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Original Article

Blood lead level among school children in an industrial city of Nepal

Gautam K[1], Pradhan S[2], Thuppil V[3], Pyakurel D[1], Shrestha A[1]

[1]*Department of Pathology, Samyak Diagnostic Pvt. Ltd., Lalitpur, Nepal*
[2]*Department of Biochemistry, Samyak Diagnostic Pvt. Ltd., Lalitpur, Nepal*
[3]*National Referral Center for Lead Projects in India, Benguluru, Karnataka, India*

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ABSTRACT

Background: Widespread use of lead has caused extensive environmental contamination and health problems in many parts of the world. Children are particularly vulnerable and even relatively low levels of exposure can cause serious health conditions. Our objective was to determine the prevalence of blood lead level in children in industrial city of Nepal, Birgunj.

Materials and Methods: The cross sectional study was done on 50 school going student in Birgunj city, Nepal from November 2016 to January 2017. Questionnaire was used to collect data. Capillary blood was drawn and Blood Lead Level was measured immediately. SPSS ver. 22 was used to analyze the data.

Results: The mean age of children in study was 12.5 ± 1.11 years.Among 50 children, 54% were male and 46% were female. The mean blood lead level was 20.33±9.36 µg/dl (male 21.08±8.87µg/dl, female 19.46±10.92 µg/dl). All the children in the study have elevated blood lead level and 84% of them have >10 µg/dl. About 26% of children have blood lead level between 15-20 µg/dl, 12% have level 20-25 µg/dl and 4% of them have more than 35 µg/dl.

Conclusion: The prevalence of blood lead level in children from the industrial city of Nepal is alarmingly high. Children exposed with chipped paints have high level of blood lead level. However, further study in large population is required to address the current situation regarding the lead exposure to children.

INTRODUCTION

Lead is a heavy metal ubiquitous in our environment which has no physiological role in biological systems.[1] Itis rather a cumulative toxicant that affects multiple body systems and is particularly harmful to young children. Its widespread use has resulted in extensive human exposure and significant public health problems in many parts of the world.[2]

Lead exposure accounts for about 0.2% of all deaths and 0.6% of disability adjusted life years globally.[3] The incidence varies with age, socioeconomic status, the population of a given community, race, and the age of the home. About one fifth of the world's disease burden from lead poisoning occurs in the western pacific, and another fifth is in Southeast Asia.[4,5]

Correspondence:
Dr. Keyoor Gautam, MBBS, MD
Department of Pathology,
Samyak Diagnostic Pvt. Ltd., Lalitpur, Nepal.
E-mail: drkeyoor@samyakdiagnostic.com

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Table 1: Blood Lead Level by Gender

	Number	BLL (µg/dl)±SD	BLL>10 (µg/dl)
Male	27	21.08 ± 8.87	54.8%
Female	23	19.46±10.92	45.2%

The most significant lead exposure in adults usually occurs at the workplace including pipe cutting, welding operations, rubber industry, plastic industry, radiator repair, battery manufacturing, the printing industry, glass manufacture, solid waste combustion, and paint manufacture. However in children other forms of environmental exposure are more important. Lead based paint, PICA, drinking water, toys, and traditional cosmetics being the common sources.[6]

Lead exposure occurs through inhalation, ingestion or occasionally skin contact.[7] In adults, about 35–40% of inhaled lead dust is deposited in the lungs, and about 95% of that goes into the bloodstream. About 15% of ingested lead is absorbed but this percentage is higher in children, pregnant women, and people with co-morbidities.The main body compartments that store lead are the blood, soft tissues, and bone. Besides these, brain, spleen, kidneys, liver, and lungs also store certain amount.[8] In adults, 94% of absorbed lead is deposited in the bones and teeth, but children only store 70% in this manner, this may be one of the reasons for the more serious health effects on children.[9] Lead is removed from the body very slowly through urine. Some amounts of lead are also eliminated through the feces, hair, nails, and sweat.[10]

The major mechanism of lead toxicity is due to increased generation of reactive oxygen species (ROS) and interference with generation of antioxidants. Lead inactivates glutathione by binding to GSH's sulfhydryl group, which causes GSH replenishment to become inefficient. Lead is also responsible for blocking the activity of 5-aminolevulinic acid dehydratase and leads to hemoglobin oxidation, which along with the lipid peroxidation can result in red cell hemolysis.[11]

Table 2: Risk Factors for elevated blood lead levels

Risk Factor	Number	Mean Blood Lead Level ± SD	P value
Chipped Pain			
Yes	21	22.0±9.8	0.27
No	29	19.1±8.1	
Lead Battery			
Yes	30	21.5 ± 7.4	0.59
No	20	19.9±9.9	
Ceramic Dishes			
Yes	16	21.9±11.9	0.39
No	34	19.5±7.9	
Water Source			
Lead Pipe	10	13.8±6.9	NA
Others	40	21.9±9.2	

**NA- Not applicable*

Leadpoisoning can cause a variety of symptoms and signs which vary depending on the individual and the duration of lead exposure. Symptoms usually develop over weeks to months as lead builds up in the body during a chronic exposure, but acute symptoms from brief, intense exposures also occur. The current reference range for acceptable blood lead concentration is less than 5µg/dl for healthy children and less than 25 µg/dl for adults. In children, the blood lead level(BLL) as low as 10µg/dlisassociated with developmental delays, deficits in behavioral functioning, decreased stature, and diminished hearing acuity. The high BLLs (i.e. ≥70 µg/dl) can cause serious health effects, including seizures, coma, and even death.[12]

MATERIALS AND METHODS

The cross-sectional study was carried out in the 50 children aged 10-15 years from the school in the industrial city of Nepal, Birgunj.Approval letter was obtained from the school authority. After Nepal Health Research council approved the study, informed consent from the participants were taken before starting the sample collection.

The questionnaire was prepared and provided to the children to fill up in the guidance of parents. Those who voluntarily gave the consent were included in the study. Sample of capillary blood were collected on aseptic condition, transported to EDTA tube and then the lead level was measured immediately.

Measurement of Blood Lead

For the measurement of Blood Lead level, LeadCare II instrument (Magellan DiagnosticsInc.,N.Billerica, Massachusetts, USA)was used. The instrument is CLIA (Clinical Laboratory Improvement Amendments) waived. Quality Control was maintained with two levels of controls provided. A single blood test (capillary or venous) at or above the reference range value of 5µg/dl is considered as elevated blood lead level.

Statistical analysis

The data was analyzed using Statistical Analysis Software (SPSS® v22.0). Analyses included standard descriptive statistics. Normally distributed variables are expressed in terms of mean ± SD (Standard Deviates), whereas non-normally distributed variables are presented as medians and ranges. Logarithmic transformation (log) was carried out for non-normally distributed variables. Mean values of study variables were also compared between and within categories using standard independent samples t-tests or unpaired t-test or Mann-Whitney U test as applicable. Chi-square test is used for comparison of proportions between variables and Analysis of Variance while comparing across

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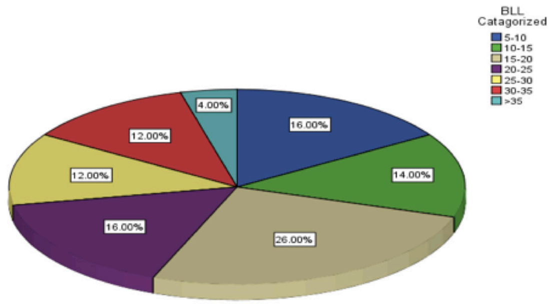

Figure1:*Distribution of Blood lead levels*

more than two groups. Relationship between variables was assessed using Pearson's correlation analysis. A p-value < 0.05 was considered statistically significant.

RESULTS

Among 50 children, 54% (n=27) were Male and 46% (n=23) were Female. The mean age of children was 12.5 ± 1.11 years. The mean BLL came out to be 20.33±9.36 µg/dl. Mean BLL in male was 21.08 ± 8.87 µg/dl whereas that for female was 19.46±10.92 µg/dl. The difference in the mean BLL between male and female was not statistically significant, p=0.54.All the children in the study have Elevated BLL and 84% of them have BLL>10µg/dl, Table 1.

About 26% of children have Blood Lead Level between 15-20 µg/dl, 12% have Blood Lead Level 20-25 µg/dl and 4% of them have more than 35 µg/dl of Blood Lead level, (fig. 1).

No significant association was observed betweenBLL and age of children (r=0.21,p-0.13). Several risk factors were analyzed including chipped paint at house, use of lead batteries, ceramic dishes and source of water. Among these children living inthe house with chipped paint had mean BLL of 22.0±9.8 µg/dl, with lead batteries had mean BLL of 21.5 ± 7.4 µg/dl, those using ceramic dishes had mean BLL of 21.9±11.9µg/dl and those using lead pipe for water supply had mean BLL 13.8±6.9 µg/dl. However these risk factors were not found to be significantly associated with elevated BLL, Table 2.

DISCUSSION

This study identified high prevalence of blood lead level among the children in Birgunj. All the children in the study had elevated BLL. About 84% of the children in this study had BLL > 10 µg/dl. According to the CDC recommendation, an area is considered as a high risk if 12% or greater of children tested are found with the BLL of ≥ 10 µg/dl.[13] So the findings of this study indicates serious health problem in children living in industrial cities like Birgunj.

While comparing the mean BLL among male and female in study, male seem to have higher mean BLL than female but was not statistically significant. This higher BLL in male can be explainedby the fact that boys spend more time in outdoor activities than girls and are subjected to greater lead exposure. However no correlation was noticed between age of children and BLL.

Before introduction of lead free gasoline, it was the main source of lead contamination. Removal of lead from gasoline and reduce use of lead have resulted in a substantial reduction in population level mean blood lead concentration in most of the countries. But in Nepal even use of lead free gasoline did not reduce the mean blood lead concentration in children. This might be because of presence of other important sources of lead including chipped paint, lead acid batteries, toys, traditional cosmetics and water sources.

Global Alliance to Eliminate Lead in Paint (GAELP) recommended a limit of 90 ppm [0.009%] in paint and many countries around the globe have established paint policies to meet this standard. In Nepal, study showed that out of a total of 75 samples, 57 (76%) of the tested paints contained lead at concentrations greater than 90 ppm (ppm). Ninety-three percent of the paints that exceeded 90 ppm had levels in excess of 600 ppm. Lead concentrations in the tested paints even ranged up to 200,000 ppm.[14] Use of these paints in homes, schools, and other child-occupied facilities increases the exposure of lead to children.

Lead acid batteries is another important source for lead exposure. Its use has been increased drastically because of electricity crisis in Nepal. Improper dumping of such used lead acid batteries can contaminate the surrounding environment with lead. Besides these water sources, traditional cosmetics, socio-economic conditions were also the source of lead exposure for the children in Nepal.[15-17] In this study the mean BLL in those children exposed to one of theserisk factor was higher than those without the exposure. However the difference in the means were not statistically significant.

LIMITATION

This study could not include children of lower age group due lack of consent. We had to limit the sample size because of financial limit. Lastly this study could not assess other risk factors including socio economic status, residency near industries, exposure to soil,dust.

CONSLUSION

The prevalence of BLL in children from Birjung; an industrial city of Nepal; is alarmingly high. Most of the children in the study even need medical treatment. Numbers of risk factors have been noticed to be associated with the lead exposure most common being chipped paint, lead acid

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batteries. Further study in large population is required to address the current situation regarding the lead exposure to children. Policy makers should initiate steps to screen the children for lead level and should develop policy to reduce the use of lead.

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