**A Survey Of Blood Lead Levels In Various Types Of Male Workers In Hilla City, Iraq**

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**Abstract**

**Background**

In Iraq, although there are numerous small-scale and medium private sector workshops which use lead-based raw materials that may pose health risks to workers, there are no workplace regulations for lead exposure.

**Method**

A cross-sectional study on the Blood lead levels of (178) occupationally exposed and a comparison group of non- exposed male workers was carried out in Hilla city – Babylon province- Iraq. Data on some risk factors such as age smoking, types of work, period of services and other variables like Body Mass Index and hypertension were gathered through structured questionnaires and interviews , body mass index , and blood pressure were measured . Blood sample was collected and analyzed for each participant by Lead Care Blood Testing System. Data analysis was performed using SPSS (version 17).

**Results**

The mean blood lead level of all groups was 23.50±16.35 the range was2.9-67. The highest blood lead mean was among workers engaged in radiator repairing ( 36.75± 20.26 ) followed by the mean of battery storage repair workers (29.80±16.16 ) . The mean blood lead level of the occupationally non exposed comparison group (13.02±6.89 ) which was significantly lower than the means of the occupationally exposed groups P<0.001. The blood lead levels were significantly increased with the increments of the following independent variables : age, period of services ,body mass index . smoking ,systolic and diastolic blood pressures .

**Conclusion**

The findings of the study have clearly demonstrated that the blood lead levels of occupationally exposed workers were considerably high and they are in danger of impending lead toxicity. The blood lead levels of the workers are influenced by their occupational practices, age, period of employement, smoking , and associated positively with high blood pressure .

**Keywords*:*** Blood lead levels, Occupational exposure , Blood pressure. Hilla city , Iraq.

**ألخلاصة**

**خلفية البحث**

في العراق تنتشر الورش الصغيرة والمتوسطة التي تستعمل الرصاص كمادة أولية تعرض العمال إلى مخاطر صحية و لا توجد فيها قواعد سلامة مهنية ضابطة للتعرض للرصاص.

**طريقة العمل**

أجريت دراسة مقطعية عرضية ل 178 عامل من الذكور معرضون مهنيا للرصاص ومنهم لم يتعرضوا

( مجموعة مقارنة ) في مركز مدينة الحلة- محافظة بابل – العراق, خلال عام 2007, تم جمع البيانات عن بعض عوامل الخطر مثل العمر, التدخين ونوعية العمل ومدته,ومتغيرات مستقلة أخرى مثل مؤشر كتلة الجسم وضغط الدم الشرياني عن طريق ورقة استبانه تم ملئها بالمقابلة الشخصية من قبل الباحث . أجريت قياسات للوزن والطول لحساب كتلة الجسم وقياس لضغط الدم كما تم قياس مستوى الرصاص لكل مشارك بطريقة Lead Care . تم التحليل ألإحصائي ببرنامج إحصاء العلوم ألاجتماعية (17Blood Testing System **ألنتائج**

كان معدل مستوى الرصاص لجميع المشتركين من العاملين الذكور (

23.50±16.3

وكان مجال مستوى الرصاص في دمهم ,ظهر أعلى معدل مستوى للرصاص في الدم عند العاملين في تصليح الراديترات36.75+20.26 يلي ذلك معدل الرصاص للعاملين في ورش تصليح 29.80+16.16 البطاريات 29.80±16.16

اظهرت الدراسة وجود فرق إحصائي معنوي مهم بين معدل الرصاص لدى إفراد العينة الضابطة والمتغيرات ألآتية : أنواع المهن, مدة العمل, تقدم العمر , زيادة الوزن, التدخين و ارتفاع ضغط الدم

**ألاستنتاج**

أوضحت الدراسة وجود زيادة إحصائية معنوية مهمة في معدلات الرصاص في دم العاملين في مهن تصليح الراديرات وتصليح البطاريات والعاملين بتصليح السيارات ورجال شرطة المرور مقارنة بمعدل الرصاص في دم المعلمين (العينة الضابطة ).ووجددت علاقة مهمة إحصائيا بين زيادة الرصاص وأنواع المهن,التدخين زيادة كل من العمر , مؤشر كتلة الجسم , وارتفاع ضغط الدم الشرياني.

**الكلمات المفتاحية:** مستوى الرصاص بالدم ,التعرض المهني , مدينة الحلة-العراق.

**Introduction**

More industrial workers are exposed to, lead than to any other toxic metals , lead is used widely in variety of industries, over 200 industries counted where lead is used; manufacture and repair of storage batteries , radiator repair, ship building , glass and rubber manufacture, printing, soldering, construction and several others 1.

The greatest source of non occupational exposure to lead is gasoline, the absorption of lead may occur through three ways , inhalation ,ingestion and skin absorption, lead can adversely affect most organs in the body2 Lower levels of lead can cause adverse health effects on the central nervous system, kidney, and blood cells. The World Health Organization (WHO) permitted 40 µg/dl as a higher limit of blood lead level for adults in the general population.3 In 1991, the Center for Disease Control (CDC) lowered the action limit for whole blood lead levels(BLLs) to 35 mcg/dL, as an action limit of blood lead level for adults.4 Recent studies have reinforced the principle that prevention is the treatment of choice for lead poisoning at blood lead levels below 45 ìg/dL5, therefore, determining and controlling lead exposure among the risk workers is very important. Blood lead levels as low as 10 micrograms per deciliter can impair mental and physical development 7,8.

The blood lead level may be increased after occupational exposure especially in developing countries due to absence of personal protective equipments ,lack of education, poor personal hygiene and under nutrition5. Increased lead level in blood can be resulted to various serious diseases including certain types of cancers , the International Agency for Research on Cancer (IARC) classified inorganic lead as a class 2A carcinogen in 2006  **9,10**. Some epidemiological studies showed excess lung cancer mortalities had been associated with abnormally increased blood lead11,12, whereas weak evidence has been found for brain cancer and  with increased dose-response from low to high lead exposure 13,14.

The US Centers for Disease Control and Prevention (CDC) guidelines define elevated blood lead levels as a level ≥10 µg/dL for children.15 However, evidence is now emerging that even levels less than 10 µg/dL can cause neurological damage.16

Some of the more recent studies have used blood lead levels to estimate cumulative lead exposure and17,18 , whereas most have assessed exposure by the use of job-exposure matrices determined by information collected through interviews or questionnaires 19.

The aim of this study is to assess the mean blood lead levels and its association with the following variables ( types of current occupations , duration of services ,body weight , blood pressure **,** age, cigarette smoking ) among- occupationally exposed Iraqi individuals enrolled in different jobs in Hilla city- Babylon province.

**Methods**

A cross-sectional study was conducted on apparently healthy individuals enrolled in small and medium industrial workshops who were occupationally exposed to lead ,all of them are ( male workers in the following private sector occupations ; battery storage repair , radiator repair , car repair , traffic police ) , male teachers who attended the dentistry outpatient clinic who are age matched and not exposed occupationally to lead are studied as comparison group ).All individuals in the studied group were with an age range from 15 to 64 years. All had no history of chronic diseases (diabetes). Duration of the study from mid of January through the end of June 2007.

The exclusion criteria included subjects unwilling to participate in the study, age below 15 or above 65 years, resident outside Hilla city, and individuals who reported chronic diseases. The research protocol was approved by the scientific committees in the Medical College, University of Babylon, and Babylon Health Directorate. Participants informed consents were taken after the nature and objectives of the study had been explained to them before collecting blood samples and answering the pre-tested questionnaire which was designed to obtain information on age, residence, current occupation ,occupational history and cigarette smoking , smokers are currently tobacco smokers or those who quitted smoking within the last six months .

**Measurements**

Blood pressure was measured by the researcher himself to all participants using mercury sphygmomanometer while the individual sitting for ten minutes and they did not use caffeine and cigarettes during the last half hour before blood pressure measurement , the blood pressure was measured twice within 10 minutes the mean of the two readings was used for data analysis. Body mass index; measured according to the formula of weighting(kilogram) divided by the square of height in (meter) :classifying underweight(BMI <18),normal(BMI18-24.5),over weight (BMI 25-29.9)and obese (BMI> 30).

**Blood lead measurement**

Since blood lead estimation is easily affected by contamination suitable precautions were taken to avoid any contamination and a trace-element-free technique was used during the handling and analysis of blood samples.

The blood samples were collected and analyzed by a trained laboratory worker. A sufficient whole blood sample was obtained from a skin-puncture using a finger stick after thorough washing of the hand to avoid contamination. The lateral side of the middle finger was used. A special heparinized capillary tube that allows collecting exactly (50 µl) of whole blood was used. For each test, the exact 50 µl whole blood sample was dispensed from the capillary tube into the treatment reagent tube using special plungers. Analysis was conducted at the Laboratory in Babylon Medical College by the same technician. Blood lead level was measured using Lead Care Blood Testing System and Lead Care Blood Test Kits. This system relies on electrochemistry and a sensor to detect lead in the whole blood where the kit is specific for quantitative measurement of lead in fresh whole blood specimens only. The performance of the Lead Care System was checked on each batch run using appropriate quality control materials, i.e. both high and low known readings lead standards by Lead Care as well. Results obtained on control samples were within the expected range.

**Statistical analysis**

Data were translated into a computerized database structure. Statistical analyses were computer assisted using SPSS, version 17. Chi square test , t test and Analysis of Variance (ANOVA) were used to test the significant of differences P value < 0.05 considered statistically significant .

**Results**

Table (1) gives the baseline characteristics of the study population , their mean age 33.33+10.58 ,the range 15-58 years . The overall BLLs mean is 23.5+16.35 ,the mean and standard deviation of the BMI is 26.33+2.71,the means and standard deviations of systolic and diastolic blood pressures are 134.13+13.44 , 79.52+10,67 respectively, while the mean duration of employments is 10.03years with a mean daily working hours of 7.7 per day .

Figure (1) shows a significant statistical association between increasing BLLs and higher age groups. X2=27.47,df=4 p<001.56.8% of participants in the age group more than 40 years showed BLLs/ more than 25/dL while only 16.1% of individuals in this age group exhibit BLL below 15/dL .Table(2) reveals the variation in the BLLs means of workers in various types of occupations ,radiator repairers have the highest BLL mean36.75± 20.26 followed by the storage battery repairing workers 29.80±16.16 , the car repairers and traffic police men showed approximately the same BLLs means22.75±14.53 and 22.22±15.05 respectively .This table demonstrates the age matching of the study groups which reflects the absence of significant difference (p =0.056) between the means of ages of the study groups (age matched ) .Table (3) reveals the comparison of BLL mean of non exposed group(teachers) who have the lowest BLL mean value13.02±6.89 with the mean values of the occupationally exposed groups, the differences are statistically significant P<0.001. .Table(4) demonstrates a significant high blood lead concentration among cigarette smokers ( t test =3.475, p<0.001).

Figure (2) shows that there is a statistical significant correlations between increasing BLLs values and increasing both systolic and diastolic blood pressures (P<0.05).Figure (3) shows a positive statistically significant association between increasing BLLS and high BMI ( F=5300 df2,P<0.006). Figure (4) reveals a statistically significant relationship between BLL concentrations and the duration of employment p<0.05.

**Discussion**

Despite its numerous uses ,lead has no biologic role in the human body20 , because of this widespread use of lead , it is a major public health concern, especially in developing countries 21 blood lead level determination has presently been accepted as the most reliable biomarker (22). Among all participants in this study the mean BLLs value was 23.5 /dL This value is much higher than the mean BLLs of the general population reported in Duhok-province, Iraq 7.3 /dL which was measured during the year 2011.23 this may be due to the origin of their sample which were taken mainly from rural and suburban regions and the nature of their geographical area as well as the low occupational exposure.

This indicates that occupationally exposed workers in Hilla city are in danger of impending lead toxicity,. this study shows a tendency towards increased BL Ls with higher age, this result agrees with the findings of other local studies which were conducted on occupationally and non occupationally exposed Iraqi adults in Basra and Baghdad provinces24,25,26.

In the current study BLLs of the workers are influenced by their occupational practices and paralleled with the duration of occupational lead exposure ( period of employment). Blood lead concentrations are noticeably higher among workers practicing radiator and battery storage repairing as compared to other groups (Police men , mechanical car repair workers as well as the non exposed control group).

Most of the workers have no idea about the toxic effects of this metal they exposed to; as a result, they pay little attention to protecting themselves from the possible inhalation or ingestion of such toxic substance, nor are they given awareness on the issue or advised to take the necessary protective measures 27 ,Previous studies showed that lack of personal hygiene and education was the prime reasons of high BLLs in those workers 3 .Hygienic practices might therefore be the preferred way to reduce lead exposure at the workplace, especially in developing countries 27. The results obtained in our study are consistent with the results of other studies carried out on the determination of the BLLs of: occupationally and non-occupationally exposed individuals in Nigeria and workers involved in various types of jobs in the United Arab Emirates 28,29.30

Our results reveal that higher BLLs is associated with the duration of exposure in work places , this finding is similar to the findings of other studies 24,31 . The current study shows that tobacco smoking is associated significantly with high BLLs Value , this finding is keeping with the findings of other studies32,33. The precise sources and mechanisms of the observed overexposure of smokers remain controversial. Possible explanations could be the facilitated transportation of airborne lead into the lungs by smoke particles34 or lead intake by more frequent hand-mouth contact 35.

The results of this study indicate a significant lead related increase in systolic and diastolic blood pressure this finding is in consistent with the findings of other researchers who studied non exposed males as well as the occupationally exposed men 36,37 .Researchers have suggested many mechanisms in order to explain the increase of blood pressure after hazardous environmental and occupational exposure to lead, these mechanisms include ; increasing inter cellular calcium due to lead exposure 38,other factors that show the effects of lead on the increase of blood pressure include ,increasing vessel contracting factors such as Endothelin39 and decreasing the responsiveness of the vessel to the beta adrenorecepor agonists40 . Several potential limitations of this study may have affected the analysis. The lack of out door and indoor environmental lead evaluation ,small sample and the lack of occupational health records.

**Conclusion**

The concentration of blood lead of workers engaged in different jobs in Hilla city is high and the workers are in danger of lead toxicity. The BLLs of the workers are influenced by their occupational practices and paralleled with the duration of employment , age , smoking ,BMI. The study results indicate a lead related increase in systolic and diastolic blood pressure. Further large-scale screening is urgently needed to reduce adverse effects of lead exposure.

**Table 1: Baseline characteristics of study variables**

|  |  |  |
| --- | --- | --- |
| **Variable** | **Mean ± SD** | **Range** |
| Age | 32.33± 10.58 | 15-58 |
| Years of work | 10.03± 6.98 | 0-30 |
| Working hours/ day | 7.73±2.53 | 0-22 |
| Height | 172.90±5.00 | 159-185 |
| Weight | 78.89± 10.18 | 59-115 |
| Lead level | 23.50±16.35 | 2.9-67 |
| Systolic blood pressure | 134.32±13.44 | 100-180 |
| Diastolic blood pressure | 79.52±10.67 | 55-110 |
| BMI | 26.33± 2.71 | 20.66-37.13 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Job title** | **N** | **Mean± SD (BLL)** | **Mean± SD**  **(Age)** |
| **Radiator Repair** | 27 | 36.75± 20.26 | 33.85± 12.08 |
| **Car Repair** | 41 | 22.75±14.53 | 31.46±10.89 |
| **Traffic Police** | 46 | 22.22±15.05 | 35.65±9.35 |
| **Teachers** | 40 | 13.02±6.89 | 30.40±9.40 |
| **Battery Repair** | 24 | 29.80±16.16 | 28.95±11.17 |
| **Total** | 178 | 23.50±16.35 | 32.33±10.58 |



***X2*= 27.417, df =4, p value < 0.001\***

**Figure 1: Distribution of BLL by age groups**

**Table 2 : Mean ±SD of BLL and Age according to job title**

**F= 11.848, df= 4, p value = <0.001\***

|  |  |  |  |
| --- | --- | --- | --- |
| **(I) job title** | **(J) job title** | **Mean Difference (I-J)** | **Sig.** |
|
| **Teachers** | radiator repair | -23.73185-\* | 0.000\* |
| car repair | -9.73366-\* | 0.032\* |
| traffic police | -9.20826-\* | 0.042\* |
| battery repair | -16.78833-\* | <0.001\* |

**F= 2.354, df= 4, p value = 0.056**

**eachersTable 3: T comparison with other groups by BLL Mean Differences**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SMOKING** | **N** | **Mean± SD** | **t-test** | **Sig.** |
| **SMOKER** | 81 | 28.02±17. 81 | 3.475 | 0.001\* |
| **NON-SMOKER** | 97 | 19.72± 14.04 |

**Table 4: Mean ±SD of BLL according to smoking**

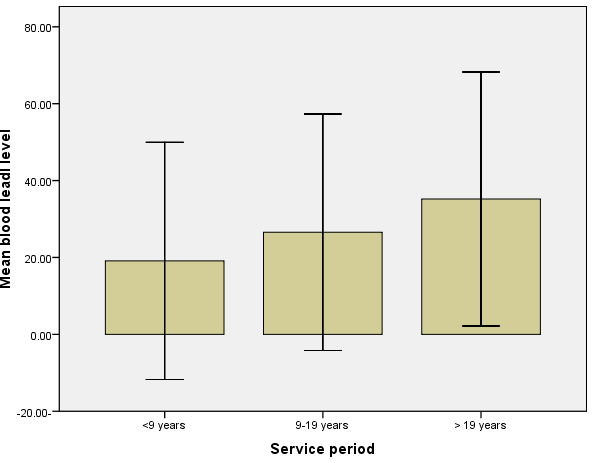


**\*p value < 0.05 is significant**

**F= 6728, df= 2, p value = <0.001\* (Diastolic blood pressure)**

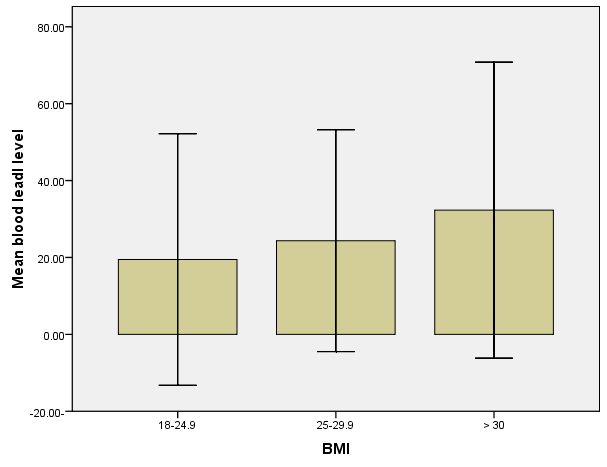
**F= 43.751, df= 2, p value = <0.001\* (Systolic blood pressure)**

**Figure 2: Systolic and Diastolic blood pressure by BLL**



**F= 5300, df= 2, p value = 0.006\***

**Figure 3: Mean ±SD of BLL according to BMI**



**F= 10.716, df= 2, p value < 0.001\***

**Figure 4: Mean ±SD of BLL according to Service Period (year)**

**References**:

Park K. Park’s Textbook of Preventive and Social Medicine; 19th ed. M/S Banarsidas Bhanot, India; 2009:662-3.

Rahim E, Hashemi M, Baghbadorani ZT. Determination of cadmium and lead in human milk. International Environmental Science Technology, 2009; 6 (4): 671-676.

Kumar TK, Chatterjee N. Darbar S. [Occupational lead (Pb) exposure of construction workers engaged in buildings construction of South Kolkata. Journal of Pharmacy Research, 2011; 4(8): 2455-57](http://libhub.sempertool.dk.tiger.sempertool.dk/gmt/ivsl/doaj/09746943_2011_4_8_2455-2457/http:/jpronline.info/article/view/8693/4420).

Nasiri MD, [Golbabaii](http://libhub.sempertool.dk.tiger.sempertool.dk/libhub?func=search&query=au:%22F%20Golbabaii%22&language=en) F,  [Koohpaii](http://libhub.sempertool.dk.tiger.sempertool.dk/libhub?func=search&query=au:%22A.R%20Koohpaii%22&language=en) AR, [Forooshani](http://libhub.sempertool.dk.tiger.sempertool.dk/libhub?func=search&query=au:%22A%20Rahimi%20Forooshani%22&language=en) AR, et al. [Biological and environmental monitoring of lead and exposure in the automobile industry.](http://libhub.sempertool.dk.tiger.sempertool.dk/gmt/ivsl/doaj/17355133_2012_8_4_1-8/http:/ioh.tums.ac.ir/browse.php?a_code=A-10-3-139&slc_lang=en&sid=1)  Iran Occupational Health Journal, 2012; 8 (4):1-9.

Rogan WJ, Dietrich KN, Ware JH, et al. The effect of chelation therapy with succimer on neuropsychological development in children exposed to lead. New England Journal of Medicine, 2001; 344:1421-6.

Wedeen RP. Lead poisoning: the evolving definition. International Journal of Occupational and Environmental Medicine, 2001; 2(1):1-3.

Schnaas L, Rothenberg SJ, Flores MF, Martinez S, Hernandez C, Osorio E, Velasco SR and Perroni E. Reduced intellectual development with prenatal lead exposure. Environmental Health Perspectives, 2006; 114: 791-799.

Ogwuegbu M. and Muhanga W. Investigation of Lead Concentration in the Blood of People in the Copper belt Province of Zambia. Journal of Environment, 2005; 1: 66 – 75.

WHO, Inorganic and Organic Lead Compounds (IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans); 2006: 87 10–17.

Binks K, Doll R, Gillies M, Holroyd C, et al. Mortality experience of male workers at a UK tin smelter. Occupational Medicine; 2005: 55: 215–226.

Jones SR, Atkin P, Holroyd C, Lutman E, et al. Lung cancer mortality at a UK tin smelter. Occupational Medicine; 2007: 57: 238.

Rajaraman P, Stewart PA, Samet JM, Schwartz BS, et al. Lead, genetic susceptibility, and risk of adult brain tumors. Cancer Epidemiology Biomarkers Prevention, 2006; 15: 2514–2520.

Wijngaarden E, Dosemeci M. Brain cancer mortality and potential occupational exposure to lead: Findings from the National Longitudinal Mortality Study, 1979–1989, International Journal of Cancer; 2006:119: 1136–1144.

Centers for Disease Control and Prevention. Preventing Lead Exposure in Young Children: A Housing-Based Approach to Primary Prevention of Lead Poisoning. Atlanta: CDC; 2004.

Gavaghan H. Lead is unsafe at any level. Bulletin of the World Health Organization; 2002: 80:82.

National report on human exposure to environmental chemicals. Centers for Disease Control and Prevention, 2001.

Lundstrom NG, Englyst V, Gerhardsson L, Jin T, et al. Lung cancer development in primary smelter workers: a nested case-referent study. Journal Occupational and Environmental Medicine; 2006: 48: 376–380.

Santibañez M, Vioque J, Alguacil J, Barber X, et al. Occupational exposures and risk of oesophageal cancer by histological type: A case–control study in eastern Spain. Journal Occupational and Environmental Medicine; 2008: 65: 774–781.

Bernard BP, Becker CE. Environmental lead exposure and the kidney. Journal of Toxicology- Clinical Toxicology; 1988: 26: 1-34.

Mhrdad R, Mysemi AP, Bahaedini LS, Haghighi KS. The relationship between blood pressure and lead exposure in battery recycling workers. Journal of Bioscience; 2011:11(7):454-58.

Barbosa JF, Tanus-Santos JE, Gerlach RF, Parsons PJ. A Critical Review of Biomarkers Used for Monitoring Human Exposure to Lead: Advantages, Limitations, and Future Needs. Environmental Health Perspectives; 2005: 113(12):1669-1674.

Al-Dosky AH, Al-Timimi DJ, Al- Dabbag SA. Lead exposure among the general population of Duhok governorate, Kurdistan region, Iraq. Eastern Mediterranean Health Journal; 2012:18(9).

Al-Rudainy LA. Blood Lead Level among Fuel Station Workers. Oman Medical Journal; 2010: 25(3):208-211.

Alanee SA. Blood Lead Levels in Non-occupationally Exposed Individuals Contacting the Specialized Surgeries Hospital in 2008. Tikrit Medical Journal; 2011, 17(2): 17-21.

Al-Dosky AH, Al-Timimi DJ, Al-Dabbagh SA. Occupational exposure to lead in Duhok city, Kurdistan region, Iraq. Duhok Medical Journal; 2011: 5(2):76–85.

Ahmed K, Engidawork AG. Lead exposure study among workers in lead acid battery repair units of transport service enterprises, Addis Ababa, Ethiopia: a cross-sectional study. Journal of Occupational Medicine and Toxicology; 2008: 3:30.

Berner A, Almehdi AM, Alwash R, Al-Neamy. FRM: A pilot survey of blood lead levels in various types of workers in the United Arab Emirates. Environmental International; 2001: 27:311-314.

Fatoki OS, Ayoade D: Leady assay in blood of occupationally and non-occupationally exposed. International Journal Environmental Health Research; 1996: 6(3):195-200.

Adela Y, Ambelu A, Tessema DA. Occupational lead exposure among automotive garage workers – a case study for Jimma town, Ethiopia. Journal of Occupational Medicine and Toxicology; 2012: 7:1531.

Mason H, Williams N. The decay of blood lead levels in workers suspended under the control of lead at work regulations. Occupational Medicine; 2005: 55(5):371-374.

Falq G, Zoghnoun A, Pascal M, Vemay N, et al. Blood lead levels in the adult population living in France. The French Nutrition and Health Survey (ENNS 2006–2007). [Environment International](http://www.sciencedirect.com.tiger.sempertool.dk/science/journal/01604120);2011: 37(3): 565–571.

Stoleski S, Stikova E, Bistimovska JK, Mijakoski D. Biological Monitoring Among Workers Exposed to InorganicLead and Its Compounds. Macedonian Journal of Medical Sciences; 2011: 4(4):428-436.

Wietlisbach V, Rickenbach M, Berode M, GuilleminM. Time trend and determinants of blood lead levels in a Swiss population over a transition period (1984–1993) from leaded to unleaded gasoline use. Environmental Research; 1995: 68: 82–90.

Weyermann M, Brenner H. Alcohol consumption and smoking habits as determinants of blood lead levels in a national population sample from Germany. Archive of Environmental Health: 1997: 57: 233–239.

Bakhtiarian A, Dizaji R, Mohaghegh A, Khansari FI, et al. The study of blood leads concentration in hypertensive and normotensive adults in Tehran's hospitals. Journal of Medical Science; 2006: 5(1):103-107.

Telisman S, Jurasovic PA, Givtkovic p. Blood pressure in relation to biomarkers of lead, Cadmium, Copper, Zinc , and Selenium in men without exposure to metal. Environmental Research; 2001: 87: 57-68.

Piccinini F, Favalli L. Experimental investigations on the contraction induced by lead in arterial smooth muscle. Toxicology; 1997: 8:43-51.

Gonick HC, Ding Y. Lead induced hypertension. Hypertension;, 1997: 30: 1487-92.

Tsao DA, Yu HS. The change of B-adrenergic system in lead induced hypertension. Toxicology; 2000: 164:127-133.