ORIGINAL ARTICLES

ESTIMATION OF BLOOD LEAD LEVELS BY ATOMIC ABSORBANCE SPECTROMETRY IN BATTERY WORKERS IN PAKISTAN

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ABSTRACT

Objective: To estimate blood lead levels (BLL) by atomic absorbance spectrometry in small scale local battery workers in Pakistan.

Study Design: Comparative cross sectional study.

Place and Duration of Study: Department of Chemical Pathology & Endocrinology, Armed Forces Institute of Pathology, Rawalpindi, from Feb 2017 to Apr 2018.

Methodology: We measured blood lead levels of 100 male workers from local battery dealing workshops (minimum exposure of 10 years) on atomic absorption spectrometry and compared with that of 100 healthy non-exposed controls living at least 30 km away from the industrial area. Independent sample t-test and chi-square were used to test the significance mean difference and association, respectively.

Results: Blood lead levels in exposed and unexposed group were 38.31 ± 3.78 and 1.84 ± 0.085 µg/L respectively. 22 (22%) workers had blood lead levels >100 µg/L and 78 (78%) had <100 µg/L which were statistically significant. In group with high BLL, 5 (22.7%) had exposure of up to 10 years while 17 (77.3%) had more than 10 years showing significant association with duration of exposure. Health problems included infertility 5 (5%), hypertension 10 (10%), gastric problems 11 (11%), confusion and headache 18 (18%), with no significant association with lead levels (p=0.306).

Conclusion: Workers involved in various processes of battery handling in local shops have elevated blood lead levels and subsequent health issues, thus necessitating improvement in health awareness in both industrial and small scale employees.

Keywords: Atomic absorption spectrometry, Blood lead levels Hypertension, Infertility.

INTRODUCTION

Lead is considered an intense poison and its toxicological appearances are notable. Exposure to lead from any of source like ingestion, Inhalation or dermal contact has been known to cause significant toxicity worldwide. Ventures traditionally connected with lead business are producing it by various means while doing purifying tasks in lead heaters, battery repairing, radiator repairing, manufacture of glass, ammo manufacturing plants, printing, preparing of ceramics products for use in homes and development work including annihilation and redesign. Intense mortality was identified with lead related introduction is very abnormal while unending poisonous quality is considerably more typical. Presentation to Lead produces malicious impacts on the hematopoietic, renal, regenerative, and focal sensory system, for the most part through expanded oxidative stress[1].

Human presentation to lead happens through different sources like leaded fuel, mechanical procedures, for example, lead purifying and coal burning, toxic paints, lead containing funnels, and essentially, battery reusing/ planning. Comprehensive information regarding production, exposure and health effects of this toxic metal is accessible. High frequency of lead danger has been accounted in lead-corrosive battery laborers in Jamaica[2], battery Recyclers in Philippines[3], battery manufacturing workers in India[4] and lead smelters in South Korea[5] and china[6].

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Blood lead levels remain the predominant biological marker used in clinical assessment, workplace monitoring, public health surveillance and regulatory authority decisions regarding removal from exposure, though a variety of other indirect markers (Free Erythrocyte protoporphyrin or Zinc Protoporphyrin, erythrocyte pyrimidine 5'-nucleotidase, Urinary ALA) are also available and have been reported from time to time[7].

Though a few local studies are available on health effects of occupational lead exposure[8], but data specifically regarding battery workers is sparse. Qasim *et al.* have reported two cases of occupational lead toxicity in adult battery workers, who were recognized, based on lead levels and were successfully treated[9]. Mohammadi *et al*. Reported a case of occupational lead poisoning in an adult battery worker who was treated for the same[10].

In developed nations because of better diagnosis and change in modern well being techniques, lead introduction has been altogether lessened. Be that as it may, in developing nations lead danger is a tenacious medical issue for laborers. The information produced from this examination would help instruct the faculty engaged with battery assembling to receive individual defensive measures and hence forth shield them from this all around perceived danger. There was a need to survey level of lead presentation in workers, who are associated with assembling of battery in our setup, as there are couple of nearby reports about metal which is source of health hazard as a whole and particular in this group. Additionally, exposed individuals often present with non-specific symptoms of lead toxicity which sometimes go unrecognized. When identified by elevated lead levels, they can be treated successfully with lead chelators.

METHODOLOGY

This comparative cross sectional study was conducted at Armed forces Institute of Pathology, Rawalpindi, over a period of one year, after approval from Institutional Review Board of AFIP, Rawalpindi. A total of 100 male battery workers (exposed individuals) were included in this study, along with equal number of age and gender matched individuals. Sample size was estimated by WHO Calculator for cross sectional study with prevalence of lead levels toxicity in adults. Required data was collected with the help of a detailed questionnaire after taking informed consent. Questionnaire included different demographic variables (age, residence, education level, working area, nature of job, urban and rural) while exposure of lead and health related outcomes due to lead toxicity included in questionnaire. Adult male workers from local battery manufacturing workshops were included in the study having exposure of 10 to 35 year duration. They were involved in different steps of manufacturing and processing like collection and transport to recycling facility, separation of component parts of batteries, smelting and refining of lead components, purification and treatment of sulfuric acid electrolyte and waste/ disposal management of batteries. Individuals with history of any chronic illness, like chronic renal impairment, diabetes mellitus, anemia due to iron deficiency or Thalassemia trait and those who have had zinc supplementation in the last six months were excluded. Healthy individuals living at least 30 km away from the industrial area were recruited randomly as unexposed group. Sampling technique used was simple random sampling which is on the basis of toss and coin method. 5ml venous blood samples were collected in EDTA tubes for Blood Lead levels. Blood lead level analyzed by Atomic absorption spectroscopy which is based on the principle that matter absorbs the light at same wave length it emits. In this technique 95% atoms absorb same radiation in ground state as they emit in excited state by using specific hollow cathode lamp for lead. For blood lead analysis, whole blood of 500 µL was pipetted out in the digestion tube, was incubated at 150°C for 45 minutes in thermosreactor after adding 1000 µL of nitric acid. The sample remaining in the tube was reconstituted with ultrapure water HPLC grade water to make volume of upto 5ml. The 0.45 micron syringe was used to filter the residues, the filtrate of 1 ml was taken to the instrument for analysis. The samples were run on Agilent 200 Atomic Absorption spectrophotometer using graphite tube atomizer. Graphite tube was heated electrically at temperature upto 3000°C to vaporize and atomize the analyte before its detection. The entire sample was atomized and a dense atom population was produced. Calculations were made against a 5-point calibration curve made from serial dilutions of the standard stock solution. Internal; quality control material provided by Recipe (whole blood metal lyophilized control level 1 and level 2). For validation of result internal standard has been used for composition, and internal quality control values were plotted on Levey-Jennings control chart.

Table-I: Descriptive stastics of quantitave variables (n=100).

Variables	Exposed group	Unexposed group	*p*-value
	Mean ± SD	Mean ± SD	(<0.05)
Age (Year)	34.0 ± 9.1	37.2 ± 8.23	0.0098
Blood lead level	38.9 ± 3.78	1.84 ± 0.85	<0.001
Duration of exposure (year)	15.81 ± 7.45	N/A	

Note: N/A=There were no exposure.

Table-II: Comparison of mean Lead levels among exposed battery workers.

Blood Lead Levels (µg/L)	n	Mean	t-test	*p*-value
<100	78	20.23	-20.98	<0.001
>100	22	102.43		

Table-II: Association of blood lead levels withmean duration of exposure in battery workers (n=100).

Year	Lead Category		Total	X^2 value	*p*-value
	Normal	Abnormal			
≤10	39 (50%)	5 (22.7%)	44	5.1	0.023
>10	39 (50%)	17 (77.3%)	56		

Statistical Analyses was done by stastical software SPSS version 24, Mean and standard deviation were calculated for quantitative parametric variables while frequency and percentage computed for qualitative variables. Independent sample t-test was used to test the significance mean difference considered as *p*-value <0.05 as significant between two groups and chi square was applied to test the association.

RESULTS

Mean age of exposed and unexposed group was 34 ± 9.1 years and 37.2 ± 8.2 years respectively. Mean lead level was 38.31 ± 3.78 µg/L and 1.84 ± 0.085 µg/L in exposed and unexposed group respectively. Mean duration of exposure in battery workers was 15.81 ± 7.45 (table-I). Keeping 100 µg/L as cutoff (WHO defined), 22 (22%) of the exposed group had higher while 78 (78%) had lower BLL, with statistically significant difference between the two groups (table-II)[13]. Moreover, we found that 22% of cases in the exposed group had lead levels >100ug/l, where as none had such levels in the unexposed group

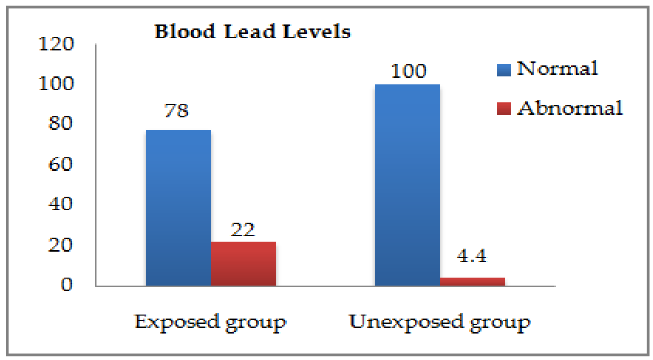

Figure: Frequency of blood lead levels in Exposed (>100 µg/L) and Unexposed group (<100 µg/L).

(fig-1). Out of the 22 cases who had high lead levels (>100 µg/L), 5 (22.7%) had exposure of upto 10 years while 17 (77.3%) had exposure of more than 10 years and the lead levels were statistically significant (*p*=0.023), showing strong association of lead levels with duration of exposure (table-III). A total of 7 individuals (7%) of exposed group were found to be using personal protective gear while handling batteries.

Various health problems identified in exposed group included infertility 5 (5%), hypertension 10 (10%), gastric problems 11 (11%), confusion and headache 18 (18%), but no significant association was seen between health problems and blood lead levels (*p*=0.306).

DISCUSSION

Occupational Lead exposure is not uncommon worldwide, but a very few researchers have actually attempted to assess the situation in our particular setup[3]. Whereas the studies available have assessed the situation in known Industrial areas, we selected a group of individuals from various small local battery dealing shops. Adverse health levels were assessed by history and clinical examination. Lead is produced by many sources like industry, water pipes etc. About fifteen percent of the individuals, working in industrial area had blood lead level above the recommended limits of occupational safety and health administration (OSHA) and require periodic medical examination. This study shows exposure of lead and lead levels in subjects who are exposed to lead while involved in battery manufacturing. A local study conducted by Dilshad *et al* in industrial setup in Waah Cantt district Rawalpindi[7,8,12], whereby exposed workers had significantly higher lead levels much similar to our study.

Blood lead levels are analyzed by different method like atomic absorption spectrometry (AAS), flame emission and stripping voltammetry method, inductively coupled plasma mass spectrometry (ICP/AES). We utilized the time tested sensitive method of graphite furnace AAS[7,14].

Most of the studies available in literature correspond with our results. Khan *et al* carried out blood lead level analysis in industrial workers and found that elevated lead levels are associated not only with many health effects but also increased oxidative stress[11-15]. In another cross-sectional study, which was carried out by Khan *et al* which revealed that 26% of workers, working in radiator repair industry had raised blood lead levels (>250 Pg/L) which correlate with the Monitoring of blood lead level in current study. Furthermore chronic exposure to lead leads to lethal effects on various body systems like central nervous system, gastrointestinal, cardiovascular, hematologic, renal, reproductive and hepatic organs. These disorders can be treated by avoiding exposure or using chelates but some disorder may not be treated[16,17]. An interesting finding in our study was the lack of significant association between the BLL and the presence of various health problems. This is in contrast to the findings by Basit *et al*[12] who found that lead acid battery workers had higher mean BLL than those who did not had such illnesses. Most of the exposed cases were identified with health problems like infertility, hypertension, gastric problems and headache[18]. Because these symptoms may occur slowly or may be caused by other things, or the patients may have blood lead levels which are not very high, chronic lead poisoning can be easily overlooked. Our finding is supported in literature as symptoms may appear at different ranges depending on the individual's characteristics[9,13,18].

Efforts are required to teach outworkers who are exposed to lead, and health care providers about medical screening, medical surveillance and importance of primary prevention of lead poisoning. Current study was conducted with small sample size and comparative cross-sectional study desgin due to lack of funding resources and shortage of time but it gives an important overview of blood lead levels in exposed population and highlightened the importance of exposed industry worker and higher blood lead levels which can further cause chronic health problems. Further advance studies should be conducted in order to determine the adverse effects of accumulated lead in these workers.

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RECOMMENDATION

Current study will go a long way in modifying the attitude and practices in our occupational workers. We strongly recommend that steps should be taken to improve the level of health awareness among the occupational workers to help reduce mortality and morbidity of workers.

CONCLUSION

There was an increased lead level in occupational worker who has lead exposure as compared to those who have no exposure. This study also emphasized the health related events are associated with the raised blood lead levels.

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CONFLICT OF INTEREST

There is no conflict of interest to be declared by any author.

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