RESEARCH PAPER

Factors Associated With Elevated Blood Lead Levels in Children

Sakshi Chaudhary[1], Uzma Firdaus[1], Syed Manazir Ali[1] and Abbas Ali Mahdi[2]

From [1]Department of Pediatrics, Jawahaharlal Nehru Medical College, Aligarh Muslim University, Aligarh; and [2]Department of Biochemistry, King George Medical University, Lucknow; Uttar Pradesh, India.

Correspondence to: Dr Uzma Firdaus, Assistant Professor, Department of Pediatrics, JN Medical College, AMU, Aligarh, India.
druzmafirdaus@gmail.com
Received: August 30, 2016;
Initial review: December 15, 2016;
Accepted: September 06, 2017.

Objectives: To determine the prevalence and correlates of elevated blood lead level in children (6-144 months) of Aligarh. **Methods:** A hospital-based cross-sectional study was conducted. Venous blood was obtained for lead estimation and a structured questionnaire was filled. **Results:** A total of 260 children were enrolled. The prevalence of elevated blood lead level was 44.2%, seen mostly in children below 5 years of age. Old and deteriorating wall paints at home was found to be significantly associated with elevated levels. **Conclusions:** Lead-based house paints are potential source of lead exposure. Meticulous renovation and painting of the walls with safe paints is desirable.

Keywords: *Causes, Lead toxicity, Prevention, Wall paint.*

Published online: September 26, 2017. PII:S097475591600093

Lead poisoning is one of the major environmental diseases among children in developing countries. A recent controversy involving a popular brand of noodles in India recently led to increased awareness about the potentials of lead toxicity [1]. Exposure to even extremely small amounts of lead can have long-term and slowly accumulating deleterious effects in children [2]. A decline in cognitive function is possible at a lead level lower than the World Health Organization/ Centers for Disease Control and Prevention (WHO/CDC) cut-off (10 µg/dL) [3,4]. Studies suggest that the population groups at greatest risk of exposure are young children and workers involved with construction, mining, and manufacturing. This may be due to greater gut absorption of lead in infants and young children than in adults [4-6].

Aligarh, a densely populated town of Uttar Pradesh, is the hub of a variety of industries and is feared to be home to children at risk of lead exposure. Hence, this study was planned to determine the socio-demographic and clinical correlates of elevated blood lead levels in children of Aligarh.

Methods

This was a hospital-based cross-sectional study carried out in children (6-144 months) attending pediatrics Out Patient Department (OPD) for either routine check-up or any physical symptom suggestive of lead poisoning like pallor, unexplained fatigue, abdominal pain, constipation or anorexia, deteriorating school performance, and recently acquired irritability or hyperactive behaviour. The children were excluded if they required admission or were taking/had taken calcium, zinc or iron supplementation in past two months. The period of the study was from February 2014 to September 2015.

The study was approved by the Institute Ethics Committee, and informed written consent was obtained from the parents/legal guardians. Details about the child's habits, rearing environment like distance from traffic (less than 100 m, 100-500 m, more than 500 m), source of drinking water, as well as maternal and paternal attributes likely to cause exposure to lead were enquired. Child's symptoms, especially of gastro-intestinal and neuro-behavioral origin were enquired and a general physical examination carried out. All the data were entered in a pre-designed proforma.

Considering the prevalence of elevated blood lead level as 12% and level of confidence of 2%, and the degree of precision as 4%, the sample size was calculated to be 260 [6].

For estimation of blood lead level, after aseptic site preparation, venous blood was drawn in Ethylene diamine tetra-acetic acid vacutainers. The labelled sample was stored in the freezer compartment (-18ºC) of the refrigerator in a sealed and airtight container to avoid contamination during storage, till it was transported to Department of Biochemistry, King George Medical University, Lucknow for analysis. Lead level was estimated by Inductively Coupled Plasma-Optical Emission Spectrometer with the help of Microwave Digestion System. A value of 10 µg/dL was considered as the cut-off for elevated blood lead levels (BLLs).

Hemoglobin estimation was done by Sahli's hemoglobinometer. The presence of anemia was defined as per WHO cut-offs [7]. Statistical analysis was done using the Statistical Package for Social Sciences (SPSS 17) for Windows. Pearson's chi-square test was applied to sets of categorical data. *P* value <0.05 was taken as statistically significant.

RESULTS

A total of 335 children were approached, 55 refused consent while 20 had one of the exclusion criteria; 260 children (59.6% males) were eventually enrolled in the study. The mean (SD) age of the study group was 54.4 (9.6) months.

The prevalence of elevated BLL was found to be 44.2%; the mean (SD) value was 55.7(227.38) µg/dL [Median (IQR) 8.4 (0-33)µg/dL] . Among the children with elevated blood lead levels, majority of children (67.8%) did not show any clinical symptoms suggestive of lead poisoning. The mean (SD) BLL was highest in age group 6 to 12 months [33.8 (5.1) µg/dL] and lowest in age group 120 months [10.9 (4.4)µg/dL]. There was no difference in lead levels across sexes.

Although factors like presence of pets in house, use of colored toys (soft vividly colored plastic toys), regular eating food-items from street vendors (yellow/ bright colored food items, candies etc.) and use of kohl were found more in children with elevated BLL than those having normal blood lead level, the differences were not found to be statistically significant (***Table* I**). Neither the source of water supply nor the use of purification method was found to affect the BLL. Maternal use of cosmetics like sindoor, lipstick and dye was found more in children with elevated BLL; however, the difference did not reach the level of significance (***Web Table* I**).

TABLE I RELATIONSHIP OF CHILD ATTRIBUTES WITH BLOOD LEAD LEVELS (*N*=260)

Child Attributes	*Normal Levels, n (%)*	*Elevated Levels, n (%)*
Pica	69 (47.6)	49 (42.6)
Thumb-sucking	16 (11.0)	12 (10.4)
Absence of hand washing	94 (64.8)	74 (64.3)
Household pets	35 (24.1)	30 (26.1)
Use of colored toys	106 (73.1)	92 (80.0)
Eating from roadside vendors	58 (40.0)	49 (42.6)
Use of Kohl	37 (25.5)	39 (33.9)
Not school-going	92 (63.4)	70 (60.9)
Use of herbal medications	23 (15.9)	16 (13.9)

All P values >0.05.

TABLE II RELATIONSHIP OF BLOOD LEAD LEVELS WITH TIME SINCE LAST HOUSE-PAINT

Time Since Last Paint	*Normal Level*	*Elevated Level*
Within 5 y	129	118
*Between 5 and 10 y	4	15
More than 10 y	1	3

**P= 0.03*

Among the demographic factors, wall paints done more than 5 years back were significantly associated with elevated BLL in children (***Table* II**).

DISCUSSION

The prevalence of elevated BLL in children of Aligarh attending Pediatric OPD was found to be 44%. None of the child's habits or parental attributes were found to be related to the BLL in children, only old and deteriorating paint on the house walls was significantly associated with elevated BLL. The flakes of old paints are likely to be chipped off from the wall and contaminate the house dust, which may be later ingested by the child through unhygienic eating habits. This could also explain increased risk of elevated blood lead levels in younger children who exhibit more hand to mouth activities and less of hand hygiene. The children with raised BLL remained essentially asymptomatic.

Limitations of the present study were that the drinking water or soil was not analyzed for lead level as these were not included for lead analysis in the protocol. These may be important sources of lead entry into the body, especially for young children who may fail in hand hygiene and ingest soil/mud more than the older children/ adults. In addition, the lead content of various colored food items as well as cosmetics may vary, which was not considered while evaluating the risk factors.

Before being phased out, leaded gasoline used to be an important source of lead exposure and elevated BLL in children [6,8]. Another important potential exposure of lead is likely to be lead dust from parents' work clothing which can be later ingested or inhaled by children at home [9]. However, in the present study we did not find occupation or other parental attributes determining the BLL in children, as also reported by other investigators [10-12]. The strikingly high prevalence of elevated blood lead levels found in Aligarh may be attributable to some other factor not addressed in the present study. In addition, elevated BLL in children was not associated with symptoms, as observed by other investigators [13].

Rising trend of lead poisoning is a cause of serious concern. Lead-based paints and coloring agents continue

to be used in India and many other countries of the world. There is dearth of available and affordable laboratory facilities for BLL estimation. We strongly need rigorous control on lead based paints and colouring agents, laboratories for BLL estimation, estimation of lead content in soil and water in high risk areas, as well as community awareness on lead poisoning. Future research should focus on identification of risk factors and burden of this preventable problem through large multicentric epidemiological studies.

Contributors: SC: collection of data and electronic preparation, UF: Study concept, study design,electronic preparation, final revision, SMA: study design, revision of manuscript and AAM: analysis of data, revision of the manuscript.
*Funding:*None; *Competing interest:* None stated.

REFERENCES

1. Nestle pulls out Maggi as Centre considers ban. Times of India 2015 Jun 05;New Delhi:p. 3 (col 7).
2. Schwartz J. Low-level lead exposure and children's IQ: a meta-analysis and search for a threshold. Environ Res. 1994;65:42-55.
3. Canfield RL, Henderson CR Jr, Cory-Slechta DA, Cox C, Jusko TA, Lanphear BP. Intellectual impairment in children with blood lead concentrations below 10 microg per decilitre. N Engl J Med. 2003;348:1517-26.
4. Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations from the Advisory Committee On Childhood Lead Poisoning Prevention. Atlanta, GA: Centers for Disease Control and Prevention; 2012. Available from:*https://www.cdc.gov/nceh/lead/casemanagement/casemanage_main.htm.* Accessed July 17, 2015.
5. Kalra V, Chitralekha KT, Dua T, Pandey RM, Gupta Y. Blood lead levels and risk factors for lead toxicity in children from schools and an urban slum in Delhi. J Trop Pediatr. 2003;49:121-3.
6. Kalra V, Sahu JK, Bedi P, Pandey RM. Blood lead levels among school children after phasing-out of leaded petrol in Delhi, India. Indian J Pediatr. 2013;80:636-40.
7. World Health Organisation, United Nations Children's Fund, United Nations Organisation. Iron Deficiency Anaemia: Assessment, Prevention and Control, AGuide for Programme Managers. Geneva, World Health Organization, 2001. Available from: *http://www.who.int/nutrition/publications/micronutrients/anaemia_iron_ deficiency/WHO_NHD_01.3/en/index.html.*Accessed July 17, 2015.
8. Nichani V, Li WI, Smith MA, Noonan G, Kulkarni M, Kodavor, M *et al*. Blood lead levels in children after phase-out of leaded gasoline in Bombay, India. Sci Total Environ. 2006;363:95-106.
9. Liu J, Ai Y, McCauley L, Pinto-Martin J,Yan C,Shen X, *et al*. Blood lead levels and associated socio-demographic factors among preschool children in the south eastern region of China. Paediatr Perinat Epidemiol. 2012;26:61-9.
10. Jain NB, Hu H. Childhood correlates of blood lead levels in Mumbai and Delhi. Environ Health Perspect. 2006;114:466-70.
11. Gogte ST, Basu N, Sinclair S, Ghai OP, Bhide NK. Blood lead levels of children with pica and surma use. Indian J Pediatr. 1991;58:513-9.
12. Saper RB, Kales SN, Paquin J, Burns MJ, Eisenberg DM, Davis RB, *et al*. Heavy metal content of ayurvedic herbal medicine products. JAMA. 2004;292:2868-73.
13. Needleman HL, Gatsonis CA. Low-level lead exposure and the IQ of children: A meta-analysis of modern studies. JAMA. 1990;263:673-8.

WEB TABLE I PARENTAL FACTORS AND BLOOD LEAD LEVEL OF CHILDREN (*N*=260)

Parental factors	*Normal Levels, n (%)*	*Elevated Levels, n (%)*
Maternal age >35 years	18 (12.4)	11(9.6)
Maternal parity >3	45 (31.0)	32 (27.8)
Maternal illiteracy	74 (51.0)	55 (47.8)
Maternal use of kohl	88 (60.7)	70 (60.9)
Maternal use of sindoor	40 (27.6)	36 (31.3)
*Maternal use of lipstick	102 (70.3)	93 (80.9)
Maternal use of dye	7 (4.80)	10 (8.7)
Paternal age >35 years	42 (29.0)	30 (26.1)
Paternal illiteracy	54 (37.2)	43 (37.4)
High risk paternal occupation	60 (41.4)	47 (40.9)

P=0.05 and OR 0.9-3.2; All other P>0.05.