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LEAD EXPOSURE IN CHILDREN LIVING AROUND THE AUTOMOBILE AND BATTERY REPAIR WORKSHOPS

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ABSTRACT

The aim of this study was to screen children 1-12 years of age for lead exposure living around automobile and battery repair workshops. A total of 190 children living in one kilometer areas around the automobile and battery repair workshops were selected from houses and schools. These were divided into two groups: group A comprised of the children living around the automobile repair workshops and group B comprised of the children living around the battery repair workshops. Among the 190 children, 115 (60.5%) were males and 75 (39.5%) were females. The mean age of the children was 8.7 years. Majority of the children was less than 4 years of age (55.8%). The blood lead levels were between the range of 1.3 - 34.2 µg/dl (mean 11.4 µg/dl). Children living around the battery repair workshops (mean ± SD 12.85 ± 6.02) had high blood lead levels (p 0.020) as compared to the children living around the automobile repair workshops (mean ± SD 10.19 ± 6.13). There was a significant negative correlation of blood lead levels and haemoglobin (r = - 0.400 and p 0.001). Children living around automobile and battery repair workshops had significantly high blood lead levels according to WHO and CDC criteria. Blood lead level (BLL) is a good screening and diagnostic test for the assessment of lead exposure in children living in lead contaminated high risk areas.

Key words: *Blood lead levels, Automobile repair workshops, battery repair workshops.*

INTRODUCTION

Lead poisoning also known as Plumbism is a significant public health problem world wide and is one of the greatest environmental threats to children. Children living around the automobile and battery repair workshops are continuously exposed to the lead. The lead concentration in whole blood is commonly used to monitor exposure to lead in the children. According to World Health Organization (WHO) and Centre for Disease and Control (CDC), blood lead level (BLL) of more than 10µg/dl is an indicator of significant lead exposure in children.[1,7,10-13,23,21,25,26,29] The manufacturing and repair of lead batteries and automobile repair workshops are among the most common sources of occupational lead exposure. Lead batteries are widely used in automobiles, forklifts, golf carts, backup power in the computer, solar and telecommunication Industries. Inefficient production and recycling operations release a big amount of lead into the environment. During the repairing and recycling of the batteries, lead is melted and resulting fumes are released in the air and also remaining lead is thrown into the open ground which is a big source of lead exposure[6'18]. Similarly lead is also released in the surrounding environment by the automobile repairing of the engine parts and radiators repair works[16]. Lead and its compounds may enter the environment from these industrial and occupational sources and may contaminate the drinking water, air, dust and food. The workers of these occupations take lead to their homes as lead may cling to their cloths, hair and other parts of the body.[2,4,15] Children who are repeatedly exposed to environment containing lead as they are living in closed vicinity of automobile repair workshops and battery manufacturing and recycling shops[19]. These children are more at risk of lead poisoning by inhaling the contaminated air, drinking the lead contaminated water and while playing on this lead contaminated soil. Young children are more vulnerable to lead toxicity as they absorb more lead as compared to adults[19]. Prolonged exposure to lead insidiously affects the different organs and systems in the body resulting in hematopoietic, cardiovascular, hepatic, renal and neurological dysfunctions with biochemical changes in the body. Lead exposure is negatively correlated with haemoglobin and RBC count.[14,27] The kidneys are particularly susceptible to toxic effects of lead and may result in nephropathy, proximal tubular damage, glomerular sclerosis, interstitial fibrosis and lowered glomerular filtration rate [3'17]. Effects on cardiovascular system including hypertension, coronary heart disease, stroke, and peripheral arterial disease were also reported.[20,22] Exposure to lead has revealed mixed pattern of serum liver enzymes depending on BLL. However, many researchers reported the lead associated liver injury in occupational workers with raised alanine aminotransferase (ALT), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) activity.[2,9] Prevention of adverse health effects induced by occupational exposure to lead depends on the capability to detect the changes at an early stage when these are still reversible. Lead toxicity is a persistent health problem for children living around the automobile and battery repair workshops in developing countries including Pakistan. Little is known about the body lead status and adverse health effects in our lead exposed children. Blood lead level (BLL) is considered as a screening and diagnostic test for accurate assessment of lead exposure in children living in lead contaminated high risk areas. Fortunately lead poisoning is a preventable and treatable disease. By taking some precautionary measure this disease can be eradicated. Thus this study was planned to find out the frequencies of increased BLL in children. We also measured the effect of increased blood lead levels on hematological parameters and liver functions in children living around the automobile and battery repair workshops.

MATERIALS AND METHODS

This cross sectional study was carried out in high risk lead contaminated areas containing lot of automobile and battery repair workshops and these workshops were continuously contaminating the soil, water and surrounding air with lead. A total of 190 children of both male and female sexes ranging from 1-12 years of age were included in this study. Children living in one kilometer areas around the automobile and battery repair workshops were randomly selected from houses and schools. These were divided into two groups: group A comprised of children living around the automobile repair workshops and group B comprised of the children living around the battery repair workshops. Before taking the blood samples from children, all the parents of the children gave their consent in writing on the form. Five ml blood was obtained by veinpuncture and equally divided into two tubes. The first 2.5 ml sample was transferred in a vacutainer containing EDTA K_3 anticoagulant for blood lead determination and complete blood counts (CBC). The remaining 2.5 ml blood sample was transferred in serum separating tube (SST).

Blood lead was analysed by using Metexchange Reagent kit manufactured by ESA Magellan Biosciences with the help of Anodic Stripping Voltammetry (ASV) 3010B ESA Lead Analyzer (Bannon and Chisolm, 2001). Complete blood count was estimated by Sysmex XS-1000i haematology analyzer (Japan). Plasma ALT was determined according to IFCC method by using ALT kit, manufactured by Pioneer diagnostic USA on Metrolab 2300 Chemistry Analyzer.

Data Analysis

The data was analysed by using standard SPSS software version-16.0. Mean ± SD is given for the quantitative variables and Frequencies and percentages are given for qualitative variables. Two- independent sample *t* test was applied to observe group mean differences. Pearson correlation was applied to observe correlation between quantitative variables. Pearson chi-square was applied to observe associations between qualitative variables. A *p*-value of <0.05 was considered as statistically significant.

RESULTS

There were 62 (39.5%) children in group A and 128 (60.5%) in group B. There were 115(60.5%) males and 75 (39.5%) females. The majority of the children included in this study were less than 4 years of age that was 55.8% of total subjects, 24.7% ranged between 4-8 years and 17.5% children were between 8-12 years of age.

The children living around automobile and battery repair workshops had significantly high blood lead levels mean 11.4 µg/dl (1.3 - 34.2 µg/dl). Among the 190 children, 98 (51.6%) had blood lead levels more than the CDC and WHO recommended levels (> 10 µg/dl). Among the 98 children with high BLL, 61 (32.1%) children had BLL between 10 and 15 µg/dl, 24 (12.6%) children had between 15 and 20 µg/dl and 13 (6.8%) had BLL more than 20 µg/dl indicating severe lead poisoning (Fig. 1).

Children living in close vacinity of the battery repair workshops (mean ± SD 12.85 ± 6.02) had high blood lead levels ($p < 0.020$) as compared to the children living around the automobile repair workshops (mean ± SD 10.19 ± 6.13) (Table 1). Male children had raised blood lead levels as compared to the female children the same area $p < 0.008$ and < 0.001 for the children living around the battery repair workshops and living around the automobile repair workshops respectively (Fig.3).

Young children exposed to lead had significantly raised blood lead levels as compared to the elder children Mean ± SD of blood lead level in children younger than 4 years of age was 10.9 ± 5.3. Children between the ages of 4-8 years had Mean ± SD of the blood lead level 13.1 ± 6.7. Mean ± SD of lead in children elder than 8 years was 10.7 ± 6.9 (Fig 2). We observed significant negative correlation of blood lead levels (BLL) and hemoglobin r -= -0.400 and p<0.00 (Fig. 4).

Table 1: *Comparison of Blood Lead levels & Hematological parameters of children living around the Automobile and Battery repair workshops (n=190)*

Parameters	Group A Mean ± SD	Group B Mean ± SD	*p* – Value
Hemoglobin (g/dl)	12.78 ± 1.16	12.2 ±.94	0.039
WBC × $10^3/\mu l$	8.34 ± 1.82	8.80± 2.11	0.095
RBC × $10^6/\mu l$	4.89 ± .69	4.77 ± .48	0.170
Hct (%)	41.97 ± 5.93	36.75 ±3.27	>0.001
MCV (fL)	85.37± 11.3	77.06 ± 7.63	0.004
MCH (pg)	27.76 ± 7.39	26.37 ±5.51	0.576
MCHC (g/dL)	31.19± 2.19	33.42 ± 1.25	>0.001
Platelets × $10^3/\mu l$	304.15 ± 76.9	350.87 ± 85.92	0.711
Lead (µg/dl)	10.19 ± 6.72	12.03 ± 6.02	0.020

Table 2: *Association of blood lead level in children living around the automobile and battery repair workshops.*

Lead Groups (µg/dl)	Total N = 190 %	Group A N = 62 %	Group B N = 128 %
1 – 10	92 (48.4%)	41 (66.1%)	51 (39.8%)
10.1 – 15	61 (32.1%)	11 (17.7%)	50 (39.1%)
15.1 – 20	24 (12.6%)	7 (11.3%)	17 (13.3%)
> 20	13 (6.8%)	3 (4.8%)	10 (7.8%)
Pearson Chi-square = 12.5			*p* = 0.006

DISCUSSION

Lead is one of the oldest known toxic metals for man and is ubiquitous in industrial environment. Among most common sources of occupational lead exposure are the manufacturing and repair of lead batteries and automobile repair workshops. Lead and its compounds can enter the environment from these industrial and occupational sources and may contaminate the drinking water, air, dust and food. Elevated blood lead levels in children living around automobile and battery repair workshops have been documented in many countries.[6,16,18]

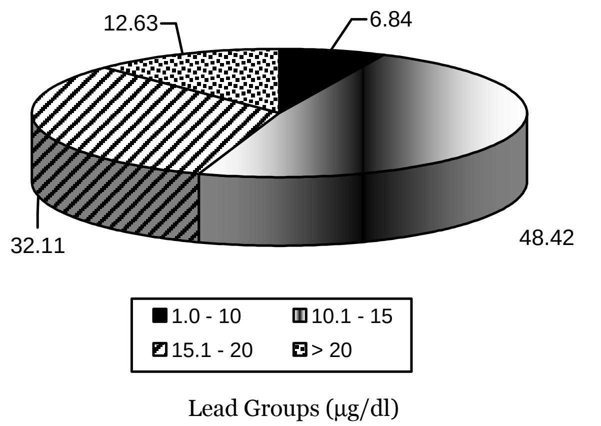


Fig. 1: *Frequency distribution of blood lead level in lead exposed children (n = 190).*

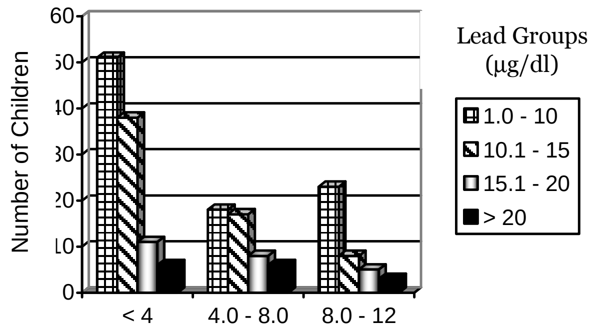


Fig. 2: *Figure 2: Bar chart of blood lead levels in different age groups.*

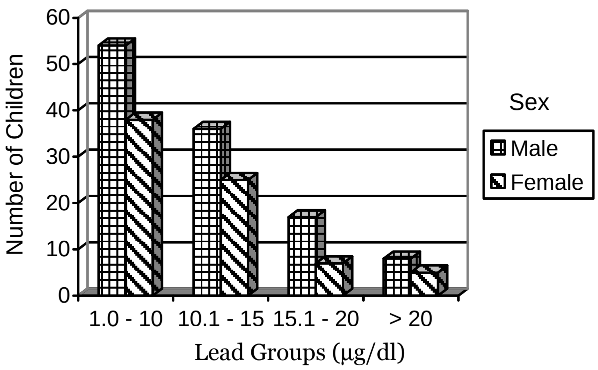
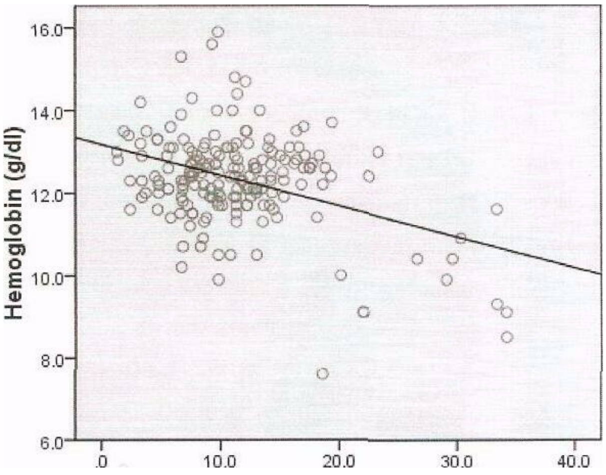


Fig. 3: *Bar chart of blood lead levels in sex groups.*



lead (µg/dl)

Fig. 4: *Scattered plots of blood lead level and hemoglobin.*

The children living around automobile and battery repair workshops had significantly high blood lead levels ranging between 1.3 - 34.2 µg/dl with a mean level of 11.4 µg/dl. High blood lead levels in these children could be due to the inhalation of lead contaminated air and drinking of lead contaminated water. The parents of these children were working in these workshops and were taking lead to their homes. The children predominantly were from families with low socioeconomic status and had poor hygienic and household facilities. Elevated blood lead levels in children living around automobile and battery repair workshops have been documented in many countries.[6,16,18]

We observed that children living around the battery repair workshops had high blood lead levels as compared to the children living around the automobile repair workshops ($p < 0.020$) and Mean ± SD was 10.19 ± 6.13 and 12.85 ± 6.02 respectively for battery repair workshops and automobile repair workshops.

In our study, at both the settings i.e. near automobile and battery repair workshops, boys were at greater risk of lead poisoning than girls. The mean blood lead level was consistently low for girls than mean level among the boys living in the same area. In boys and girls living around the automobile repair workshops the mean blood lead levels were 10.5 µg/dl and 8.4 µg/dl respectively. Similarly the mean blood lead levels in boys and girls living around battery repair workshops were 13.4 µg/dl and 10.6 µg/dl respectively. This gender difference was also found in BLL screening among children living in Russia and United State.[8,24]. Young children are more vulnerable to lead toxicity as compared to the adults. Because they absorb more lead as compared to the adults due to "hand to mouth habit" and take lead in their mouths from contaminated sources.[19]

Haematological system is one of the most sensitive targets for lead toxicity and our study results supported this view. Similar findings were reported in many previous studies.[14] Lead causes anemia by inhibiting heme and globin synthesis.[5,23,28] We observed significant negative correlation of blood lead levels (BLL) and haemoglobin (mg/ld) $r = -0.400$ and $p < 0.00$ showing that as lead level increases haemoglobin decreases or as lead level decreases, haemoglobin increases.

It is **concluded** that children living around automobile and battery repair workshops had significantly high blood lead levels. Blood lead level (BLL) is a good screening and diagnostic test for accurate assessment of lead exposure in children living in lead contaminated high risk areas.

Increased lead body burden causes impairment of multiple body functions including haematological and hepatic dysfunction in children living around the automobile and battery repair workshops. Elevated blood lead levels are negatively correlated with haemoglobin levels in lead exposed children.

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REFERENCES

1. Alan H. Stern. Derivation of a Target Level of Lead in Soil at Residential Sites Corresponding to a De Minimis Contribution to Blood Lead Concentration. Risk Analysis. 1994; 14 (6): 1049-1056.
2. Al-Neamy, Almehdi, Alwash, R. Pasha, Ibrahim A, Bener A. Occupational lead exposure and amino acid profiles and liver function tests in industrial workers. Int. J. Environ. Health. Res. 2001; 11 (2): 181-8.
3. Bravo Y, Quiroz Y, Ferrebuz A, Vaziri N D, Rodriguez-Iturbe B. Mycophenolate mofetil administration reduces renal inflammation, oxidative stress, and arterial pressure in rats with lead-induced hypertension. Am. J. Renal. Physiol. 2007; 293 (2): 616-23.
4. C. Aguilar-Garduno, M. Lacasana, M.M. Tellez-Rojo, G. Aguilar-Madrid, L.H. Sanin-Aguirre, I. Romieu, M. Hernandez-Avila. Indirect lead exposure among children of radiator repair workers. Am. J. Industr. Med. 2003; 43 (6): 662-667.
5. C. Jin, Y. Li, Y.L. Li, Y. Zou, G.L. Zhang, M. Normura, G.Y. Zhu. Blood lead: Its effect on trace element levels and iron structure in hemoglobin. Nucl. Instr. and Meth. 2008; 266: 3607-3613.
6. Carlos Morales Bonilla and Evelyn A. Mauss. A Community-Initiated study of blood lead levels of Nicaraguan Children Living Near a Battery Factory. Am J Public Health. 1998; 88: 1843-1845.
7. Centers for Disease Control and Prevention. Prevent-

ing Lead Poisoning in Young Children: A Statement by the Centers for Disease Control, October 1991. Atlanta, GA: US Dept of Health and Human Services; 1991.
8. Counter SA, Buchanan LH, Ortega F. Gender differences in blood lead and hemoglobin levels in Andean adults with chronic lead exposure. Int J Occup Environ Health. 2001; 7 (2): 113-118.
9. Dioka, Oresakwe, Adeniyi.and Meludu. Liver and renal function tests in artisans occupationally exposed to lead in mechanic village in Nnewi, Nigeria. Int. J. Environ. Res. Pub. Health. 2004; 1: 21-25.
10. Helen J. Binns, Caria Campbell, Mary Jean Brown. Interpreting and Managing Blood Lead Levels of Less Than 10 µg/dL in Children and Reducing Childhood Exposure to Lead: Recommendations of the Centers for Disease Control and Prevention Advisory Committee on Childhood Lead Poisoning Prevention. Pediatrics.2007; 120 (5): 1285-1298.
11. Jennifer Reenan. Diagnosing Pediatric Lead Toxicity. Virtual Mentor AMA. 2005; 7 (12).
12. Jill Manahan, Christina Brockman, Scott E. Woods. Lead Poisoning in Children Still a Serious Risk. Resident & Staff Physician .2006; 52 (10).
13. John F Rosen. Adverse health effects of lead at low exposure levels: trends in the management of childhood lead poisoning. Toxicology 1995; 97 (1-3): 11-17.
14. Karita K, Yano E, Dakeishi M, Iwata T, Murata K. Benchmark dose of lead inducing anemia at the workplace. Risk Analysis. 2005; 25 (4): 957-62.
15. Khwaja MA. Environmental health: lead exposure and its impacts on children. SDPI Res News Bull 2003: 1-3.
16. Leibovitch S, Geva T, Mordel A, Tirosh M, Sack J. Lead poisoning in two families from a car battery workshop. Harefuah. 1989; 116 (2): 96-8.
17. Loghman-Adham, M. Renal effects of environmental and occupational lead exposure. Environ. Health Perspect. 1997; 105: 928-39.
18. Marie Vahter, S. Alien Counter, Goran Laurell, Leo H. Buchanan, FernandoOrtega, Andrejs Schtitz, Staffan Skerfving. Extensive lead exposure in children living in an area with production of lead-glazed tiles in the Ecuadorian Andes. Int Arch Occup Environ Health 1997; 70: 282-286.
19. Mary Jo Trepka-Using Surveillance Data to Develop and Disseminate Local Childhood Lead Poisoning Screening Recommendations: Miami—Dade County's Experience. AJPH2005; 95 (4): 556-558.
20. Menke A, Muntner P, Batuman V, Silbergeld E.K, Guallar E. Blood lead below 0.48 micromol/L (10 microg/dL) and mortality among US adults. Circulation. 2006; 114: 1388-94.
21. Morri Markowitz. Lead Poisoning. Pediatrics. 2000; 21: 327-335.
22. Navas-Acien A, Guallar E, Silbergeld E.K, Rothenberg, S.J. Lead exposure and cardiovascular disease-a systematic review. Environ. Health Perspect. 2007; 15: 472-82.
23. Nitin B. Jain, Francine Laden, Ulrich Guller, Anoop Shankar, Shamsah Kazani. Eric Garshick. Relation bet-ween Blood Lead Levels and Childhood Anemia in India. Am J Epidemiol. 2005; 161 (10): 968-973.
24. Pirkle JL, Kaufmann RB, Brody DJ, Hickman T, Gunter EW, Paschal DC. Exposure of the U.S. population to lead, 1991-1994. Environ Health Perspect. 1998; 106: 745-750.
25. Richard L. Canfield, Charles R. Henderson, Deborah A. Cory-Slechta, Christopher Cox, Todd A. Jusko, Bruce P. Lanphear. Intellectual Impairment in Children with Blood Lead Concentrations below 10 µg per Deciliter. N Engi J Med 2003; 348 (16): 1517-1526.
26. Shantanu Rastogi, Irina Kats, Malka Messner, Sushma Nakra, Warren Seigel. Lead Toxicity in Pregnancy and Newborns: A Case Report. Journal of Children's Health 2003; 1 (3): 355-360.
27. Stoleski S, Karadzinska-Bislimovska J, Stikova E, Risteska-Kuc S, Mijakoski D, Minov, J. Adverse effects in workers exposed to inorganic lead. Arch. Hig. Rada. Toksikol. 2008; 59 (1): 19-29.
28. WHO (World Health Organization) (1995), Environmental Health Criteria 165: Inorganic Lead, United Nations Environment Programme, International Lab-our Organization, and WHO, Geneva.
29. Zaki M, El-Shazly M, Abdel-Fattah K, El-Said, F. Curtale. Lead toxicity among working children and adolescents in Alexandria, Egypt. Eastern Mediterranean Health Journal 1998; 4 (3): 520-529.