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Effect of chronic lead exposure on children of Yangon, Myanmar (2): Physical growth and development

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A cross-sectional comparative study was undertaken to explore the effect of chronic low-level lead exposure on the growth and development of children, 82 children in Yangon, who were chronically exposed to lead and 82 non-exposed children who were sex and age matched with the exposed subjects were studied. Blood lead was determined as the indicator for lead exposure. Mean blood lead levels in exposed children were 34.85 ± 9.99, 32.5 ± 18.23 and 36.44 ± 22.37 μg/dl for below 3 years, 3-6 years, and above 6 years age groups respectively while the corresponding values in the non-exposed children were 11.33 ± 8.55, 13.17 ± 8.9, and 15.03 ± 8.7 μg/dl. The differences were statistically significant ($p<0.001$ for all age groups). Percentage of children with height-for-age less than (-3SDs) of National Center for Health Statistics (NCHS) standard was found in 12% of the exposed children but none in the non-exposed ones. Percentage of children with weight-for-age below 3SDs was found in 10% of the exposed children but only 2% among the nonexposed group. Results from the Denver's Developmental Screening Test showed that 23.5% of the exposed children were suspected of having developmental retardation while in the corresponding value in nonexposed children was 12.5%. Present study thus highlighted the detrimental effect of chronic low-level lead exposure on the growth and development of children.

INTRODUCTION

The growth-retarding effects of blood lead concentration have not been well defined. Although the adverse effect of overt plumbism on physical growth has long been recognized [1, 2], the effect of low-level lead exposure on physical growth was not well documented. It was first explored by Schwartz *et al*. using data from the National Health and Nutrition Examination Survey (NHANES) II of 1976-1980 [3]. The NHANES II data for 2695 children 7 years old (included Non-Hispanic Whites, African-Americans, and Mexican-Americans) indicated that blood lead level (range = 4-35 μg/dl) was a statistically significant predictor of children's height, weight, and chest circumference, with control for age, race, sex, and nutritional covariates. However, the cross-sectional nature of the NHANES II survey limited causal inference regarding the relationship.

The results of subsequent studies have been inconsistent. A retrospective study of the growth of 54 Hispanic children from birth to 48 months of age suggested a negative correlation between weight gain and higher blood lead between 15 and 24 months of age [4]. Two longitudinal studies on the African-Americans and non-hispanic Whites did not find any significant association between blood lead and physical growth [5, 6]. In another longitudinal study on the German children, covariate-adjusted heights at 15 and 33 months of age were negatively associated with postnatal blood lead concentrations [7]. Indeed, with control for other variables, including the child's medical history, dietary history, behavior, tobacco smoking of parents, and socio-demographic factors, a study of Danish children showed an inverse association between tooth lead and height [8]. As the similar kind of studies have not been conducted in Myanmar yet, the present study was carried out to explore the impact of chronic low-level lead exposure on the children of Myanmar in terms of physical growth and development.

MATERIALS AND METHODS

It was a cross-sectional comparative study on the children of Myanmar (1 to 12 years old) whose parents were occupationally exposed to lead in the selected townships of Yangon namely New Dagon (South), Hlaingtharyar and Thingangyun, conducted from December 2001 to July 2002. The three townships were selected as the former two townships have Industrial Zones where the battery factories and small-scaled battery shops were located. In Thingangyun Township, there is one ward called "Kyiphwarye" where almost the whole community was engaged in lead smelting business. From each township, list of occupations related to use of lead, were obtained from the Office of Industrial Zones (New Dagon and Hlaingtharyar) and Township Development Committee. According to the list, battery factories, battery shops and lead smelting sites were visited together with the township medical officer and staff from the Industrial Zones/ Township Development Committee. During the visits, lists of workers' children between 1 to 12 years of age were obtained. Children of the workers of Industrial Zones lived in separate areas while children of the workers from Thingangyun lived adjacent to the work site. All children between 1 to 12 years of age listed were recruited for the study.

Parents were given complete information regarding the nature of the study and only the children of those parents who gave voluntary consent were participated in the study. The parents were interviewed for basic demographic information, past and present occupational history, past medical history, and personal hygiene. All children were medically examined, including medical history, anthropometric measurements (height and weight) laboratory tests (blood lead, urinary coproporphyrin) and developmental screening with Denver's Test was done on under-six-year children. Comparable non-exposed subjects from the same selected townships were also assessed with the same procedure.

Determination of blood lead

Blood lead determination was done by dithizone extraction method as described by the National Institute of Occupational Safety and Health in 1987 [9].

Physical growth

Subjects' weight and height were measured (in light clothes and barefoot) to 0.1 kilogram and 0.1 centimeter, respectively, with use of bathroom scale and steadiometer.

Developmental screening test

The development of the children was screened with Denver's Test which is designed to compare a given child's performance on a variety of tasks to the performance of other children of the same age. It can be interpreted as Normal, Suspect and Untestable development of the children between birth and six years of age [10].

Statistical analysis

Comparison of the blood lead levels between the exposed and non-exposed children was made by employing Student's "t" test. For comparison of the height-for-age and weight-for-age values between the two groups chi- square test was applied.

RESULTS

Table 1 presents the general characteristics of the study population. Exposed and non-exposed children were comparable in age, family income and educational attainment of parents.

Table 1. Characteristics of the study population

Characteristics	Exposed	Non-exposed
Total no. of children	82	82
Male	54	44
Female	28	38
Age (mean ± years)		
< 3 yr	1.9 ± 0.81 (14)	2.0 ± 0.90 (14)
3 – 6 yr	4.5 ± 1.06 (32)	4.7 ± 1.12 (34)
>6 yr	9.3 ± 2.21 (36)	9.22 ± 2.13 (36)
Family income (kyats/month) (mean ± S.D.)	16975 ± 153.33	16500 ± 63.58
Father's educational attainment (avg. standard passed)	9.1 ± 3.4	9.07± 2.7
Mother's educational attainment (avg. standard passed)	5.5 ± 2.2	5.2 ± 3.0

Figures in parenthesis show number of samples

Table 2. Comparison of mean blood lead level between exposed and non-exposed children

Age (Year)	Blood lead level (µg/dl) (n) Exposed (82)	Non-exposed (82)	P value
< 3	34.85 ± 9.99 (14)	11.33 ± 8.55 (12)	< .001
3 – 6	32.5 ± 18.23 (32)	13.17 ± 8.92 (34)	< .001
> 6	36.44 ± 22.37 (36)	15.03 ± 8.72 (36)	< .001
Total	34.92 ± 5.32	12.98 ± 8.75	<0.001

Figures in parenthesis show number of children

Table 2 presents the mean blood lead levels of exposed and non-exposed children. For all age groups, exposed children had significantly higher blood lead levels than the non-exposed. Differences were statistically significant. For all age groups, the blood lead levels of exposed children were higher than the cut-off point 15 µg/dl, while in the non-exposed group, children less than 6 years old had <15 µg/dl blood lead level and only in >6 year old group that blood lead level was in borderline.

Comparison of height for age and weight for age of exposed and non-exposed children are shown in Table 3. Percentage of children with height-for-age less than (-3SD) was found in 12% of the exposed children but none in the non-exposed. The differences were statistically significant (p<0.001). Although majority of the children from both groups were found to be in the more than (-2SD) category, higher percent (10% vs 2%) of exposed children had weight for age less than (-3SD). The differences were statistically significant (p<0.005).

Table 3. Comparison of height for age between exposed and non-exposed children

	Exposed % (no)	Non-exposed % (no)	P-value
Height for age			
More than -2 S.D*	64 (52)	78 (64)	0.04
Between (-2 S.D) to (-3 S.D)*	24 (20)	22 (18)	0.71
Less than (-3 S.D)*	12 (10)	0	0.001
Weight for Age			
More than -2 S.D*	54 (44)	71 (58)	0.02
Between (-2 S.D) to (-3 S.D)*	36 (30)	27 (22)	0.18
Less than (-3 S.D)*	10 (8)	2 (2)	0.05

*NCHS (1983)

Table 4. Developmental screening of exposed and non-exposed children

Category	DENVER Interpretation	Number of children	%
Exposed	Normal	25	73.5
	Untestable	1	3.0
	Suspect	8	23.5
Non-exposed	Normal	28	87.5
	Suspect	4	12.5

Results of the developmental test are presented in Table 4. The screening test showed that higher percent of exposed children were suspected of having developmental retardation than the non-exposed children.

DISCUSSION

There are few published investigations on the relationship of blood lead and growth. Some investigators indicate that children with blood concentrations between 2.40 and 2.88 umol/L are characterized by short stature when compared with standards of height [11, 12]. On the other hand, other studies report that children who experienced severe lead poisoning did not differ in stature from their controls who happen to be their siblings [13]. Experimental studies do show that neurobehavioural deficits, organ pathology, and weight deficits in rats are evident at blood lead concentrations that range from 8.0 to 24.0 µg/dl[14].

The present is the preliminary study to find the blood lead profile of children whose parents were occupationally exposed to lead and to determine the effect of chronic lead exposure on the growth and development of children. According to the Center for Diseases Control's (CDC) lead values, blood lead level of more than 10 µg /dl in a child is considered high. Results of the present study implied that all children whose parents were exposed to lead from their occupation had high blood lead levels and thus run the risk of chronic lead poisoning. They had significantly higher blood lead levels than their non-exposed counterparts. As both groups of children resided in the same community and comparable in age and ***socioeconomic status*** the differences in the biochemical indicators most probably reflect the parents' exposure to lead. Finding of high blood lead levels in certain percent of non-exposed children might probably due to living in the community where environmental exposure to lead was present.

Findings of the present study is in accord with the others as percentage of having less than (-3SD) height for age and weight for age values of NCHS standard were significantly more among the exposed children than the non-exposed. This finding, although, showed association between under-nutrition and increased blood lead level, is not conclusive evidence of the detrimental effect of chronic lead exposure on the physical growth of children, as dietary and other assessments related to nutritional status had not been conducted. But the findings emphasized the need to conduct more research in this aspect and for appropriate precautionary measures to be undertaken.

The results of the Denver's Developmental Screening Test indicated that, exposed children might be having developmental retardation. As the nature of the test is screening only, it could not be drawn into conclusion, but pointed out the need for further testing by more definitive tests.

The present study demonstrated that children of the parents who were involved in occupation exposed to lead were causing chronic lead exposure to the workers' children as evidenced by the blood lead levels. This exposure might also be exerting detrimental effects on the health of the children as shown by the anthropometric measurements and developmental screening test and more research should be devoted in this context to have conclusive evidence.

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