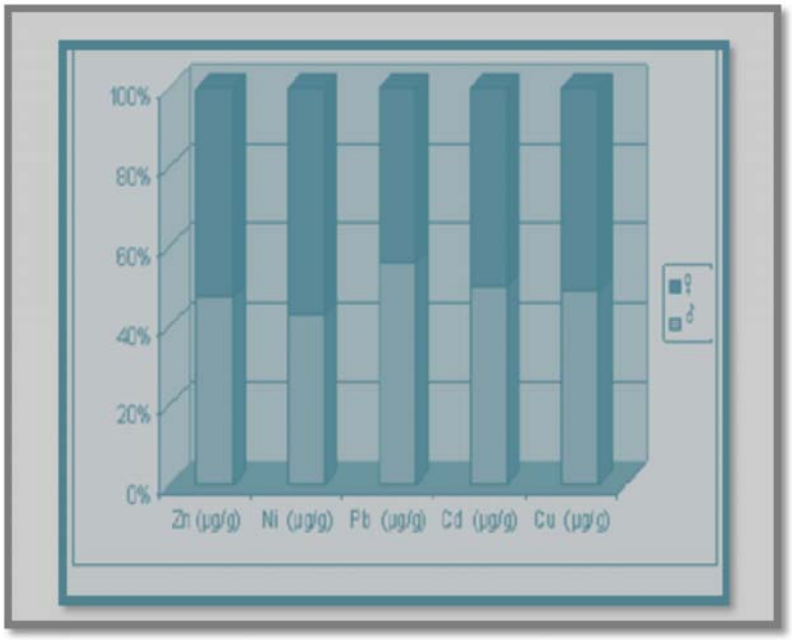

Fig 2: Sex related levels of Cd, Pb, Cu, Zn and Ni in nape of neck hair.

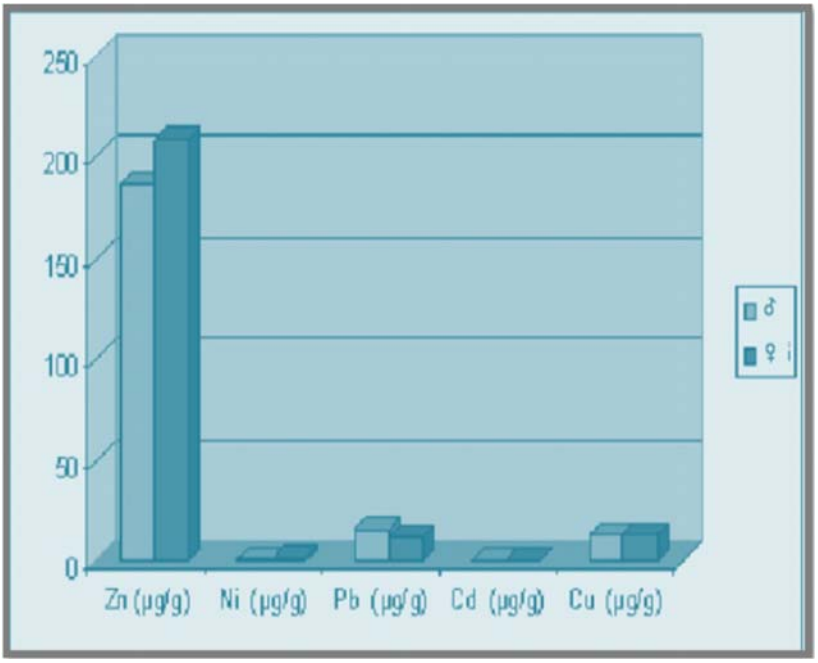

Fig 3: Sex related levels of Cd, Pb, Cu, Zn and Ni in nape of neck hair.

(ii) Age factor

Samples were collected from 50 male and female donors from Latakia. Their ages ranged from 1-75 and they were divided into five age groups:

1-10 volunteers of ages range from 1-15 years.
2-10 volunteers of ages range from 16-30 years.
3-10 volunteers of ages range from 31-45 years.
4-10 volunteers of ages range from 46-60 years.
5-10 volunteers of ages range from 61-75 years.

Also here samples underwent a series of processes:

1-washing 2- drying 3- digestion then they were analyzed by ICP-MS

Table 3 reveals the findings of the levels of elements of Cd, Pb, Cu, Zn, and Ni in hair in relation to age

Table 3: Age- related Levels of Cd, Pb, Cu, Zn and Ni in nape of neck hair analyzed by ICP-MS.

Age	Number of volunteers	Pb (µg/g)	Cd (µg/g)	Zn (µg/g)	Cu (µg/g)	Ni (µg/g)
1-15	10	8.3±0.7	0.4±0.09	217±18.3	11.5±1.2	1.1±0.2
16-30	10	11.9±1.7	0.5±0.02	225.4±12.2	14.3±2.1	0.9±0.1
31-45	10	13.1±1.2	0.5±0.01	231.5±15.3	12.4±3.6	1.5±0.3
46-60	10	14.2±1.4	0.6±0.04	198.1±11.2	13.6±3.1	1.2±0.6
61-75	10	16.2±1.6	0.5±0.02	182.2±9.8	12.7±2.3	1.9±0.4

It's obvious from these findings that the levels of elements didn't depend on age except for Pb which it's content was directly proportional to age; the absorption of Pb was age function, the levels of Cd, Cu, Zn, and Ni did not depend on age but on other covariates such as environmental factors, dietary habit, smoking, drinking water, alcohol addiction, and other individual practices. These factor by turn would influence the contents of elements in hair.

These findings were statistically analyzed as shown in figures 4-8 which reveal that the levels of Cd, Pb, Cu, Zn, and Ni differed significantly between the age groups.

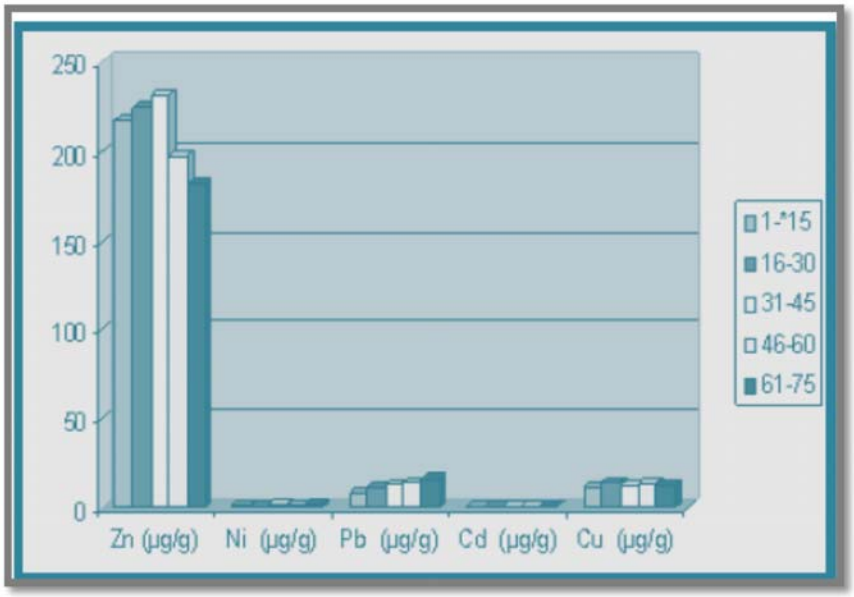

Fig 4: Age related levels of Cd, Pb, Cu, Zn and Ni in nape of neck hair.

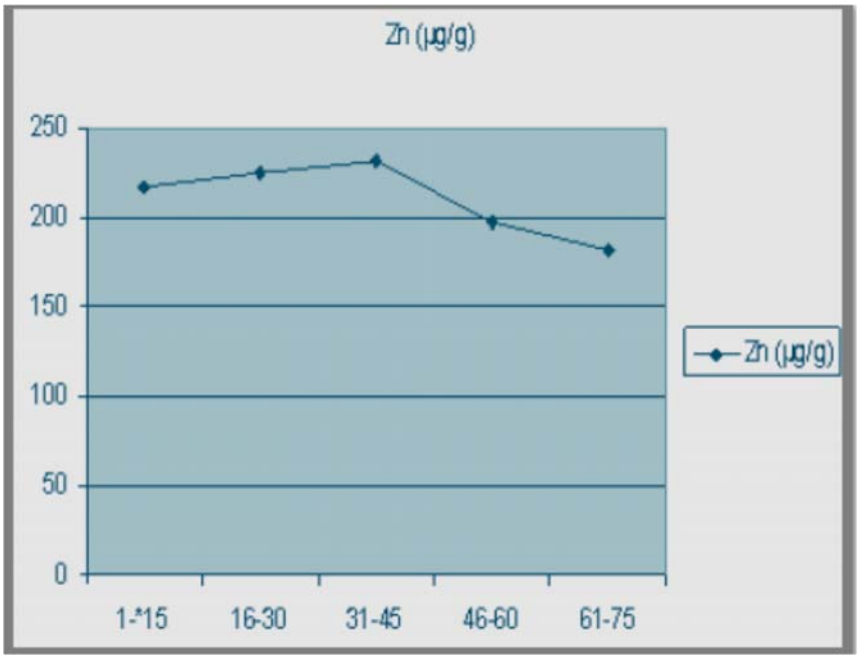

Fig 5: Age related level of Zn in nape of neck hair.

It's noticed from Figure 5 that the curve of Zn concentration peaked at age of 45 then declined from high values, reaching a minimum at age of 75. In addition, it's noticed from figures 7, 8 that the levels of Cu and Ni in hair samples were inversely proportional, that is, when level of one element increased at any age stage the levels of the other would decline. That's because Ni displaced Cu easily from body tissues according to the order of activity for metals.

As for Cd level. it's obvious that there were no significant differences at various ages while they depended on direct Cd exposure through its industry and inhalation of the released fumes as well as smoking cigarettes

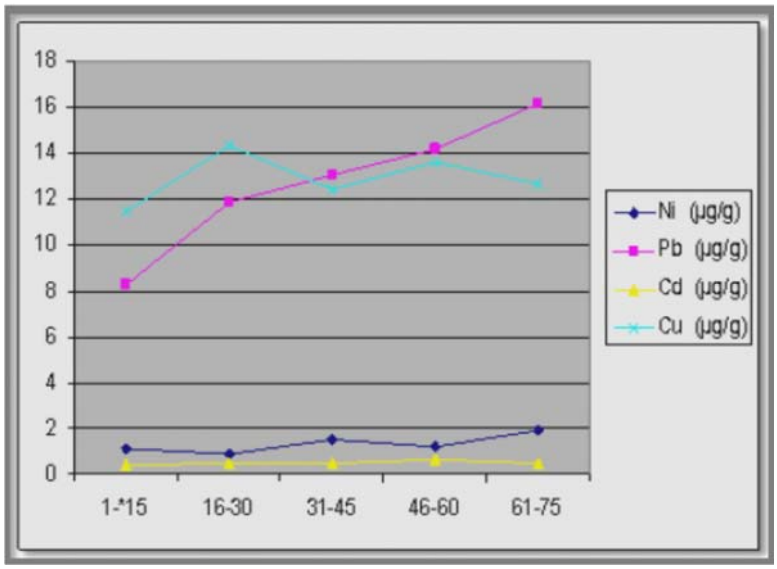

Fig 6: Age related levels of Cd, Pb, Cu and Ni nape of neck hair.

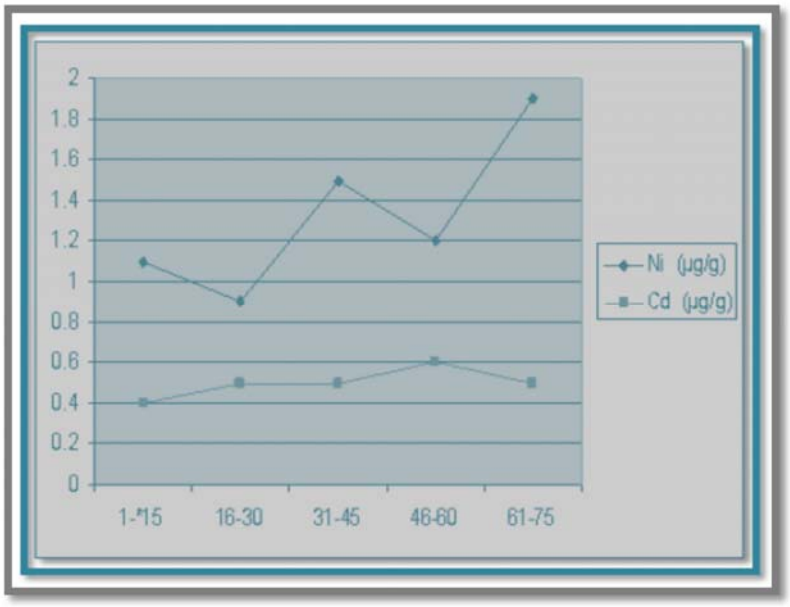

Fig 7: Age related levels of Cd and Ni in nape of neck hair.

Finally, the obtained findings were close to those determined using standard methods. Comparing to references it was found that lead levels were related to age in form of direct proportion as well as to gender [8]

All mentioned previously affirmed the potential of hair to be utilized by analytical chemistry lab as a biomarker for environment pollution and body exposure to toxic elements. Therefore, hair analysis is considered to provide reliable and effective technique for assessing elements levels that accurately evaluates the entire levels of elements in the human body.

Over the past thirty years many research articles and manuscripts involving hair analysis revealed that this type of analysis as an effective and practical means for assessment of heavy metals in the human body. Furthermore large-scale

prospective studies showed that person's hair taking up contaminants of heavy metals is considered a criterion for the degree of exposure to the environment pollution. Beside, hair is considered an adequate deposit of information on health status of the human body as well as an excellent bi-monitor for assessment of levels of accumulated heavy metals [1-14]

It can be concluded that levels of toxic metals in person's hair depend on the degree of exposure to these contaminants in addition to other environmental factors, individual habits of alcohol administering, smoking, nutrition, working, industry, and farming activity due to their influence on the absorption and levels of these metals on the human body.

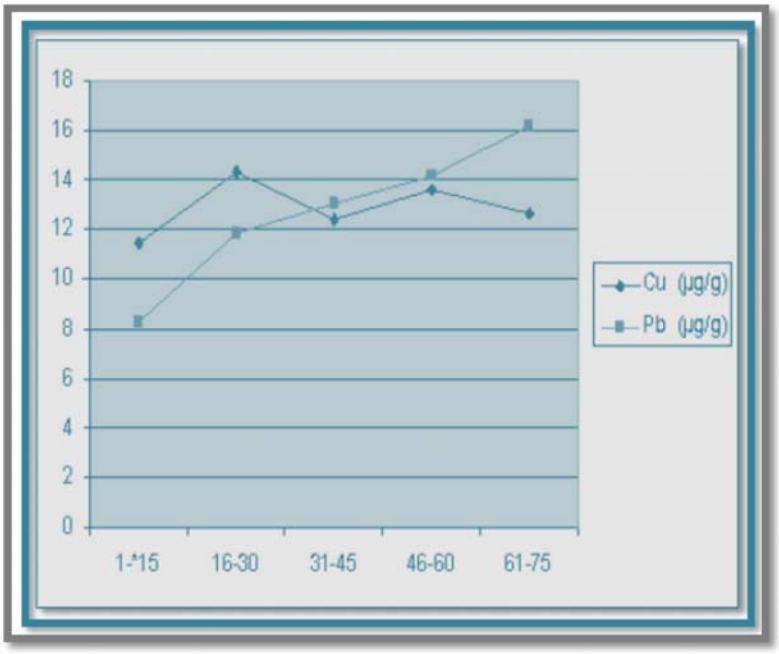

Fig 8: Age related levels of Pb and Cu in nape of neck hair.

4. Conclusions

This research involving nape of neck hair presents a new type of analysis in terms of biochemistry, clinical diagnosis, and analytical chemistry. Compared to other types of clinical specimens, hair is reliable, inexpensive and with advantages over blood and urine. It can serve labs of biochemical industry. For these reasons it's recommended to adopt hair analysis beside other analytical ones of blood and urine that are used in clinical diagnostic labs as well as in environmental ones.

5. Acknowledgments

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