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Effect of chronic lead exposure on children of Yangon, Myanmar (1): blood lead and urinary coproporphyrin profiles

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To study blood lead and urinary protoporphyrin levels of the children in Yangon, Myanmar, who were chronically exposed to lead, a total of 82 children whose parents worked in the small-scaled accumulator battery repairing and reconditioning-recharging shops in New Dagon (South), Thingangyun, and Hlaingtharyar townships were studied. Eighty- two non-exposed children who were sex and age matched and comparable in socioeconomic characteristics as exposed children served as controls. Blood lead and urinary coproporphyrin levels were determined as indicators for lead exposure. Mean blood lead levels in exposed children were 34.85+9.99, 32.5+18.23 and 36.44+22.37 ug/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 ug/dl. The differences were statistically significant ($p<0.001$ for all age groups). Coproporphyrin levels were found to be 243.7+20.8, 172.1+13.8, and 326.4+32.4 ug/L in the exposed children for less than 3 years, 3-6 years, and above 6 years age groups respectively. The corresponding values in the non-exposed children were 85.4+28.0, 114.2+22.0, and 115.1+14.5 ug/L. The differences were also statistically significant in less than 3 year age and more than 6 year age groups ($p<0.001$ for both groups).

INTRODUCTION

The relationship between environmental hazards and the health of human communities is of growing concern and increasing interest to governmental and public health administrators, politicians and public [1]. There is no doubt at all that human industrial activities release chemicals into the general environment and not infrequently, episodes of chemical poisoning occurred [2,3]. In developing countries like Myanmar, the major problem of occupational chemical poisoning arises in small-scaled private owned industries where there is some extent of local pollution by hazardous substances. Lead is widely accepted as a major environmental threat. Improved medical surveillance has decreased the number of overt cases of lead poisoning but the consequences of long term increased lead absorption and its sub-clinical health impact, especially on the nervous system, remains a major concern [4].

The growth-retarding effects of blood lead concentration have not been well defined. Some studies report no residual effects associated with lead poisoning [5, 6] whereas others indicate growth retardation associated with moderate and high blood lead concentration [7, 8]. The difficulty of ascertaining a clear relationship between blood lead concentration and growth is that high concentration of lead is usually found under poor socioeconomic conditions. The purpose of the present study was to assess the blood lead levels of children of Myanmar who were chronically exposed to lead related to physical growth, development and the parameters of increased lead absorption. The present paper is concentrating only on the blood lead and urinary coproporphyrin levels of the study population.

MATERIALS AND METHODS

It was a cross-sectional, community-based study on the children of Myanmar (1 to 12 years old) whose parents were occupationally exposed to lead in the selected townships of Yangon, conducted from December 2001 to July 2002. The study areas were New Dagon (South), Hlaingtharyar, and Thingangyun Townships. As a preliminary study, the capitol of Myanmar, Yangon, was purposely chosen. 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, the list of desired occupations 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, the 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.

After arrangements had been made, children, together with either of their parents were requested to come to the respective urban health centres. Parents were given a 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 also medically examined, including medical history, anthropometric measurements (height and weight), laboratory tests (blood lead, urinary coproporphyrin) and developmental screening with Denver's Test [9] was done on under-six-years children. Comparable non-exposed subjects from the same selected townships were also assessed similarly to serve as controls.

Determination of blood lead

Blood lead determination was done by dithizone extraction method as described by NIOSH (1987) [10].

Determination of urinary coproporphyrin

Urinary coproporphyrin level was measured by the method as described by Askevold in 1956.

Statistical analysis

Comparison of the blood lead levels and urinary coproporphyrin levels between the exposed and non-exposed children was made by employing Student's "t" test for parametric data and X^2 test for nonparametric data. For comparison of the above parameters among the different nature of parents' occupation among the exposed group, analysis of variance test was used.

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 2 presents the mean blood lead and urinary coproporphyrin 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

Table1. Characteristics of the study population

Characteristics	Exposed	Non-exposed
Total no. of children	82	82
Male	54	44
Female	28	38
Age (mean ±years)		
0 – 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 and mean coproporphyrin levels between exposed and non-exposed children

Age (year)	Blood lead level (ug/dl) (n)			CPU level (ug/L) (n)		
	Exposed (82)	Non-exposed (82)	P value	Exposed (82)	Non-exposed (82)	P value
0 – 3	34.85 ± 9.99 (14)	11.33 ± 8.55 (12)	< .001	243.7 ± 20.8 (14)	85.4 ±28.0 (12)	< .001
3 – 6	32.5 ± 18.23 (32)	13.17 ± 8.92 (34)	< .001	172.1 ± 13.8 (32)	114.2 ± 22.0 (34)	NS
>6	36.44 ±22.37 (36)	15.03 ± 8.72 (36)	< .001	326.4 ± 32.4 (36)	115.1 ± 14.5 (36)	< .001
Total	**34.92 ± 5.32**	**12.98 ± 8.75**	**<0.001**	**252.07 ±23.2**	**110.38 ±19.9**	**<0.01**

Figures in parenthesis show number of sample
NS = not significant

significant. Mean CPU level for exposed children is 243.7 ± 20.8 ug/L for under 3 years, 172.1 ± 13.8 ug/L for 3 to 6 years and 326.4 ± 32.4 ug/L for more than 6 years age groups. In non-exposed children the corresponding values were 85.4, 114.2, and 115.1 ug/L. Although exposed children had higher urinary coporporphyrin levels in all age groups, the differences were statistically significant in less than 3 years age group and more than 6 years age group only.

Blood lead levels of children disaggregated by the nature of parents' occupation are shown in Figure 1. It was found that children of lead smelters and parents involved in battery repairing had the highest blood lead levels, although the differences were not significant. Children were of comparable age.

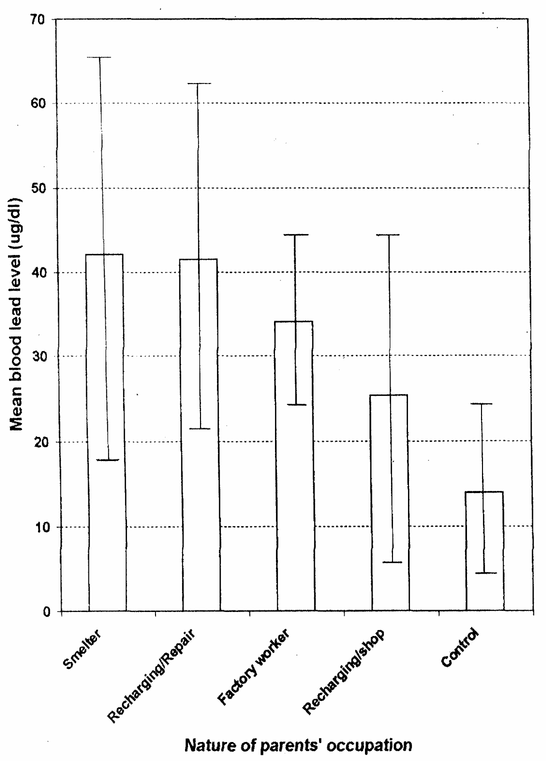

Fig 1. Mean blood lead level of children by nature of parents' occupation

Comparison of percentage of children with high blood lead and urinary coproporphyrin levels using the cut-off point of 10 ug/dl and ≥75 ug/L respectively, between exposed and non-exposed children is shown in Table 3.

In all age groups, number of children with high blood lead levels was found to be significantly more in exposed children. No children among the exposed had blood lead level lower than the cut-off value. The differences were significant. Except for <3 years age group, percentage of children with coproporphyrin level more than the cut-off value of 75 ug/L was significantly higher among the exposed children than in the non-exposed children.

Table 3. Comparison of percentage of children with high blood lead and urinary coproporphyrin levels between exposed and non-exposed children

Blood lead level	Exposed No.(%) (n=82)	Nonexposed no.(%) (n=82)	p value	Copropor-phyrin Level	Exposed no.(%) (n=82)	Nonexposed no.(%) (n=82)	p value
0-3 yr				0 -3 yr			
<10 ug/dl	0	8 (9.75)		<75 ug/L	2 (2.45)	4 (4.89)	0.68
≥10 ug/dl	14 (17.07)	4 (4.87)	< 0.01	≥75 ug/L	12 (14.63)	8 (9.76)	0.30
3-6 yr				3 -6 yr			
<10 ug/dl	0	18 (21.95)		<75 ug/L	10 (12.19)	22 (26.83)	0.02
≥10 ug/dl	32 (39.02)	16 (19.51)	<0.001	≥75 ug/L	22 (26.83)	12 (14.63)	0.05
>6 yr				> 6 yr			
<10 ug/dl	0	24 (29.27)		<75 ug/L	10 (12.20)	20 (24.39)	0.04
≥10 ug/dl	36 (43.91)	12 (14.63)	< .001	≥75 mcg/L	26 (31.70)	16 (19.51)	0.07

Cut-off point for high blood lead and coproporphyrin levels in children: ≥ 10 ug/dl and ≥ 75 ug/L (Centers of Disease Control) (1991)

DISCUSSION

Since time immemorial, it has been known that lead exposure is deleterious to health. Various studies have been undertaken on environmental, occupational and other exposure to lead. Children, being most susceptible to ill effects of lead exposure have been given particular attention [1, 2, 4].

The present study is the preliminary study to evaluate 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 Centre of Diseases Control (CDC) lead values, blood lead level of more than 10 ug/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 and urinary coproporphyrin excretion 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 be due to living in the community where environmental exposure to lead was present.

Blood lead and urinary coproporphyrin levels among the exposed children, sub-categorized by their nature of their parents' occupation, showed that lead smelting ran the highest risk of exposure, followed by battery repairing. Children whose parents were doing only battery recharging alone and/or selling of battery had lowest levels of blood lead among the exposed children. The finding highlights the hazardous nature of work in the context of lead exposure. Lead smelting releases lead fumes which can readily enter the body via respiratory tract. Besides, families of the lead smelters resided adjacent to the work-site and thus more likely to be exposed. In battery repairing, the old or condemned battery is opened and the lead plates are taken out. Lead is recovered by beating the old plates to obtain lead paste. The latter is then powdered in a mortar. Thereafter, lead powders are melted and moulded into lead rods for soldering. A paste is made from the lead oxide powder and is then pressed onto the grid manually. Thus, battery repairing is more exposed to lead than selling batteries and recharging. As mentioned previously, children of parents working in the Industrial Zones lived separately from work-site, and yet had high blood lead levels. Lead transmitted into the homes via contaminated parental work clothing was the probable source of excessive lead exposure to the children.

The present study demonstrated that although lead smelting, battery repairing and small-scaled battery factories are small scale in nature, use of lead in these shops were causing chronic lead exposure to the workers' children as evidenced by the blood lead and urinary coproporphyrin levels.

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