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Relation between Blood Lead Levels and Anemia in lead-exposed battery workers of Lucknow City

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ABSTRACT

Introduction: The prevalence of anemia, especially anemia due to iron deficiency, is very high in developing countries such as India. Lead has been recognized as a poison for millennia and has been the focus of public health regulation in much of the developed world for the better part of the past century. Anemia in children is also a substantial problem in India, and leads to increased morbidity and mortality.

Method: The study was conducted on 135 subjects divided into study and control groups. The inclusion criteria for study group were age between 20 to 40 years, exposure to Lead (Pb) more than five years, BMI less than 25 and having no any systemic diseases. The lead exposed subjects were taken from battery workshops of Lucknow city. Recruited subject were explained about the study protocol.

Result: The mean Pb level in cases was found significantly ($p<0.001$) different and exceptionally higher as compared to controls. In contrast, the mean hemoglobin (Hb%) level in cases was found significantly ($p<0.001$) different and lower as compared to controls.

Discussion: The aim of the present study was to evaluate the effect of increased blood lead level and correlate with hemoglobin level in battery workers of Lucknow city. We hypothesized that increased blood lead level causes Anemia in battery workers; to test our hypothesis we tested hemoglobin level in chronic lead acid battery workers. We found those battery workers who were exposed ≥10 years have decrease hemoglobin level in body and they all are become Anemic.

Conclusion: In this study, relatively higher blood lead levels in lead exposed battery workers were significantly associated with elevated risk of moderate and severe anemia.

Key words:
Battery Workers, Lead, iron deficiency, hemoglobin, Anemia

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1. INTRODUCTION

The prevalence of anemia, especially anemia due to iron deficiency, is very high in developing countries such as India, and we may not have directly considered all confounding factors. However, we controlled for factors closely associated with other causes of anemia in the multivariable regression models. However, the causes of anemia in India are multifactorial and the National Family Health Survey did not explore the relation of increased anemia risk to elevated blood lead (Pb) level by anemia severity, accounting for sociodemographic, economic, and other confounding factors (International Institute for Population Sciences and ORC Macro, 2002; Center for Operations Research and Training and International Institute for Population Sciences, 2000). Lead Poisoning due to long term exposure at work is one of the major occupational disease worldwide (National Institute for occupational safety and health, 2001). In developing countries many workers in small and medium size industries are faced with problem of lead exposure.

Anemia in children is also a substantial problem in India (Bentley and Griffiths, 2003) and leads to increased morbidity and mortality. Adverse health effects of anemia in children include impaired psychomotor development and renal tubular function, poor cognitive performance, and mental retardation (Ozcay et al., 2003). The association of lead toxicity with anemia in children has been explored in the past, primarily in populations at high risk, such as children living near a lead smelter (Schwartz et al., 1990). There is little information regarding the relation between lead levels <40 µg/dl and anemia in children. We hypothesized that after controlling for potential confounders, blood lead levels ≥10 µg/dl would be associated with a higher risk of anemia of varying severity in comparison with levels <10 µg/dl.

Although anemia has long been accepted as one of the effects of lead toxicity, the general opinion has been that it is to be expected only at relatively high blood lead levels, i.e., in excess of 80 µg/dl. Nevertheless, in the group of secondary lead smelter workers studied, hemoglobin levels of less than 14µg/dl were found in a sizable proportion (40%o) of individuals with blood lead concentrations lower than 80µg/dl. Since iron deficiency has been shown to enhance lead retention and lead toxicity in experimental Studies (Six and Goyer, 1972) and negative correlations between serum iron and blood lead had been found in both children (Delves et al., 1973) and healthy non-exposed male adults (Wibowo et al., 1976) although not in another experimental study on male volunteers the possibility of iron deficiency contributing to the relatively high prevalence of anemia in the group of secondary lead smelter workers. It was decided to explore the problem of anemia in lead-exposed workers further, to assess the possible role of iron deficiency (Cools et al., 1976).

2. MATERIAL AND METHODS

The study was conducted on 135 subjects divided into study and control groups. The inclusion criteria for study group were age between 20 to 40 years, exposure to Lead (Pb) more than five years, BMI less than 25 and having no any systemic diseases and having no any confounding factor with relation to anemia . The control groups were not exposed to lead but having same age and BMI. The lead exposed subjects were taken from battery workshops of Lucknow city. Recruited subject were explained about the study protocol. Proper occupational history was taken and clinical examination was done to include any systemic diseases.

2.1. Blood Lead Estimation

Venous blood samples were taken in a climate-controlled room before the beginning of a regular workday (between 7:00 AM and 9:00 AM), after the subjects had fasted for 10hrs. The subjects were seated while samples were drawn. Blood specimens for lead measurement were drawn into a 10-ml polypropylene tube with sodium heparin as anti-coagulant and stored at -20°C until assayed. The Blood Lead Level (BLL) was estimated by Lead Care- II system, based on atomic absorption furnace in both the groups.

2.2. Hemoglobin Estimation

A hemoglobinometer is a medical measuring device of hemoglobin blood concentration. The hemoglobin level was estimated by Sahli's haemoglobinometer method. A single mark pipette (haemoglobinometer pipette) for measuring 20 cumm (0.02ml) of blood are used, around or square haemoglobinomete tube graduated in percentage (10-140) and gram percentage (2 to 20). A rectangular box, comparator fixed with 2 solid standard coloured glass rods. The opaque white background provides the necessary contrast for comparison.

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Table 1

Basic characteristics (Mean ± SD) of two groups

Characteristics	Controls (n=70)	Cases (n=65)	P - value
Age (yrs)	38.16 ± 6.82	38.34 ± 7.98	0.887
Height (cm)	163.56 ± 5.20	163.94 ± 6.31	0.701
Weight (kg)	65.26 ± 6.18	63.15 ± 8.09	0.091
BMI (kg/m^2)	24.82 ± 2.34	24.41 ± 2.26	0.306
Chest circumference (cm)	82.51 ± 3.26	82.83 ± 3.80	0.604
Abdominal circumference (cm)	72.47 ± 3.69	68.94 ± 5.93	0.205
Hip circumference (cm)	80.74 ± 4.57	82.25 ± 7.38	0.154

Table 2

Biochemical parameter levels (Mean ± SD) of two groups

Parameters	Controls (n=70)	Cases (n=65)	P - Value	OR (95%CI)
Pb (µg/dl)	5.53 ± 1.75	35.04 ± 13.39	<0.001	2.47 (1.54-4.71)
Hb (%)	12.06 ± 1.55	9.47 ± 1.72	<0.001	1.32 (1.11-2.47)

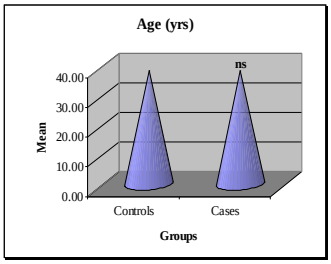

Figure 1

Mean age of two groups (ns - p > 0.05)

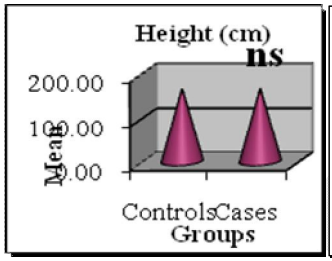

Figure 2

Mean height of two groups (ns - p > 0.05)

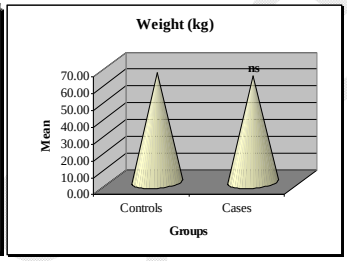

Figure 3

Mean weight of two groups (ns - p > 0.05)

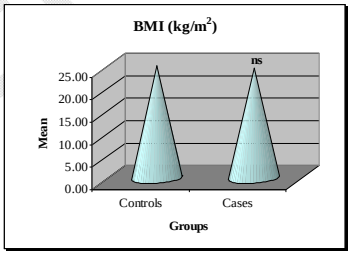

Figure 4

Mean BMI of two groups (ns - p > 0.05)

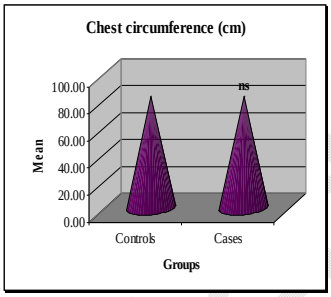

Figure 5

Mean chest circumference of two groups (ns- p > 0.05)

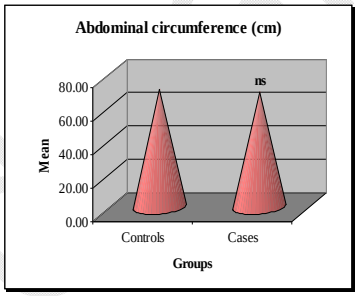

Figure 6

Mean abdominal circumference of two groups (ns- p > 0.05)

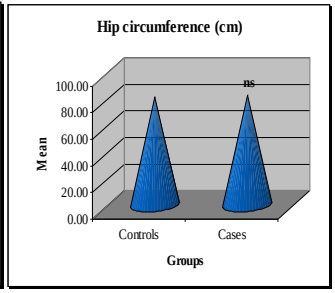

Figure 7

Mean hip circumference of two groups (ns- p > 0.05)

Principle

The amount of hemoglobin can be estimated by conversion of known volume of blood into acid haematin by addition of dilute HCL and subsequent calorimetric comparison with a suitable standard. The values are measured in gm%.

3. RESULTS

3.1. Basic characteristics

The present study evaluates the autonomic and hemodynamic variation in battery workers of Lucknow city. Total 65 men battery workers (cases) were recruited. The age matched 70 healthy men were also recruited served as controls. The basic characteristics of two groups are summarized in Table 1 and also shown graphically in Figures 1-7. The mean age, height, chest circumference and hip circumference were slightly higher in cases than controls while weight, BMI

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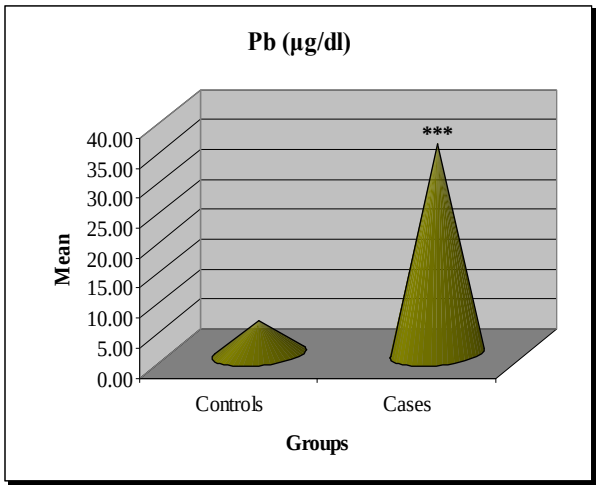

Figure 8

Biochemical parameter levels of two groups at admission (***-p<0.001)

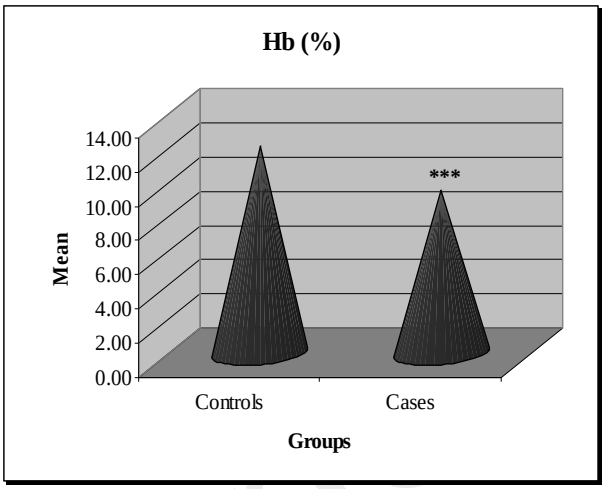

Figure 9

Biochemical parameter levels of two groups at admission (***-p<0.001)

and abdominal circumference were higher in controls than cases. However, all basic characteristics did not differed (p>0.05) between the two groups i.e. found to be statistically the same.

3.2. Biochemical parameter

The biochemical parameter (Pb and Hb%) levels of two groups at presentation are summarized in Table 2 and also shown graphically in Figures 8-9. The mean Pb level in cases was found significantly (p<0.001) different and exceptionally higher as compared to controls. In contrast, the mean hemoglobin (Hb%) level in cases was found significantly (p<0.001) different and lower as compared to controls. In cases, the increase in Pb and decrease in Hb% showed 2.47 (OR=2.47, 95% CI=1.54-4.71) and 1.32 (OR=1.32, 95% CI=1.11-3.47) fold more variations respectively as compared to controls.

3.3. Statistical analysis

Data has been presented as the mean ± SD of all the observations. The values from the two groups (exposed and control subjects) were compared by independent Students't' test. Non-parametric alternative Mann-Whitney U test was also applied where the data was not normal or heterogeneous. Odds ratio with 95% CI was used as a measure of effect size using binary logistic regression analysis. A two-sided (α=2) p<0.05 was considered to be statistically significant. All the analyses were performed on STATISTICA (version 6.0) software. Data were calculated by M.P. Negi, Statistician in Central Drugs Research Institute (CDRI), Lucknow.

4. DISCUSSION

The effects of lead on the hematopoietic system have long been recognized, and lead-induced anemia has historically been an important component of the clinical picture of lead poisoning. This has included not only the occasional rather acute anemia, with an important hemolytic component, observed in cases of acute exacerbation of chronic lead poisoning, with lead colic or lead encephalopathy, but, more frequently, the chronic type of lead anemia, due to the toxic inhibition of heme synthesis. In several cross-sectional clinical studies of lead-exposed male workers, we have found a significant prevalence of low hemoglobin levels (Lilis et al., 1977; Lilis and Fischbein, 1977). The aim of the present study was to evaluate the effect of increased blood lead level and correlate with hemoglobin level in battery workers of Lucknow city. The study was conducted on 65 battery workers and 70 age and sex matched controlled. We study the anthropometric parameter, hemodynamic parameter, hematological parameter, and lipid profile in cases and control. We hypothesized that increased blood lead level causes Anemia in battery workers; to test our hypothesis we tested hemoglobin level in chronic lead acid battery workers. Our result suggests that weight, BMI, and abdominal circumference were higher in control than cases. It reveal that lead may have impact on appetite and in turns decrease food intake and decrease the weight although no significant difference were observe in baseline anthropometric parameter. Lead causes anemia by impairment of heme synthesis and an increased rate of

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red blood cell destruction (Goyer and Rhyne, 1973). On the other hand, it is also possible that iron deficiency, which is a proven cause of anemia, leads to increased absorption of lead in the body, resulting in high blood lead levels (Bradman et al., 2001; Hammad et al., 1996; Wright et al., 2003; Yip et al., 1981).

5. CONCLUSION

The mean Pb level in cases were found 35.04 ± 13.39 (µg/dl) and control were 5.53 ± 1.75 (µg/dl) which are significantly ($p<0.001$) different and exceptionally higher as compared to controls. In contrast, the mean hemoglobin (Hb%) level in cases were found 9.47 ± 1.72 Hb % and control were 12.06 ± 1.55 Hb % which are significantly ($p<0.001$) different and lower as compared to controls. In summary, in this study, relatively low blood lead (Pb) levels in lead exposed battery workers were significantly associated with elevated risk of moderate and severe anemia. We found those battery workers who were exposed ≥10 years have decrease hemoglobin level in body and they all are become Anemic. Since lead pollution can be controlled and steps can be taken to reduces the prevalence of anemia in battery workers of India.

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REFERENCES

1. Bentley ME, Griffiths PL. The burden of anemia among women in India. *Eur J Clin Nutr*. 2003, 57, 52–60
2. Bradman A, Eskenazi B, Sutton P, Athanasoulis M, Goldman LR. Iron deficiency associated with higher blood lead in children living in contaminated environments. *Environ Health Perspect*, 2001, 109, 1079–84
3. Center for Operations Research and Training and International Institute for Population Sciences. National Family Health Survey (NFHS-2), India. Maharashtra preliminary report, Delhi, India: Population Research Center, Institute of Economic Growth; and Mumbai, India: International Institute for Population Sciences, 2000
4. Cools A, et al. Biochemical response of male volunteers ingesting inorganic lead for 49 days. *Int. Arch. Occup. Environ. Health*, 1976, 38, 129
5. Delves H, Bicknell J, Sind Clayton B. The excessive ingestion of lead and other metals by children, In: Environmental Health Aspects of Lead. CEC, Luxembourg, 1973, p. 345
6. Goyer RA, Rhyne BC. Pathological effects of lead. *Int Rev Exp Pathol*. 1973, 12, 1–77
7. Hammad TA, Sexton M, Langenberg P. Relationship between blood lead and dietary iron intake in preschool children: a cross-sectional study. *Ann Epidemiol*., 1996, 6, 30–3
8. International Institute for Population Sciences and ORC Macro. National Family Health Survey (NFHS-2), India. Delhi: main report. Vadodara, India: Center for Operations Research and Training; and Mumbai, India: International Institute for Population Sciences, 2002
9. Ruth Lilis, Alf Fischbein, Josef Eisinger, William E Blumberg, Sidney Diamond, Henry A Anderson, William Rom, Carol Rice, Laszlo Sarkozi, Steven Kon, Irving J Selikoff. Prevalence of lead disease among secondary lead smelter workers and biological indicators of lead exposure. *Environ. Res*. 1977, 14(2), 255-285
10. Lilis R, Fischbein A. Results of an investigation of employees of a secondary lead smelter in Vernon, California, Initial Report of a Clinical Field Survey, Report to the National Institute of Environmental Health Sciences, Jan. 1977
11. National Institute for occupational safety and health (NIOH). Health Hazard evaluation: occupational exposure to lead. DHHS (NIOSH) Pub. No. 2001-113
12. Ozçay F, Derbent M, Aldemir D, Türkoğlu S, Baskin E, Ozbek N, Saatçi U. Effect of iron deficiency anemia on renal tubular function in childhood. *Pediatr Nephrol*. 2003, 18, 254–6
13. Schwartz J, Landrigan PJ, Baker EL Jr, Orenstein WA, von Lindern IH. Lead-induced anemia: dose-response relationships and evidence for a threshold. *Am J Public Health*, 1990, 80(2), 165–8
14. Six KH, Goyer RA. The influence of iron deficiency on tissue content and toxicity of ingested lead in the rat. *J. Lab. Clin. Med.* 1972, 79, 128
15. Wibowo AAE, et al. Interaction between lead and iron metabolism, a probable cause of female susceptibility to inorganic lead. Paper presented at 2nd International Workshop on Permissible Limits for Occupational Exposure to Lead, Amsterdam, September 1976
16. Wright RO, Tsaih SW, Schwartz J, Wright RJ, Hu H. Association between iron deficiency and blood lead level in a longitudinal analysis of children followed in an urban primary care clinic. *J Pediatr*. 2003, 142, 9–14
17. Yip R, Norris TN, Anderson AS. Iron status of children with elevated blood lead concentrations. *Pediatr.,* 1981, 98, 922–5

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