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Original Article

Paediatrics Section

Blood Lead Levels in Children of Southwest Iran, Aged 2-6 Years and Associated Factors

GHOLAMREZA PANAHANDEH[1], ABOLFAZL KHOSHDEL[2], ESFANDIAR HEIDARIAN[3], MASOUD AMIRI[4], HADIS RAHIMINAM[5]

ABSTRACT

Introduction: Lead is one of the toxic metals that can cause several complications in children.

Aim: This study was conducted to determine Blood Lead Levels (BLLs) in healthy children and its association with individual and environmental factors.

Materials and Methods: This descriptive-analytical study was conducted on 262 healthy children aged 2-6 years in Shahrekord, Southwest Iran in 2013. After taking serum samples from the children, the checklists of effective environmental factors on lead toxicity were completed after interviewing the parents. BLLs were determined by ICP-MS. Data were analysed by descriptive and analytical statistics (chi-square and ANOVA) in SPSS 16.

Results: BLLs ranged 0.4-52.8 (mean: 6.9±7.9) ng/ml. BLL was significantly associated with father's education level, house colour damage, canned food use and soil eating ($p<0.05$), but not with age, gender, economic status, proximity to factory and kohl use ($p>0.05$).

Conclusion: BLL can cause serious health risks for children in Shahrekord and is associated with certain risk factors. It is necessary to screen for these risk factors.

Keywords: Environment, Poisoning, Toxicity

INTRODUCTION

Lead is a highly toxic metal with well known adverse effects [1]. However, the effects and complications of lead in children have been addressed more frequently, because exposure to lead in childhood may affect the entire lifetime. The main disorders associated with exposure to lead are due to induction of oxidative stress [2] with certain adverse complications such as emotional and behavioural disorders [3], cognitive problems and decline in IQ [4], attention and academic achievements in preschool children [5].

Currently, approximately four million families have children with exposure to high levels of lead [6]. Lead is found normally in human body and considered pathological in small amounts [7]. However, the safe levels of lead for children have not yet been determined. For example, Center for Disease Control and Prevention (CDC) recommends BLLs to be ≤ 10 µg/dl varying depending on race, social class and levels of public health [6]. However, CDC considers 5µg/dl to be the reference BLL in children [5]. The environmental factors for lead poisoning in children are fossil fuel poisoning [8,9], drinking water [10,11], melting batteries [12], food [13], house dust [14] and exposure to cosmetics, colour and newspaper [15].

Lead is absorbed by the body through various ways. This toxic metal may be absorbed by the body through oral mucosa, nose, or eyes, but the most important ways of lead's entering the body, especially in children, are inhalation and food [16]. A study demonstrated that environmental factors, sociocultural factors such as parent's low education level, unemployment, occupational lead exposure and low social class, smoking at home, worn out building, consumption of contaminated vegetables, playing in contaminated environment and being male contributed to lead poisoning among children [17].

In a study, the mean level of lead poisoning in children was estimated to be approximately 57µg/dl and all the studied children were reported to have lead poisoning [18].

Adoption of certain preventive strategies, particularly for children at high risk, can help to prevent the adverse effects of lead. Therefore, determining the prevalence rate of lead poisoning can pave the way to conduct a purposeful and well organized intervention, particularly because lead poisoning has no obvious symptoms [6]. The aim of this study was to investigate BLLs in children and its association with environmental and individual variables in Shahrekord, Southwest Iran.

MATERIALS AND METHODS

This descriptive-analytical study was conducted on 262 healthy children aged 2-6 years who visited a Private Health Center for regular health check up, rather than any specific disease, in Shahrekord between October-December, 2013. The participants were enrolled according to convenience sampling. The inclusion criteria were no medical diseases, no previous lead poisoning and no diagnosis of anemia; the exclusion criteria were not volunteering to participate in the study. The children's parents provided signed informed consent for their children's participation in the study. The Ethical Committee of the Shahrekord University of Medical Sciences approved the study's protocol with approval number 4-2-92. The blood samples (3cc) were taken after completing the questionnaires and interviewing the parents. A checklist was developed according to other studies and its validity confirmed by experts [3,8,9,14].

The data on father's education level and economic status were recorded in a questionnaire of demographic characteristics. The amount of used canned foods was also noted. If the child used more than two canned foods per week and the remaining canned food was left in the can, he/she was assigned to Group 1, if the child used 1-2 canned foods per week and the remaining food was left in the can, he/she assigned to Group 2 and if the child used 1-2 canned foods per week and the remaining food was not left in the can, he/she assigned to Group 3 and those children that did not use canned food assigned to Group 4.

The children were categorised into four groups according to safety levels of innovation of their houses (according to US Environmental Protection Agency): living in houses with highly unsafe renovation, moderately unsafe renovation and lowly unsafe renovation and without unsafe renovation [19]. The children were categorised into two groups according to their houses' proximity to factory: presence/absence of factory near house. The children were categorised into

four groups for soil eating: high, moderate, slightly and never. If all three types of soil eating were present in a child for at least one month, the level of soil eating was considered high. Moreover, the children were categorised into four groups according to the level of colour damage and loss of house: high, moderate, slightly and never [20].

The children were assigned to three groups according to the rate of kohl use. If a child used kohl each month, he/she was assigned to Group 1. If a child used kohl more than once a year and less than once a month, he/she was assigned to Group 2 and if a child used kohl once a year, he/she assigned to Group 3 and those children that did not used kohl assigned to Group 4.

BLL was measured using inductively coupled plasma mass spectrometry (ICP-MS 7500a, Agilent, USA). The samples were poured into polyethylene, clamshell and clean tubes containing no anticoagulants for isolating serum. Then, the blood samples were kept at room temperature for 30 minutes to 1 hour to clot. After clotting, the samples were centrifuged at 1000 REV/minute for 15 minutes. After centrifugation, 1 ml of the isolated serum was poured into 2 ml clamshell tube and immediately frozen at -20°C. Necessary arrangements were made including keeping the samples under cold chain circumstances in transfer and in the destined laboratory.

Because the samples needed no special preparation, they were transferred to a tube containing argon nebulizer using an autosampler and introduced into heated plasma chamber by argon. Each time, a 0.25 ml sample was introduced into the instrument using the autosampler. On average, 10 minutes was spent for each sample. The results on the samples were expressed in ng/ml. Then, the data were analysed by descriptive and analytical statistics (ANOVA and t-test) in SPSS 16.

RESULTS

In this study that investigated the association of effective factors on BLL, the frequency and effect of certain factors such as age, gender, father's education level, economic state, proximity to factories and home age are shown in [Table/Fig-1]. BLL ranged 0.4-52.8 (mean: 6.9±7.9) ng/ml. The children were categorised into six groups according to BLL: over 50 ng/ml, 40-49.9 ng/ml, 30-39.9 ng/ml, 20-29.9 ng/ml, 10-19.9 ng/ml and under 10 ng/ml.

As shown in [Table/Fig-1], BLL is significantly associated with father's education level ($p<0.05$).

Moreover, the frequency and association of other variables with score scales of High, Moderate and Slightly are shown in [Table/Fig-2]. As shown in [Table/Fig-2], mean BLL was associated with all studied variables except for kohl use ($P>0.05$).

DISCUSSION

In this study, the range of BLL was estimated to be 0.4-52.8 ng/ml with mean level of 6.9±7.9 ng/ml in children aged 2-6 years in Shahrekord, Southwest Iran. Even, the lead amounts of less than 10 µg/dl have been reported to cause decline in IQ in children under six years [7,21]. Despite the fact that Shahrekord County is not considered to be an industrial region, the environmental pollution due to industries is not much considerable.

Some studies conducted in Iran have shown that lead poisoning, especially in children, is much heavier than poisoning due to other metals [22,23] and BLL has been obtained even up to 57 µg/dl [18]. Maleknejad S et al., study reported BLL in children to range from 4.924 µg/dl to 11.643 µg/dl [24].

BLL of children in industrial cities such as Shanghai, China [25], Morelos, Mexico [26] and Dhaka, Bangladesh has been reported to be 22.49 µg/dl, 7.23 µg/dl and 15.0 µg/dl, respectively [8].

Such varying figures of children's lead poisoning in different regions can be due to different poisoning levels in different regions, socioeconomic conditions of the community and adoption of strategies to reduce lead poisoning and environmental pollution in different countries.

In the present study, several factors such as father's education level, house age, house colour loss, consumption of canned foods and soil eating were found to be effective on BLL. Consistent with these findings, a study demonstrated that socioeconomic status played a determinative part in lead poisoning in children [27]. Kaiser R et al., study demonstrated that some factors including soil eating, parent's low education level and proximity to busy roads were associated with BLL in children [8]. Besides that, Etchevers A et al., study indicated that BLL was significantly associated with house colour loss, old house renovation, oral manual behaviours and passive smoking [28]. A study showed that the age of child, lower economic status, building age, presence of deteriorated paint, home-apartment type and recent renovation were associated with BLL in children [29].

Variables	Group	Number (%)	Serum levels of lead (ng/ml)						Mean level of serum lead (ng/ml)	p-value
			<10	10-19.9	20-29.9	30-39.9	40-49.9	>50		
Age	2 year	54(21)	50	2	1	0	1	0	6.2 ± 4.9	0.06[a]
	3 year	71(27)	64	4	0	1	2	0	8 ± 6.8	
	4 year	43(16)	40	2	0	1	0	0	6.1 ± 5.8	
	5 year	50(19)	41	4	2	1	1	1	9.6 ± 9.1	
	6 year	44(17)	35	5	3	0	1	0	8.6 ± 8.1	
Sex	Male	137(52)	120	10	3	2	1	1	7.4 ± 6.7	0.69[b]
	Female	125(48)	110	7	3	1	4	0	8.5 ± 7.1	
Education level (father)	Illiterate	14(5.3)	11	0	1	1	0	1	14.5 ± 11.7	0.04[a]
	High school completion	130(49.6)	115	5	3	2	5	0	9.3 ± 7.4	
	Bachelor's degree	100(38.2)	87	11	2	0	0	0	4.5 ± 5.8	
	Bachelor's degree<	18(6.8)	17	1	0	0	0	0	2.8 ± 5.4	
Economic status	Poor	15(5.7)	12	1	0	1	0	1	13.9 ± 5.8	0.21[a]
	Moderate	109(41.6)	92	8	4	1	4	0	9 ± 7.6	
	Good	85(32.4)	79	4	1	0	1	0	5.7 ± 5.8	
	Very good	53(20.3)	47	4	1	1	0	0	6.3 ± 6.4	
Proximity to factory near house	Yes	23(8.8)	18	2	1	0	2	0	11.1 ± 9.6	0.09[b]
	No	239(91.2)	212	15	5	3	3	1	7.5 ± 6.6	

[Table/Fig-1]: Frequency and the levels of significance of age, gender, fathers' education level, economic status and proximity to factory with mean blood lead level.
[a]ANOVA test; [b] t-test

Variables	Group	Number (%)	Serum levels of lead (ng/ml)						Mean level of serum lead (ng/ml)	p-value[a]
			<10	10-19.9	20-29.9	30-39.9	40-49.9	>50		
Used canned food	High	7(2.6)	4	0	0	2	1	0	18.9 ± 20.4	<0.0005[a]
	Moderate	35(13.4)	26	3	2	1	2	1	13.3 ± 11.1	
	Slightly	161(61.5)	146	10	4	0	1	0	4.9 ± 6.1	
	Never	59(22.5)	54	4	0	0	1	0	6.1 ± 4.9	
Soil eating rate	High	3(1.1)	0	0	1	1	1	0	12.6 ± 37.4	<0.0005[a]
	Moderate	7(2.7)	4	1	1	0	0	1	18.2 ± 16.2	
	Slightly	54(20.6)	36	10	4	1	3	0	10.2 ± 11.5	
	Never	198(75.6)	190	6	0	1	1	0	4.1 ± 4.8	
Unsafe renovation	High	16(6.1)	8	4	0	1	2	1	17 ± 17.8	<0.0005[a]
	Moderate	31(11.8)	13	8	5	2	3	0	12.6 ± 16.6	
	Slightly	86(32.8)	81	4	1	0	0	0	3.2 ± 5.9	
	Never	129(49.2)	128	1	0	0	0	0	1.6 ± 3.8	
level of colour damage	High	2(0.80)	1	0	0	0	0	1	30.9± 30.9	<0.0005[a]
	Moderate	10(3.8)	2	0	2	2	4	0	15.5 ± 30.5	
	Slightly	50(19.1)	32	13	4	1	0	0	7.1 ± 10.3	
	Never	200(76.3)	195	4	0	0	1	0	3.6 ± 4.6	
Used kohl	High	1(0.4)	1	0	0	0	0	0	4.1± 7.2	0.99[a]
	Moderate	1(0.4)	1	0	0	0	0	0	4.1± 5.2	
	Slightly	30(11.2)	26	2	1	1	0	0	7.3 ± 6.9	
	Never	230(87.7)	202	15	5	2	5	1	8.1 ± 6.9	

[Table/Fig-2]: Frequency and the levels of significance of the frequency of use of canned foods, soil eating, unsafe renovation, level of colour damage and kohl use with mean serum levels of lead.
[a]ANOVA test; [b] t-test

In the present study, mean BLL did not change with increase in age. Moreover, BLL was not significantly associated with gender. However, some studies have demonstrated that lead poisoning is more prevalent in boys than in girls and BLL escalates with increase in age [24,30].

Obviously, children with parents with higher educational levels and socioeconomic status live in better environments and are monitored for their behaviours more strictly. Such parents are more likely to have appropriate information about children nutrition and exposure to other environmental chemicals.

Clearly, the severity of lead poisoning can be influenced by many factors and different methodologies in different studies and different ways to control for confounders may influence certain variables.

LIMITATION

Lack of studying all variables involved in children's BLL and blood minerals, as confounders, is a limitation of the current study.

CONCLUSION

The presence of lead in the children's blood in Shahrekord, Southwest Iran represents a risk for contaminated children's health. Risk factors for increased BLL in children were found to be father's education level, house colour lose, consumption of canned food and soil eating. As lead poisoning cannot be diagnosed in many children and remains undiagnosed, determination of risk factors for lead poisoning in children can pave the way to adopt certain programs to screen children who are at high risk so that the chronic complications due to poisoning with this heavy metal can be minimized.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Paediatrics, Shahrekord University of Medical Sciences, Shahrekord, Iran.
2. Associate Professor, Department of Paediatrics, Shahrekord University of Medical Sciences, Shahrekord, Iran.
3. Professor, Clinical biochemistry Research Center, Shahrekord University of Medical Sciences, Shahrekord, Iran.
4. Associate Professor, Department of Epidemiology and Biostatistics, Shahrekord University of Medical, Shahrekord, Iran.
5. General Practitioner, Shahrekord University of Medical Sciences, Shahrekord, Iran.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Abolfazl Khoshdel,
Associate Professor, Department of Paediatrics, Shahrekord University of Medical Sciences,
Shahrekord, Iran.
E-mail: nikakhosh@gmail.com

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