QUANTITATIVE ANALYSIS OF LEAD LEVEL IN HUMAN SCALP HAIR IN SOME OCCUPATIONALLY EXPOSED WORKERS IN PETROL STATION IN BAGHDAD [+]

Manal Kamal Rasheed [*]

Abstract :

Over the last three decades, there has been an increasing awareness of environmental and occupational exposures to toxic or potentially toxic trace elements. Chemical investigation was conducted into the concentrations of Lead in scalp hair samples of some selected workers who work at occupational settings which expose them to metal contaminants. The measured concentrations of Pb was compared with the level in workers who were unlikely to be occupationally exposed to the studied metal contaminants. Traces of Lead was found in all the samples analyzed. However the concentration of the studied metals was higher in occupationally exposed workers than those who was not likely to be occupationally exposed to the metals.

The objective is to assess the concentrations of lead(pb) in scalp hair workers who are exposed to metal hazards of their occupational settings in petrol station in Baghdad and compared with those who are not likely to be exposed to the metal.

The samples were randomly selected from thirty workers who work at three petrol station located in Bagdad. Twenty samples were also collected from individuals who were virtually not occupationally exposed Pb. The metal quantitative analysis using atomic absorption spectrophotometer.

The range concentration of lead obtained from scalp hair workers occupationally exposed individuals were found to be 0.03-0.2mg/L compared with lead in scalp hair workers unexposed to metal contamination 0.009-0.013mg/l . The mean(± SD) (0.106± 0.064)mg/L was highly significantly increased in scalp hair of the occupationally exposed as compared to unexposed to metal(0.01±0.001)mg/L, $p<0.005$.There was highly significant positive correlation between the concentration of pb and the duration of exposed to metal($r=0.89$,$p<0.0005$).

The results of this study have revealed that the average concentration of lead in human scalp hair of occupationally exposed workers increases with increased number of years spent by an individual at the work place.

Key words: **Human hair, scalp, Lead, exposed worker, petrol station.**

التحليل الكمي لمستويات الرصاص في شعر فروة الرأس لبعض العاملين في محطات تعبئة البنزين في مدينة بغداد

منال كمال رشيد

[+] **Received on 2/10/2014 , Accepted on 5/5/2015**

[*] **Assistant Prof. / Collage of Medicine /University of Bagdad.**

المستخلص :

لأكثر من ثمانية عقود سابقة ,هناك وعي للتعرض البيئي والمهني للعناصر السامة أو الى جهد عناصر السامة النادرة. التحليلات الكيميائية توصلت الى أن المستويات الرصاص في فروة الرأس لعينات أختيرت لعمال يعملون في مهن تعرضهم الى تلوث معدني . التراكيز المقاسة لعنصر الرصاص قد تم مقارنتها مع المستويات عند العاملين الذين لم يتعرضوا للملوثات كيميائية المدروسة. ان النماذج التي تم تحليلها وجد فيها اثار لعنصر الرصاص . ووجدت ان تراكيز المعدن المدروس كانت ذو قيمة عالية في العمال المهنيين المتعرضيين للتلوث المعدني أكثر من اولئك الذين لم يتعرضوا مهنيا للتلوث .

العيينات قد أختيرت عشوائيا من ثلاثين عامل يعملون في ثلاث محطات تعبئة وقود في مدينة بغداد وعشرين نموذج أخر كانت قد أختيرت من اشخاص لم يتعرضوا عمليا للرصاص بشكل مهني .وقد حللت النماذج كميا بأستخدام جهازالمطياف الضوئي بطريقة الامتصاص الذري .

الهدف من الدراسة هو تقييم مستويات الرصاص في فروة رأس العاملين الذين تعرضوا للمعدن الخطير(الرصاص) نتيجة عملهم في محطات تعبئة البنزين ومقارنتها مع العاملين الذين لم يتعرضوا بشكل دائم الى لمعدن الرصاص.

إن مدى تركيز لعنصر الرصاص المأخوذ من فروة رأس العاملين المتعرضين يتراوح بين 0.03- 0.2 (ملغم\لتر) , ومقارنتها مع الاشخاص الذين لم يتعرضوا للتلوث بالمعدن 0.009-0.013 ملغما لتر. أن معدل مستوى الرصاص في فروة رأس العاملين المتعرضين للمعدن(معدل ± أنحراف المعياري) هو(0.106 ± 0.064)ملغم التر\و زيادة معنوية عالية عند مقارنتها مع معدل مستوى الرصاص في فروة رأس الاشخاص الذين لم يتعرضوا للتلوث المعدني (0.01±0.0013) ملغم التر , . p<0.0005 وهناك علاقة معنوية موجبة بين تركيز الرصاص (ملغم التر) ومده التعرض للمعدن الرصاص في فروة رأس العاملين المتعرضين للمعدن الخطير, r=0.89,p<0.005

النتائج لهذه الدراسة أظهرت ان معل التركيز لمعدن الرصاص في فروة الراس للعمال المهنيين المتعرضين للتلوث المعدني يزداد مع زيادة عدد السنين التعرض في موقع العمل .

الكلمات المفتاحية : شعر الانسان , فروة الرأس , الرصاص , تعرض العمال , محطات البنزين.

Introduction :

During the last three decades the investigation of trace element concentration in human scalp hair has become increasingly popular for monitoring environmental exposure [1], and evaluating systematic intoxication [2]. Studies have shown that human scalp hair can record the level and changes of many elements in the body over a long period of time [3]. Changes in the chemical composition of hair are believed to depend on alterations of external and internal media of the human body. The controversy of using hair to assess essential element is established, yet researchers have undoubtedly found many correlations of essential elements to diseases (such as coma, anemia, convulsion, paralysis, hallucination, muscular tremor, headache et cetera), metabolic disorders, environmental exposures, and nutritional status [4]. It is considered that the hair of healthy individuals contain each element within a well-defined range of concentration [3,5] and it can be considered as a potential indicator of both external and internal long term exposure to environmental pollutants. When these metals

enter the body of living organisms even in trace amounts, they may not be metabolized but accumulate and attain levels which may be toxic to the organism.
The human hair, though lesser known as site for accumulation of metals, it accumulates more lead per unit weight than any tissue in the body including even body fluids such as blood and urine [3].
Due to the nature of the environment and human activities, some people are exposed to trace amounts of lead through air, soil, household dust, food (fruit juice, soft drink etc), drinking water (lead levels in water increase as water stands in pipes) and various consumer products [5].
Similarly, agricultural activities, heavy industrial activities, constructional works, industrial emissions, smelters, refineries, leaded gasoline and other technological advancements are other sources of lead pollutants. The hair may serve as important indicators for occupational exposure of heavy metals pollutant which to a large extent become toxic to human beings [6].
The element lead has been very widely studied in man due to its widespread occurrence and toxic effects. There is no known nutritional value of lead and it is stored in the bone by replacing calcium. In the pre-natal level, lead exposure may lead to an increase risk of prematurity and reduction of gestational age in humans. Lead-exposure causes adverse neuro-psychological effects among young children and numerous endocrinal disturbances among adults. It has shown that human scalp hair lead concentration can be used very successfully to document population exposure to this toxic element [4]. The idea of hair analysis is very inviting, because it is easily painlessly removed, normally discarded compared to blood. Also while urine and blood tend to show current or recent body status, hair represents a longer time frame potentially years, this gives more analytically accurate results because elements occur in hair at higher levels [7]. Trace element concentrations in hair are related to those in blood serum and urine but are usually at least ten times higher [7].This makes hair an absolutely excellent choice in certain situations and as a screening tool [7]. In many instances the hair of human's especially that of males is cut and disposed off as waste materials. Apparently such unwanted hair could be analyzed and studied to learn of both external and internal exposure of the population to contamination.
Therefore, the aim of this study is to assess the concentrations of lead in workers who are exposed to metal hazards and those who are not likely to be exposed by means of the nature of their occupational settings in petrol stations in Baghdad.

Subjects and Methods :

The samples were randomly selected from thirty workers who work at three petrol station located in Bagdad. Twenty samples were also collected from individuals who were virtually not occupationally Pb exposed. Subjects were classified into four groups : Occupationally exposed pb(sit 1, sit 2, sit 3) and un occupationally exposed pb (sit 4) .Sampling was conducted once every month for three months period from January to March, 2010. The hair samples collected were stored in carefully labeled clean polythene bags and identified with the age of donors and the sample location. The samples were then prepared and chemical analysis was performed by using atomic absorption spectrophotometer (AAS).
Hair samples were digested according to the procedure of [8] by acid digestion method.
Preparation of hair sample: Washing of the sample is critical to remove " loosely bound, exogenous , metal-containing materials ' on the hair before analysis, Hair submitted for analysis is cut into very short pieces .Samples are rinsed with acetone and allowed to drain . Each sample is washed twice with detergent to remove surface contaminations employing Tronic X-100.,a nonionic detergent which has been shown more effective than other cleaning

agent for removing contaminants safely without affecting the internal elemental composition of the hair matrix [9]. Washing of the hair samples to remove superficial contamination is the foremost requirement. However, the use of such washing methods prior to the element analysis remove minute quantities of elements from the hair strands. This degree of loss is dependent on the washing method employed [10].

This washing is followed by the rines with deionized water two rinses of acetone and a final drain .Samples are then dried at approximately 75 degree Celsius.

Weight about 100 mg of hair sample into a kieldahl flask, add 20ml of con. HNO_3(65%), 50 ml conc.$HCLO_3$ (70%). Heat until dense white fumes are given off. Cool and dilute to 100 ml with distilled , deionized water, prepare a blank in parallel then inject 10 µl of sample into the furnace atomizer and determine the mineral by using perkin- Elmer (USA)A AS (Atomic Absorbance spectrophotometer) model 305B.

The absorbance of the samples were measured and the concentrations of Pb in each prepared sample quantified from the generated calibration curves.

Results :

The result of the measurement the concentrations of Lead in human scalp hair of thirty occupationally-exposed and twenty occupationally-unexposed subjects from designated sampling sites in three petrol station in Baghdad , is presented by Figure 1 .

Figure 1 shows the diagrams of the mean levels of Pb in occupationally exposed and unexposed subjects. The diagram reveals the high variation nature of the metals

Levels in hairs of workers who are exposed (the mean was 0.1 mg/L) and little variation in unexposed subjects (the mean was 0.012 mg/L) as shown in (Figure 3).

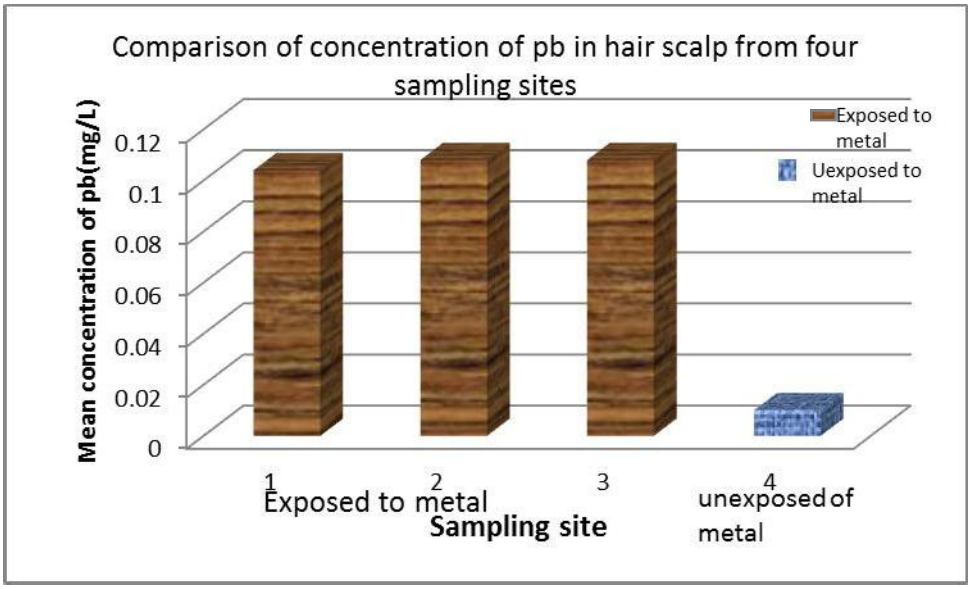

Figure (1): The comparison of concentration of pb in hair scalp from four sampling sits

As depicted by Figure 2, the variations in the concentrations may be due to the variations in the number of years spent by the workers at the work environment.

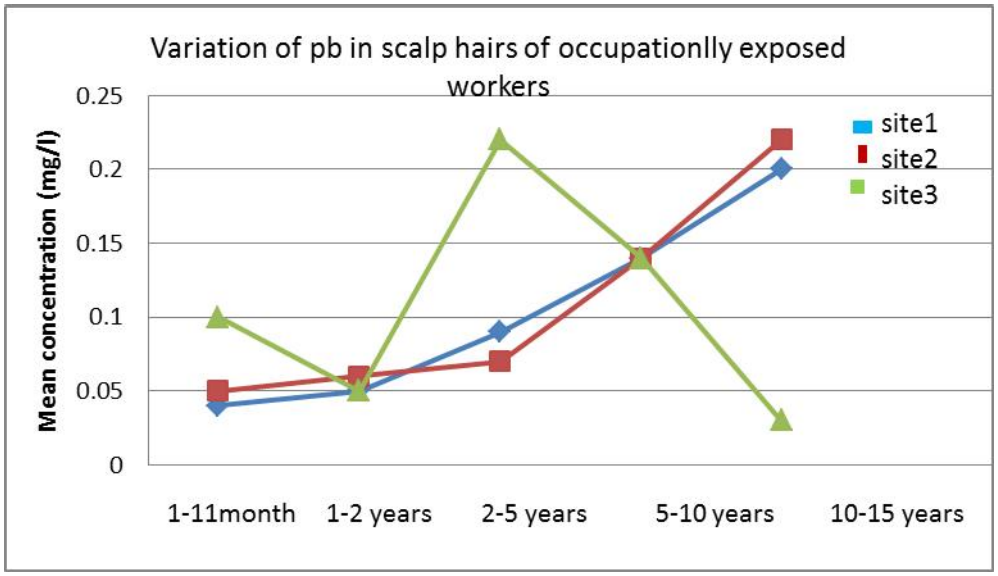

Figure (2):Variation of pb concentration in hairs of occupationally exposed workers.

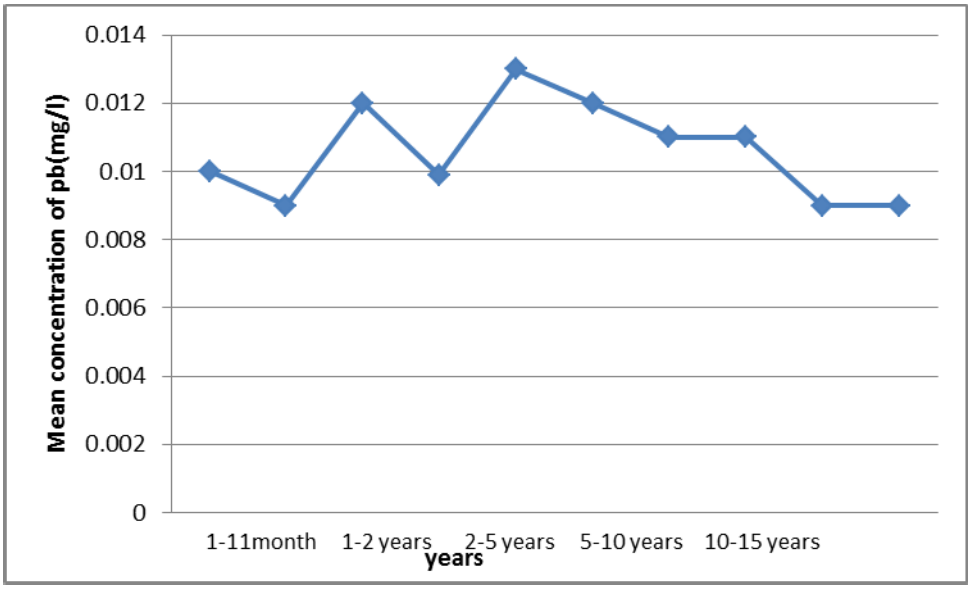

Figure (3):Variation of pb concentration in hairs of occupationally unexposed subjects

Table 1 show highly significant increase of mean level Pb in scalp hair of occupationally exposed workers (0.106±0.064) mg/L as compared to unexposed to metal(0.01±0.001), p<0.0005 .

Table (1): Variation of hair pb level (mean± SD) and range of occupationally exposed workers and unexposed to metal

Hair pb(mg/L)	Exposed workers to metal	Unexposed to metal
Sample size	30	20
mean± SD	0.106 ± 0.064	0.01± 0.001
Range	0.03-0.22	0.009-0.013
t-Test	6.5×10^{-9}	P< 0.0005*

***Highly significant correlation .**

The result also showed comparison of the pb concentrations in scalp hair exposed workers with respect to the number of years spent at the work settings. The outcome of the analysis is presented by Table 2.

Table (2): The mean levels of Pb in scalp hair of occupationally exposed workers in relation to duration of exposure

Years of working	Mean (±SD) concentration of lead (mg/L)	sig
1-11 months	0.063 ± 0.02	0.9
1-2 years	0.054±0.001	0.6
2-5 years	0.134± 0.07	0.08
5-10 years	0.147±0.001	0.05
10-15 years	0.163±0.09	0.005

SD= standard deviation

Figure 4 showed the correlation between the concentration of pb and the duration of years exposed to the metal. The correlation was highly significant $p<0.005$, $r=0.89$.

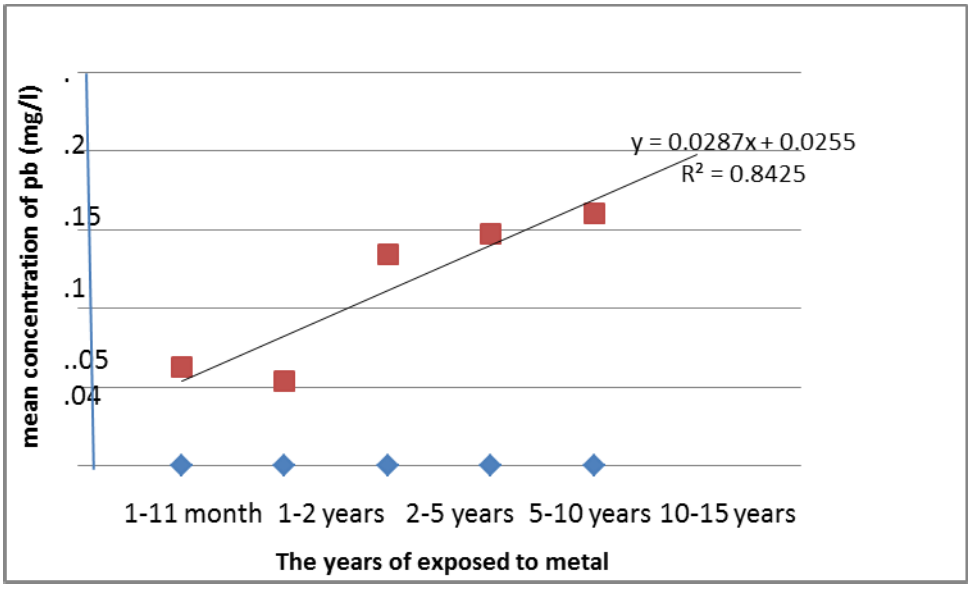

Figure (4): The correlation between the concentrations of pb (mg/l) and duration of exposed to metal

Discussion :

Hair provides one of the most accurate records of the health and trace metal status of the human body. For long, blood and urine analysis were the main sources of information on the body's burden of trace metals. Studies of human exposure to Pb in Nigeria using human tissues have reported high levels of Pb in urine [11] , and blood samples [12] . Hair is an excellent indicator of past changes in metabolism and environmental exposure to metals [13]. The growth rate of human hair is approximately 1 cm per month [14]. Hair analysis for trace elements is influenced by a number of factors including geographical location [15] age and sex [16], Hair color [16] and treatment with various chemicals and shampoos are also variables to consider [15]., Scalp hair consists of the protein keratin, which contains a high

proportion of the sulphydryl groups(-SH)containing amino acid, cysteine [17] , [13]. Hair samples treated with hair dye materials have been observed to contain very high levels of Pb after thorough washing to remove the dye. This suggests that Pb in its compounds when applied externally or deposited on the hair does enter the hair fiber [18]. Thus trace metals initially as a surface contaminant may become incorporated into the hair structure, probably through attachment to the –SH groups in the hair. Lead as a trace metal in the human tissues have received the most attention and several studies have examined the physiological and behavioral effects of Pb especially with reference to hyperactivity in children [19].
The result of the measurement the concentrations of lead in human scalp hair of thirty occupationally-exposed and twenty occupationally-unexposed subjects from designated sampling sites in three petrol station in Baghdad , is presented by Figure 1 .

The highest average (Pb 0.1122mg/L) concentration in hair was recorded in workers recruited from sampling point 1 of Bagdad . However, as expected, the least average pb concentration was reported in hair samples from sampling point 4 (unexposed), where the workers were not expected to be exposed to the metal due to the nature of their occupational settings. In general, relatively high Pb concentrations were observed in hair samples collected from workers who were literally exposed to the metals due to the nature of their work settings. This is not surprising, since workers in sampling points 1, 2 and 3 are exposed to metal particles including smokes, fumes and particulate matter.
Figure 1 shows the diagrams of the levels of Pb in occupationally exposed and unexposed subjects. The diagram reveals the high variation nature of the metals levels in hairs of workers who are exposed and little variation in unexposed (Figure 3). As depicted by Figure 2, the variations in the concentrations may be due to the variations in the number of years spent by the workers at the work environment.
Table 1 show highly significant increase of Pb in scalp hair of occupationally exposed as compared to unexposed to metal $p<0.0005$, which agree with Katarzyna Chojnacka, 2012) [20] reported in his study that was higher level of mineral in hair subjects who living in the vicinity of the industrial chemical complex emitting this element and presented mineral content of scalp hair reflected the environment /residence of the subjects and can serve an indicator of environmental pollution from local industry. Although some studies reveal correlation between given metals in hair of persons living in industrial areas, the level of a given element might be influenced not only by the level of another element, but probably by the whole group of elements, gender, lifestyle, etc. which agree with Chojnacka et al. 2006 [21].
The result showed comparison of the pb concentrations in exposed workers with respect to the number of years spent at the work settings. The outcome of the analysis is presented by Table 2. Figure 2 . The differences in the concentrations of the pb with respect to the number of years spent. As shown by Table 2, there was significant difference in the concentration of pb in hairs of workers who have spent 5-10 years and 10-15 years working in their various occupational settings than who have spent 1-11 months and 1-2 years in the same work places. These result agree with Melita Kosanovic, 2010 [22].
This result suggests that Pb concentration levels in human scalp hair are dependent on the work settings and risks factors. The correlation analysis of Pb in human scalp hair in exposed workers showed a strong positive($r=.089$) $p<.0.005$ association between the metals and time of exposed . (figure 4).
A detailed insight in mechanisms of metals and metalloids incorporation into hair is crucial for better understanding and interpretation of results. Although hair is the widely accepted matrix for monitoring of some toxic elements such as lead or mercury, special attention should be paid

to ubiquitous elements and their interrelationship. In order to get comparable results, sampling by untrained personnel should be avoided. Washing and digestion procedures should be standardized. Because of the ease with which samples can be collected, transported, stored and analyzed, hair analysis is valuable in screening individuals and populations for exposure to heavy metals [23].

Conclusion :

These data indicates the level of human exposure to heavy metals in petrol station in Baghdad. These observations suggest Pb poisoning of a high magnitude arising from environmental factors probably largely due to high gasoline lead. There is an urgent need to initiate a gradual phase out of the use of leaded gasoline in petrol station in Baghdad and the concentrations of lead obtained in occupationally exposed workers increased with increasing duration of employment. This study has showed that human scalp hair may serve as important indicators for occupational exposure of metal pollutant. It is envisaged that the results of this study will enrich the understanding of occupational hazards and human safety.

Reference :

1. Eman Elsheshtawya, Salwa Tobara, Khalid Sherraa, Sohayla Atallahb *etal.*: Study of some biomarkers in hair of children with autism , Institute of Psychiatry, Ain Shams University 2090-5408 c, 2011.
2. Eleonor Blaurock-Buscha Omnia R. AMIN,b and Thanaa RABAHc: Toxic Metals and Essential Elements in Hair and Severity of Symptoms among Children with Autism" Journal of Clinical Medicine .http://www.maedica.org/articles/2012/1/2012, No1_pg38-48.pdf
3. Bouchard, M., Laforest, F., Vandelac, L., Bellinger, D., &Mergler, D:. "Hair manganese and hyperactive behaviors: Pilot study of school-age children exposed through tap water". *Environmental Health Perspectives* ; 115, 122–127, 2007.
4. Krystyna Srogi , Zamkowa 1,Poland.:"Hair analysis for monitoring environmental pollution and the resulting human exposure to trace metals": *Environnement, Risques & Santé*;.,Volume 5, Number 5, 391-405, 2006.
5. Mehra R,Thakura A.S.: "Relation between lead, cadmium ,zinc , manganes and iron in hair of environmentally exposed subjects" *Arabian journal of chemistry*. 01.-014, 2012.
6. Mikulewcz M., Chojnacka K., Zielinska A.,Michalak I.,: "Exposure to metals from orthodontic appliances by hair mineral analysis". *Environ Toxicol Pharmacol.* 32, 10, 2011.
7. Gil F.Her nadez AF., Marquez C., Femia P.,Olmedo P., et al.: "Biomonitorzation of cadmuim, chromium ,mangnases,nickel and lead in whole blood, urine axillary hair and saliva in an occupationally exposed population", *Sci. Total Environ.*, 409,1172.(IVSL), 2011.
8. Harkey, M. "Anatomy and physiology of hair Forensic Science International", 63, 9–18, 1993.
9. Morton, J., Carolan, V. A., & Gardiner, P. H.: "Removal of exogenously bound elements from human hair by various washing procedures and determination by inductively coupled plasma mass spectrometry". *Analytica Chimica Acta* 455(1), 23–34, 2002.

10. Hasan, M. Y., Kosanovic, M., Fahim, M. A., Adem, A.,& Petroianu, G.: "Trace metal profiles in hair samples from children in urban and rural regions of the United Arab Emirates". *Veterinary and HumanToxicology*, 46(3), 119–121, 2004.
11. Ogunfowaken AO, Famuyiwa SO, Adenuga AA, Fatoki OS : "Determination of cadmium and lead in urine of some Nigerian subjects". *Int. J. Environ. Health Res.* 12 (3): 283-287, 2002.
12. Adeniyi F A, Anetor J I :" Lead poisoning in two distant states of Nigeria: an indication of the real size of the problem". *Afr. J. Med.Med. Sci*,28 (1-2): 107-112, (IVSL), 1999.
13. Katarzyna Chojnacka, Agnieszka Saeid ,Izabela Mchalak, Marcin Milkulewicz : Effects of local industry on hair metals content in human hair, Pol .J. Environ. Stud. Vol 21, No. 6, 1563-1570, 2012.
14. Chojnacka K., Zielinska A.,Michalalak I., Gorechi H: The effect of dietary habits on mineral composition of human scalp hair, Environ, Toxically Phormacol, 30,188, 2010.
15. Rosborg I, Nihigard B, Gerhardsson L :"Hair element concentration in female in one acid and one alkaline area in southern Sweden". *Ambio* 32 (7): 440-446, 2003.
16. Bertazzo A, Costa C, Biasiolo M, Allegri G, Cirrincrone G, Presti G: "Determination of copper and zinc levels in human hair: influence of age, sex and hair pigmentation". Bio. Trace Elem. Res. 52: 37-53, 1996.
17. Ferre ,Huguet N., Nadal M., Schuhmacher M.D, *et al.* :Monitoring metals in blood and hair of the population living near a hazardous waste incinerator Biol .Trace Elem. Res. 128,191, 2009.
18. Krystyna Srogi: Hair analysis for monitoring environmental pollution and the resulting human exposure to trace metals,Environnement, Risques & Santé. Volume 5, Number 5, 391-405, 2006.
19. Koller K, Brown T, Spurgeon A, Levy L:" Recent developments in low level lead exposure and intellectual impairment in children.Environ". *Health Perspect*,112 (9): 987 – 994, 2004.
20. Katarzyna chojnacka ,Agnieszka Said , Lzabela Michalak: "Effects of local industry of heavy metals contend in human ":*Pol. J. Environ. Stud*, , Vol 21,No.6, 1563-1570, (IVSL), 2012.
21. Chojnacka, K., Górecka, H., & Górecki, H.:" The influence of living habits and family relationships on element concentrations in human hair". *Science of the Total Environment*,366, 612–620, 2006.
22. Melita Kosanovic · Milan Jokanovic : "Quantitative analysis of toxic and essential elements in human hair Clinical validity of results". *Environ Monit Assess* DOI 10.1007/s10661-010-1484-6, 2010.
23. D. Varrica, E. Tamburo, G. Dongarrà, F. Sposito:."Trace elements in scalp hair of children chronically exposed to volcanic activity" *(Mt. Etna, Italy)*, DOI:10.1016/j.scitotenv.09.058, (IVSL), 2013.