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Effect of personal habits, age and style of playing with toys on blood lead levels of children in Ahmedabad

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ABSTRACT

To assess lead levels in school going children of Ahmedabad, 233 school children between 3-7 years of age were investigated for blood lead levels (BLLs). Blood samples were micro-digested for analysis of lead by Atomic absorption spectrophotometer using graphite furnace technique (GF-AAS). The mean blood lead level and standard error among school children was found to be 2.82±0.17 μg/dL. However, three children had blood lead levels more than 10 μg/dL. The blood lead levels were influenced by personal habits and style of playing with a toy and category of toys.

KEYWORDS: Lead, GF-AAS, Blood lead level (BLL), Children, Toys

Introduction:

Lead constitutes 0.002% of the Earth's crust, and in nature it exists mainly as lead sulphide. Lead has become widely distributed in the biosphere only in the past few thousand years, almost entirely as the result of human activity (National Research Council, 1992). Once lead is introduced into the environment, it persists. Lead is a heavy metal with a bluish-grey colour. It has a low melting point, is easily moulded and shaped, and can be combined with other metals to form alloys. For these reasons, lead has been used by humans for years and is widespread today in products like storage batteries, pigments and paints, glazes, vinyl products, shot and ammunition, cable covers, and radiation shielding (WHO, 2010). In spite of a century of accumulated evidence about its danger to the health of children, lead continues to be added to paints, pigments, toys, traditional medications, cosmetics and other consumer products, especially as manufacturing shifts to low-income countries that lack environmental and product content controls and policies (WHO, 2010).

Lead is an environmental toxicant that may affect the nervous, hematopoietic, endocrine, renal, and reproductive systems. Lead exposure in young children is a particular hazard because children absorb lead more readily than adults because the developing nervous systems of children are more susceptible to the effects of lead. Blood lead levels (BLLs) at least as low as 10 μg/dL can adversely affect the behaviour and development of children (MMWR, 1997).

Liu et al (2012) demonstrated that Children are vulnerable to lead toxicity, and exposure to lead has been linked to poor school performance and delinquency in children and adolescents. Even low-level lead below 10 μg/dL can cause intellectual deficit. They found that subclinical effects on the central nervous system (CNS) are the most common effects. The most important effect is cognitive impairment, measured by IQ tests.

In most countries, including the United States, blood lead concentrations are maximum at approximately 2 years of age and then decrease without intervention. Blood lead concentration is associated with lower IQ scores as IQ becomes testable reliably, which is at approximately 5 years of age (Yan et al, 1998)

Children are at higher risk for lead poisoning because their smaller body is in a continuous state of growth and development. When children crawl or walk, they are constantly on the floor and therefore more prone to ingesting and inhaling dust that is contaminated with lead (Woolf et al, 2007). Both soil and paint lead contributed to dust lead levels, but paint contributed significantly more lead to house dust than soil .Children who spend time outdoors put soil or dirt in their mouth which may contribute to children's blood lead levels. The lead-based paint is more important contributor of lead to house dust than lead-contaminated soil (Lanphear and Roghmann, 1997).

Lead poisoning is one of the most common childhood diseases of toxic environmental origin. Children around the world today are at risk of exposure to lead from multiple sources. Lead poisoning accounts for about 0.6% of the global burden of disease (WHO, 2009).

Ingestion is the most common route of exposure to lead for children. Once lead has been swallowed, it enters a child's body by absorption from the gastrointestinal tract (WHO, 2010).

Toxic exposures in children are of a significant concern because of a number of factors, including a higher metabolic rate and greater surface area to weight ratio than adults, immaturity of organ systems, and rapid growth and development of organs and tissues such as bone and brain. Children's exposure also differs from that of adults because children drink more fluids, eat more food, and breathe more air per kilogram of body weight. Young children's frequent hand to mouth activity creates a path way for lead in toys and other products to enter the body. Children receive multiple low dose exposures daily from a variety of products with which they come into contact, in addition to chemicals in household dust and the outdoor environment (Becker, 2010).

Review of literature:

In Saratov, Russia, Rubin et al (1997) conducted the first evaluation of blood lead levels among Russian children. The mean blood lead level of 579 samples analyzed at the Centers for Disease Control and Prevention was 7.7μg/dL (range 3.0 to 35.7 μg/dL). Nriagu et al (2011) reported that mean blood lead level (BLL) in US children of 6 months to 15 years of age was 3.8μg/dL. In Thailand, mean BLL was 7.71μg/dL in children of 3-7 age group (Neesanan et al, 2011). Mean BLL was found to be 6.4 μg/dL in children with age of 5-11 years in South Africa (Mathee et al, 2005).Mean BLL in China was 5.95 μg/dL in children below 6 years (Zhang SM et al., 2005).Mean BLL of Bangladeshi children of 4-12 years age was 15.0μg/dL (Kaiser et al, 2001) and in Japan mean BLL was only 2.61μg/dL (Yoshinanga et al, 2012).

The mean BLL of Indian children in different cities is reported to be different. Mean BLL of children of 3-12 years in Lucknow was reported to be 9.3 μg/dL (Ahmed et al,2010),in Nagpur it was 18.4μg/dL for children in the age group of 6 months to 6 years (Patel ,et al.,2001),in Chennai it was 11.4μg/dL in children of 3-7 years age group (Roy et al.,2009,-Palaniappan,2012).In Delhi, Kalra et al (2013) reported different mean BLLs in different areas of Delhi. In Dariyagunj area it was 7.6μg/dL and in Shahpur it was 4.1μg/dL. The children age group was 6-10 years. Vyas et al (2013) reported BLL of 1.69 ± 0.37 μg/dL with the range of 0.40-6.19 μg/dL for children in rural areas in the vicinity of proposed bene-

fication plant. CDC is no longer using the term "level of concern" and is instead using the reference value to identify children who have been exposed to lead and who require case management. Experts now use a reference level of 5 µg/dL to identify children with blood lead levels that are much higher than most children's levels (CDC, 2012).

Methods and materials:

(i) Questionnaire based survey:

Randomly 1063 children aged 3-7 years were selected from different localities of Ahmedabad and were subjected to questionnaire. Ahmedabad is a big city. It is divided by Sabarmati river in two parts viz. eastern and western Ahmedabad. Eastern Ahmedabad is a mixture of residential area as well as industrial area. The western Ahmedabad is purely residential area.

The parents/guardians were explained about the aims and objectives of the study in their mother tongue. Written prior consent was taken from them as per institutional ethical guidelines. A questionnaire was prepared in which we inquired about the category/type of toys like dolls, teethers, animals, vehicles and other type of toys. Socio-economic status of the parents was also recorded. In addition to that, other things like style of playing, chewing, throwing, and sucking habits were recorded. Other habits like eating of coal/mud/wall paint/chalk, nail biting and thumb sucking were also recorded. In addition to these anthropometric observations like height, weight, head circumference, arms span were recorded. Balance was used to measure weight in kilogram (LC=0.5kg).The measure tape was used to measure height, head circumference and arm span (LC=0.5cm).The interview with children along with his/her mother/father/guardian was carried out at either school or at the home of children.

(ii) Metal analysis:

233 healthy school going children aged 3-7 years were selected from Ahmedabad (Gujarat) for analysis of lead in blood depending upon their cooperation. 3ml venous blood was collected in heparinized vacuettes taking due precautions at the school premises or their home. The collected heparinized vacuettes were transported carefully to the laboratory in dry ice packs and stored at 0-4 C in deep freezer. 2 ml of whole blood was microwave digested using 2 ml of metal free nitric acid (HNO_3) and 0.2 ml hydrogen peroxide (H_2O_2) (Vyas et al,2013,Sathawara et al,2007). This procedure was carried out in wet digestion system (Milestone, Model Start- D, Italy). Blank samples were also run during the procedure. The digested samples were filled in polypropylene vials. Final volume was made up to 10 ml using triple distilled water and centrifuged. Vials, Teflon vessels and all other lab wares for microwave digestion were cleaned by soaking in 10 % (v/v) HNO_3 for 24 hours and washed with triple distilled water before use. The supernatant was transferred to sample cups for metal analysis by GF-AAS (Model 800,Perkin Elmer, USA). Metal concentration was measured after performing calibration by NIST approved standards.

(iii) Statistical Analysis:

The statistical analysis was accomplished by software package, SPSS 16.0. For statistical analysis, standard descriptive statistics and repeated-measures ANOVA were used for the outcome. The significance level was set at $P< 0.05$.

Results and discussion:

Mean BLL of total children was found to be 2.82±0.17 µg/dL. Mean BLL of male children was found to be 2.84±0.23 µg/dL whereas mean BLL of female children was found to be 2.79±0.25 µg/dL. BLL was slightly more in male children but the difference was not statistically significant. Further, children were divided in two groups viz. < 5 years and ≥5 years. It was observed that the children above or equal to 5 years of age (≥5) had higher BLLs compared to the children below the 5 years of age but the difference was not significant (Table-1). As Ahmedabad is divided by Sabarmati river in eastern and western Ahmedabad, children were also divided as per their residential area in western region and eastern regions. Western region is purely residential area whereas eastern region is residential as well as industrial area. Mean BLL in eastern region children was found to be 2.87±0.16µg/dL whereas in western region mean lead level was found to be 2.71±0.41µg/dL The difference between blood lead levels in males and females of eastern and western regions was not significant (Table-2).

Table-1: Blood lead levels (µg/dL) of children*.

Subjects	Age(Years)	Mean± SE
All Males	3-7	2.84±0.23 (120)
All Females	3-7	2.79±0.25 (113)
Total Children	≥5	2.99±0.17 (146)
Total Children	<5	2.51±0.33 (87)
Total Children	3-7	2.82±0.17 (233)

***Figures in parenthesis indicate number of subjects.**

Table-2: Region-wise distribution of blood lead levels (µg/dL) of children*.

Region	Subjects	Mean ± SE
East region	Total	2.87±0.16 (156)
	All Males	2.97±0.23 (82)
	All Females	2.76±0.23 (74)
West region	Total	2.71±0.41 (77)
	All Males	2.57±0.53 (38)
	All Females	2.86±0.40 (39)

***Figures in parenthesis indicate number of subjects.**

Children toys contain lead which may be released by different pathways such as the following; via saliva during mouthing, via sweat during dermal contact or via gastric fluids after partial ingestion (Guney and Zagury, 2012). The migration of lead through toy may depend on the style of playing with the toy and their habits. To know the contribution of lead due to the style, the children were classified as per their style of playing like sucking, throwing and chewing. The result showed that children having a habit of chewing when they play with toy had higher BLLs (3.66±0.53 µg/dL) than other styles (Table-3) but the difference is not statistically significant. The children who have tendency to throw the toy while playing has least BLL (1.88 ± 0.43µg/dL).The children who suck the toy during playing had mean BLL of 2.60±0.15µg/dL. This may be due to the fact that while chewing the lead from the toy may migrate resulting into higher blood lead level. The mean BLL of the children is below the level of concern but 3 children with chewing habit had BLL exceeding the WHO/CDC level of concern of 10µg/dL and 35 number of children had BLL greater than reference value of 5µg/dL (CDC, 2012).

Table-3: Distribution of blood lead levels (µg/dL) of children as per their style of playing with toy*.

Style of playing	Mean ± SE
Sucking	2.60±0.15 (169)
Throwing	1.88±0.43 (10)
Chewing	3.66±0.53 (54)

***Figures in parenthesis indicate number of subjects.**

Children were also classified as per their personal habits like coal/chalk/dust eating or nail biting or thumb sucking(Table-4).The mean BLL of children having habit of coal/chalk/dust eating or nail biting or thumb sucking is higher than the BLL of children who have no such habits. It is also seen that children who have more than one habit, have higher mean BLL.

Table-4: Blood lead levels (µg/dL) of children as per their personal habits*

Habit	Mean± SE
Coal/Chalk/Dust eating	3.72±0.50** (45)
Nail biting	3.21±0.40** (33)
Thumb sucking	2.77±0.54** (16)
Any Two habits	3.98±0.60** (34)
No habit	1.94±0.14 (105)

***Figures in parenthesis indicate number of subjects.**
**** Significant (p<0.05)**

When habit of coal/chalk/dust eating was compared with the children without any habit, the difference in mean BLL was significant (p<0.05). When habit of nail biting was compared with the children without any habit, the difference in mean BLL was also found to be significant (p<0.05). Further, when thumb sucking was compared with the children without any habit, the difference in mean BLL was again found to be significant (p<0.05). Children with any two habits were compared with children without any habit, it was also found to be significant (p<0.05).

Children were also classified as using branded and unbranded category of toys (Table-5). Children using branded toys have mean BLL (1.87± 0.35µg/dL) lower than the children using unbranded toys (3.01±0.19µg/dL) and the difference is significant (p<0.05). Though mean BLL was lower than the level of concern, 1 child using branded toys and 1 child using unbranded toys had BLL above level of concern with values 10.53µg/dL and 19.56µg/dL respectively. Mean BLL in unbranded toy users is found to be significantly higher than branded toy users (p <0.05). So it can be inferred that higher BLL may be due to presence of higher lead content in unbranded toys.

Table-5: Distribution of blood lead levels (µg/dL) of children using branded and unbranded toys*.

Category of toys	Mean ± SE
Branded	1.87 ±0.35 (n=39)
Unbranded	3.01±0.19** (n=194)

***Figures in parenthesis indicate number of subjects.**
**** Significant (p<0.05)**

Conclusion:

Mean BLL of male and female children was almost same, but BLL of children above or equal to 5 years was higher than the mean BLL of children below 5 years of age. In western region, BLL of children were lower than the BLL in eastern region but the difference was not significant. This means BLL is not influenced region or sex but it is influenced by age. BLL of children chewing the toy had higher mean BLL indicating the migration of lead due to style of playing. BLL is affected due to personal habits of children. It is evident that due to regulations on lead branded toy may contain low level of lead than the unbranded toys not following regulations resulting in the higher BLL of user children. Mean BLL was found to be less than the WHO/CDC threshold of concern (10 µg/dL) and reference value of 5µg/dL.

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