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Clinical Evaluation of Occupational Lead Exposure in Adults of Road Side Market Places of South Kolkata, India

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Studies conducted throughout the world has established beyond doubt that elevated blood lead levels may lead to detrimental health effects. It is an environmental toxicant that affects nearly every system in the body. Lead is a highly toxic substance, exposure to which can produce a wide range of adverse health effects. There are many ways in which humans are exposed to lead *i.e.*, through deteriorating paint, lead batteries, household dust, bare soil, air, drinking water, food, ceramics, home remedies, hair dyes and other cosmetics. Lead poisoning, the oldest recognized occupational disease, remains a danger for children and adults. In this study blood lead levels of about 232 adults of both sexes, age ranges between 20-40 years, working in road side small markets, food stalls and hotels of South Kolkata were investigated. Very little information on the blood lead distribution of the adults involving these road sides businesses is available. This study was undertaken to determine blood lead levels among adults spend most of their time in day and night besides some most congested main roads and crossings of south Kolkata. The results indicated that blood lead levels in the areas close to main roads ranged from 1.8 to 29.63 µg/dl, with a median level of 12.32 µg/dl. The blood lead levels of 88.94 % of adult equal or exceeded to 10 µg/dl, the current international action levels. Automobile emission, dust, congested traffic, prolonged hours of work in the polluted areas, low nutritional status and lack of education were among the factors associated with elevated blood lead levels.

Key Words: Lead toxicity, Kolkata, Air pollution, Lead analysis, Health hazards.

INTRODUCTION

Lead occurs naturally as a sulfide in galena. It is a soft, bluish-white, silvery gray, malleable metal with a melting point of 327.5 ºC. Elemental lead reacts with hot boiling acids and is attacked by pure water. The solubility of lead salts in water varies from insoluble to soluble depending on the type of salt. Lead is a natural element that is persistent in water and soil. Most of the lead in environmental media is of anthropogenic sources. The mean concentration is 3.9 µg/L in surface water and 0.005 µg/L in sea water. River sediments contain about 20,000 µg/g and coastal sediments about 100,000 µg/g. Soil content varies with the location, ranging up to 30 µg/g in rural areas, 3000 µg/g in urban areas and 20,000 µg/g near point sources. Human exposure occurs primarily through diet, air, drinking water and ingestion of dirt and paint chips[1,2].

Lead may cause irreversible neurological damage as well as renal disease, cardiovascular effects and reproductive toxicity. Lead has been implicated in a number of health effects, ranging from severe encephalopathy to and death to subtle effects on IQ[3]. Lead enters humans most frequently through ingestion and inhalation, skin absorption and in utero exposures. Most individuals ingest lead *via* food almost daily. Humans have been mining and using this heavy metal for thousands of years, poisoning themselves in the process due to accumulation and exposure. Blood lead levels (BLL) once considered safe are now considered hazardous, with undetected threshold limits. Lead has no known physiologically relevant role in the body. The toxicity of lead comes from its ability to mimic other biologically important metals, most notably calcium, iron and zinc which act as cofactors in many enzymatic reactions. Lead is able to bind to and interact with many of the same enzymes as these metals but, due to its differing chemistry, does not properly function as a cofactor, thus interfering with the enzyme's ability to catalyze its normal reaction(s). Most lead poisoning symptoms are thought to occur by interfering with an essential enzyme δ-amino levulinic acid dehydratase or ALAD[4-6].

Literature revieled that exposure to lead can damage the nervous, hematopoietic and renal systems. Extremely elevated blood lead levels > 70 µg/dL can cause severe neurological problems (*e.g.*, seizure, coma and death)[7]. Although severe cases are rare today the threshold for harmful effects of lead remains unknown[8].

By 1991, CDC had lowered the BLL threshold 66.6 % to 10 µg/dl, from 30 µg/dl in 1975[9,10]. In response to studies in the late 1980s that linked BLLs as low as 10 µg/dl with decreased intelligence and other adverse neurodevelopmental effects[11-13].

Lead has been identified as one of the most commonly occurring contaminants[14]. Vehicular emission and effluents from battery industries had been major contributors to the excessive amounts of lead in the Indian environment. The total estimated release of lead from vehicular traffic emission is 640 TPY[15]. About 50-70 % of this is expected to be released as emissions into the environment. These annual mean values have come down to 350 ng/m^3 in 1996 and 220 ng/m^3 in 1997 as reported in CPCB annual report of 1997-98. This report also indicates that highest emission of lead in Delhi followed by Kolkata, Mumbai and Chennai among the four mega cities. Congested traffic on main roads in cities and old vehicles serves as distributed sources of lead pollution[16]. According to the United Nations (UN) reports, Kolkata the historic well-known city is one of the most polluted cities in the world. However, the systematic data on major pollutants present in the atmosphere of Kolkata are lagging. The present study is centered on Kolkata lies on the eastern bank of the river Hooghly and situated in the Gangetic delta about 100 km from the Bay of Bengal. Within the 104 km^2 of the total city area, 11,500 (approx.)

small and large factories are situated. Out of them about 42 factories produce lead alloys, lead ingots and are located in populated areas. Lead mines, primary and secondary lead smelters and battery-recycling plants discharge lead to the air, to surface waters and to groundwater[17].

Kolkata, the second largest metropolis in south Asia is one of the worst polluted cities in the world. Rapid and unplanned urbanization, uncontrolled vehicular density on insufficient badly cared-for road space, low turnover of old vehicles with too frequent breakdowns and higher use of leaded petrol fuel increases the air pollution in Kolkata[18].

The aim and objective of this study was to ascertain the extent of the lead burden among adults in those polluted area of South Kolkata and the factors related to it, while paying particular attention to the association between blood-lead levels and the distance of their work places from main road. Recent studies showed that pollution is a major concern in Kolkata and the suspended particulate matter (SPM) level is high when compared to other major cities of India[19].

EXPERIMENTAL

Study population: We carried out our survey around number of congested main roads crossings of south Kolkata such as Gariahat crossing, Rasbehari Ave. Golpark crossing, Ballygaunj crossing and Jadavpur 8.B crossing. First of all we selected various food stalls, small markets besides those main roads and crossings and gather volunteers those who works there and spent most of their daily in those polluted areas for their business purposes. Volunteers of both the sexes aged 20-40 were choosen for the study. Six individuals were excluded because they had been recently joining their businesses (some less than month) in these areas.

Questionnaires: Before sample collection, a consent form with expanded information about lead was given to them requesting their consent for blood lead test. Those who were agreed to the lead test then completed a questionnaire about their socio demographic parameters, education, nutrition, potential sources of lead exposure, duration of work of their road side stalls. Questionnaires were translated from English to Bengali and then retranslated into English. Some questionnaires had to be administered by trained interviewer because some workers were not able to complete them without assistance. To determine the exposure to automobile exhaust, volunteers were asked whether their stalls was situated near to a highway or intersection of major roads, a street with moderate to heavy traffic or a street with little traffic.

Sample collection and analysis: After disinfecting the venipuncture site with 95 % ethanol, *ca.* 5 mL of blood was withdrawn from each subject through sterilized syringe. Vacuntainer tubes equipped with blue tap (trace metal free) containing heparin were used. The blood was refrigerating at 4 ºC until the samples were transported to the laboratory, where they were kept at -20 ºC until the blood lead assays were performed. The blood lead levels were determined by graphite furnace atomic absorption spectrophotometry with Zeeman background correction. The samples were diluted 1:10 with 1 % Triton-X-100 in 0.1 % nitric acid and a mixture of ammonium dihydrogen phosphate and magnesium nitrate was used as chemical modifier. Quantification limits obtained for Pb is 0.18 µg/dl in 1:10 blood dilution, corresponding to 1.8 µg/dl in total blood. For the determination of quantification limits a blood sample was obtained from a non-exposed person, the Pb concentration was determined in 10 preparations and the calculations were made according to the IUPAC recommendations[20].

Statistical analysis: Statistical analysis were conducted using SAS software[21]. The centers for disease control and prevention in Atlanta, Georgia associated adverse affects in children with blood lead levels as low as 10 µg/dl or greater or less than 10 µg/dl. The independent variables were gender (female or male), age (20-30 or 31-40 years), business area where individuals spend most of their daily (shops, stalls) close to the main road crossings or interior areas from the busy main roads, consumption of food and water from their stalls (yes or no), daily consumption of milk (yes or no) for blood lead concentrations less than the quantification limit, samples values were estimated by substituting the quantification limit (1.8 µg/dl).

RESULTS AND DISCUSSION

Lead concentration in the blood is less than 1.8 to 29.63 µg/dl. Median values obtained from the volunteers worked close to the congested heavy traffics main roads crossings were higher than those obtained from the volunteers worked far interior areas from the main roads. Because of that the variables were assessed separately in two groups of adult volunteers with regard to area of business, close to or far from the heavy traffic main road crossings.

The median blood lead level in the area close to main roads was 12.32 µg/dl with a range of 1.8 to 29.63 µg/dl. In the other areas far from the main roads the median was 3.47 µg/dl with a range of 1.8 to 17.53 µg/dl (Table-1). In the areas close to the busy main road crossings the percentages of adult volunteers with blood lead levels greater than or equals to 10 and 20 µg/dl were 88.94 and 7.89 %. In the areas far from the main roads, 85.71 % of the adult presented blood lead levels below 10 µg/dl and 14.28 % were above or equals to 10 µg/dl (Table-2).

There were significant difference in median blood lead level in male and female volunteers in the marketing areas close to the main roads (15.63 µg/dl *vs.* 7.36 µg/dl; $p < 0.001$) as in the areas far distant from the main roads (4.42 µg/dl *vs.* 2.07 µg/dl; $p < 0.001$) (Table-3). There were no significant differences in the median blood lead levels in the groups aged 20-30 and 31-40 years in the areas close to the main roads (10.48 µg/dl *vs.* 9.86 µg/dl; $p < 0.081$) and in the areas far from busy main roads (6.75 µg/dl *vs.* 5.76 µg/dl; p? < 0.94) (Table-3).

In this study among the variables associated with blood lead levels, the most important was the area of their business. It was well known that due to their chemical stability in soil, lead and other heavy metals can persist on the ground for many years, even after the closure of the main source of contamination became a permanent

TABLE-1
BLOOD LEAD LEVELS AMONG 232 ADULTS AGED 20-40 YEARS IN THE AREAS OF ROAD SIDE MARKETS OF SOME CONGESTED MAIN ROAD CROSSINGS IN SOUTH KOLKATA

Business area	n	Median (µg/dl)	Range (µg/dl)	p#
Close to main roads*	190	12.32	1.80-29.63	
Other areas far from main roads**	42	3.47	1.80-17.53	<0.001

*Roadside workers and businessman of Jadavpur 8B bus stand crossing, Gariahat crossing, Rasbehari Avn. Golpark crossing, Ballygaunj crossing (urban, congested heavy traffic areas of south Kolkata).
** Interior of Jadavpur, Garia, Dhakuria far from busy main roads (urban and rural areas, interior from main roads).
# p value comparing medians by Wilcoxon tow-sample t test.

TABLE-2
PERCENTAGE OF ADULT VOLUNTEER BY BLOOD LEAD LEVELS GROUP IN THE AREAS OF ROAD SIDE MARKETS OF SOME CONGESTED MAIN ROAD CROSSINGS IN SOUTH KOLKATA

Blood lead level (µg/dl)	Volunteers close tomain roads (n = 190)		Other areas far from main roads (n = 42)		Total (n = 232)	
	n	%	n	%	n	%
< 10	21	11.06	36	85.71	57	24.57
≥ 10	169	88.94	6	14.29	175	75.43
≥ 20	15	7.89	–	–	15	6.46

TABLE-3
EFFECTS OF SOME VARIABLES ON THE BLOOD LEAD LEVELS OF 232 ADULTS AGED 20-40 YEARS FROM AREAS IN AND AROUND THE MARKETING PLACES OF HEAVY TRAFFIC MAIN ROAD CROSSINGS OF SOUTH KOLKATA

Variable	Volunteers close to the main roads			Volunteers far from the main roads		
	n (%)	Median[a]	p[b]	n (%)	Median[a]	p[b]
Entire group	190	12.32		42	3.47	
Age (year)						
20-30	86 (45.26)	10.48		19 (45.23)	6.75	
31-40	104 (54.73)	9.86	< 0.081	23 (54.76)	5.76	< 0.94
Gender						
Male	100 (52.63)	15.63		30 (71.42)	4.42	
Female	90 (47.36	7.36	< 0.001	12 (28.57)	2.07	< 0.001

[a]µg/dl, p[b] = value comparing medians by Wilcoxon tow-sample test.

source of environmental lead exposure for humans living in the area[18]. Vehicular emission was major contributors to the excessive amount of lead in the Indian environment. The amount of the lead inhaled and absorbed through skins depends on the lead levels in the area and the amount of air inhaled by the individuals and as the marketers spend at least 12-14 h around the heavy traffic congested main roads areas so they are more susceptible to inhale and absorbed high amount of lead. The marketers whose area of businesses is very close to the main roads and crossings are more prone to absorbed and inhaled lead as the pollution levels of those main roads crossings are very high. As the farthest areas from the congested main roads was low pollution levels due to low traffics load so the individuals who worked in those interior roads side markets have very low chance of lead burden into their body.

Gender was independently associated with blood lead levels in the present study. With regards to the findings of higher blood lead levels among male than among females this is frequently described in the literature for male and female in the same age groups[22]. Males are more prone to getting outside for their occupational needs than females, being probably more exposed to soil dust, smokes, *etc.* also males are more prone to some bad habits like cigarette smoking, consumption of tobaccos become vulnerable to lead toxicity. Menstrual bleeding can be include as another factor explaining lower blood lead levels in female volunteers. Furthermore most of the females worked in those places spend less time in their occupation than males.

Due to low levels of education most of those adults are nutritionally deprived become prone to nutritional deficiency. Due to their low socioeconomic status most of these people unable to maintain good personal hygiene and habits which could somewhat minimize their personal lead burden. Lead exposure is an environmental problem closely linked to lower socioeconomic status and the general effects of poverty and the specific health effects of lead can generally overlap and be quite difficult to disentangle[24]. Many authors have observed that low socioeconomic status is associated with blood lead levels[25].

Conclusion

In this study area of occupation is the key influencing factors for elevated blood lead levels in South Kolkata, far or close to busy congested main roads crossings, gender and their work hours in roads sides markets. Elevated blood lead levels were seen in those who worked close to main road side food stalls, restaurants, markets *etc.* in comparison to other volunteers who worked far distant from main roads and these needs attention for individual medical assessment and clinical follow up.

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