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Assessment of lead level in 1 to 6 years old children in Mashhad city, north east of Iran

Abstract

Background: Lead is a harmful heavy metal for humans, especially for children. Lead has adverse effects on central nervous system development, bone growth, heme synthesis and kidney functions. Lead has become widely distributed in the environment especially in developing countries. In a study performed on 206 children aged 1 to 7 years who were referred to pediatric outpatient clinic and pediatric emergency service of Imam Reza hospital of Mashhad, 74.8% of children had blood lead levels (BLL) more than 100µg/Lit which was more than other counties children blood lead level.

Objectives: Based on our previous study that in children who admitted in hospital the blood lead level was high, we designed this study to assess blood lead level in children of Mashhad city north east Iran.

Materials and methods: It was a cross sectional study with a cluster sampling method which was carried out on 74 children, 1 to 6 years old in 51 primary care clinics. The clinics cover all the city. We also studied selected risk factors. Distribution of obtained data was not normal, so we normalize the data. Variables were analyzed by SPSS version 11.5, T-Student test and $p<0.05$ was considered significant.

Results: In 13.5% of children, the BLL was more than 100µg/Lit. There was a relation between old house lived children and BLL. There was also a relation between low family income and BLL.

Conclusion: In comparison with developed countries, BLL of children in Mashhad are acceptable. Low family income is significant predictors of having higher BLLs. The flakes of house paints are a potential source of lead poisoning for children.

Keywords: lead, children, iran, clinics

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Ahmadshah Farhat,[1] Habibollah Esmaily,[2] Emad Askary,[3] Ashraf Mohammadzadeh,[4] Mohammad Reza Majdy[5]

[1]Assistant professor of neonatology, Mashhad University of Medical Sciences, Iran
[2]Associated professor of biostatistics, Mashhad University of Medical Sciences, Iran
[3]General physician, Mashhad University of Medical Sciences, Iran
[4]Professor of neonatology, Mashhad University of Medical Sciences, Iran
[5]Associated professor of pediatrics, Mashhad University of Medical Sciences, Iran

Correspondence: Asgari Jafarabadi E, Assistant professor of neonatology, Neonatal Research Center, Imam Reza Hospital, Faculty of Medicine, Mashhad University of Medical Sciences, Iran, Tel +98(511)7689260, Email dr.askery@hotmail.com

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Introduction

In 1991, the Centers for Disease Control and Prevention (CDC), defined blood lead levels of 100 micrograms/liters as toxic and should prompt public health actions. The CDC also recognized that a blood lead level of 100 micrograms/liters did not define a threshold for the harmful effects of lead and recent studies have extended the level to <100 micrograms/liters.[1]

Children are more likely than adults to be exposed to lead because of their exploratory behavior and because they absorb more of any ingested dose. The major anatomic targets of lead toxicity are the blood, nervous system, gastrointestinal tract, and kidneys. Lead interferes with normal heme biosynthesis. Typically, a microcytic, hypochromic, and mild hemolytic anemia appear in children that are exposed to excess lead. These children are prone to developing brain damage. The brain damage may either be very subtle, producing mild dysfunction, or may be significant and lethal. In young children, sensory, motor, intellectual, and psychological impairments have been described, including reduced IQ, learning disabilities, retarded psychomotor development, blindness, and in more severe cases; psychoses, seizures and comas. In children, excess lead interferes with the normal remodeling of calcified cartilage and primary bone trabeculae formation in the epiphyses. The gastrointestinal tract is also affected, and is characterized by severe, poorly localized abdominal pain. Chronic renal damage may also occur.[2]

Most symptoms of lead poisoning are non-specific. The symptoms range from fatigue, concentration difficulties, sleep disturbances, headaches, weight loss, nausea, and myalgia with mild to moderate toxicity to the classic features of severe toxicity of abdominal cramps, renal disease, encephalopathy, convulsions, and peripheral neuropathy. Motor neuropathy leads to the classic lead palsy, affecting the long extensor muscles of the limbs. Lead induced Fanconi syndrome is more likely to occur in children. Unique features include a blue line on the dental margins of the gums and saturnine gout.[3] Today lead, poisoning rarely results in severe symptoms, but there is growing evidence that unwarranted exposure, even with blood lead levels below those usually associated with symptoms, can lead to poor classroom performance, impaired educational performance, inattention and hyperactivity, juvenile delinquency, impaired motor development, behavioral problems, and lower IQ levels.[4]

Unlike overt lead toxicity, where there is usually one identifiable source, low-level environmental exposure to lead is associated with multiple sources (petrol, industrial processes, paint, solder in canned foods, water pipes) and pathways (air, household dust, street dirt, soil, water, food). Evaluation of the relative contributions of sources is therefore complex and likely to differ between areas and population

groups.[5] In multivariate analyses, gender, age, generational status, home language, family income, education of head of household, age of housing, and source of drinking water were statistically significant independent predictors of having higher blood lead levels.[6]

There has been a growing concern in the last few years with the exposure of children to environmental chemicals. Children have a greater exposure to environmental pollutants than adults, because their metabolic needs and behaviors put them at special risk of contact with chemicals when they breathe, eat, drink, or play.[7] The average gastrointestinal absorption of lead is much greater in infants and young children than in adults and the absorption is increased in the presence of nutritional deficiencies that are more common in children than in adults, e.g. deficiency of iron.[4]

Although adverse health effects of heavy metals have been known for a long time, exposure to heavy metals continues and is even increasing in some areas. For example, Tetraethyl lead remains a common additive to petrol, although, this usage has decreased dramatically in developed countries.[7] In recent years, most developed countries have made concerted efforts that have led to a reduction in the introduction of lead into the ambient environment, reflecting a decline in the commercial use of lead, particularly in petrol.[8] In a study carried out in California on one to six year old children, 7.25% of children had blood lead levels more than 100 micrograms/liters. In a study carried out in Massachusetts, 22% of six month to six year old children had blood lead levels more than 100 micrograms/liters. In a study carried out in Vancouver, Canada, 8.1% of two to three year old children had blood lead levels more than 100 micrograms/liters.[9]

The level of exposure to lead is falling in some developing countries because of the reduced use of lead in petrol and elsewhere, however, lead continues to be a significant public health problem in developing countries, where considerable variations in the sources and pathways of exposure still exist.[7] According to studies in some developing countries, in Cape Province of South Africa, over 90% of the children in some urban and rural communities had blood lead levels more than 100 micrograms/liters. In Mexico City, 44% of children aged one and a half to five had blood lead levels more than 100 micrograms/liters.[5] In Uruguay, 36% of children aged less than 14 had blood lead levels more than 100 micrograms/liters. In Waxy City of China, 27.3% of children had blood lead levels more than 100 micrograms/liters.[9] In Visayas region in the central Philippines, 21% of children had blood lead levels more than micrograms/liters.[10] In Jakarta in Indonesia, 35% of children had blood lead levels more than 100 micrograms/liters.[11] In India, 29% of children had blood lead levels more than 100 micrograms/liters.[12]

The significance of lead poisoning has recently gained public attention in Iran, but there are no sufficient data to support this. In a study performed by Fahat on 206 children aged one to seven years old who were visited at the pediatric outpatient clinic and the pediatric emergency department of Emam Reza Hospital of Mashhad, from January 2001 to January 2002, the mean blood lead level was 121.95±33.59 micrograms/liters and in 74.8% of children the lead levels were more than 100 micrograms/liters.[9] According to this study, children in Mashhad were at high risk of lead poisoning. In June 2002, the National Iranian Oil Company announced that the production of petrol containing lead had been stopped since March 2002. The current study was designed to assess the extent of lead poisoning among children in Mashhad.

Methods

It was a cross sectional study with a cluster sampling method. Children are more exposed to environmental pollutants than adults, and they are more vulnerable to the toxic effects of these chemicals. The sample size of the study was calculated according to the results of Farhat's study (10), with a 95% confidence and standard deviation 35.3 and error of 8µgr/Lit. It was carried out on 74, 1 to 6 years old children in 51 governmental primary care clinics in Mashhad from April to May of 2007. These primary care clinics cover the entire city. the entrance criteria was children 1-6year old whose parents gave us just written consent for study and we did not exclude any case. We took 1 or 2 samples from each clinic and the samples were not random. Each sample consists of 3 to 5cc of venous blood. In this study, the samples were sent to toxicology laboratory of Emam Reza hospital in heparinized tubes and analyzed by same laboratory and same toxicology laboratory technician. The Perkin Elmer 3030 atomic absorption spectrophotometer was used with the heated graphite absorption system, and the standard addition calibration method. The method of obtaining data was interviewed with the parents of the children, and written informed consent was obtained. We also studied selected risk factors and the children diseases were not recorded. The data were obtained through questionnaires prepared before the study by toxicologist and pediatricians and public health care professional. The obtained data include; type of paint used in houses, date of the last painting of houses,[13–15] monthly income of families[6] and number of family members.[16] The obtained data was analyzed by SPSS version-11.5 software. We tested normality of lead levels with Kolmogorov-Smirnov test; they did not have a normal distribution, so we describe lead level by median and interquartil range (IQR) and analyzed by nonparametric Mann-Whitney test and spearman correlation. and $p<0.05$ was considered significant.

Results

In this study, we measured blood lead levels on 74 children aged 1 to 6 years old in Mashhad. The mean age of children was 45.23±18.39 months, and the median (Interquartail Range, IQR) blood lead level was 72.5(27)µg/Lit. The minimum lead level was 36µg/Lit and the maximum lead level was 163µg/Lit. In 13.5% of children, the lead levels were more than 100µg/Lit. 35.4% of children were male and 64.6% were female. Median and IQR blood lead levels of boys were 73(22)µg/Lit and median and IQR blood lead level of girls was 65(22). According to Mann-whitney test, there was no significant difference between the two groups ($p=0.57$). We classified the type of house paint into two groups; 1- non oil color (plastic) and, 2- oil color and houses without paint. We identified the type of house paint in 72% of children, which 28% of them had non oil color house paint, with a median and IQR blood lead level of 69(25)µg/Lit. 72% of them had oil color house paint or house without painting, with a median and IQR blood lead level of 67(18)µg/Lit. According to Mann-Whitney test, there was no significant relation between type of house paint and blood lead level ($p=0.199$). We also identified date of the last painting of houses. The mean time was 2.09 years ago with a standard deviation of 1.55. According to spearman correlation, there was a negative correlation between time of the last painting and blood lead level of children ($r_s=-0.609$, $p=0.003$). It means that blood lead levels of children who live in houses with older painting are higher. We asked them about the monthly family income and number of family members, in order to assess the economic status of children's families. The lowest monthly income was 300000 Rials

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(30 Dollars) and the highest was 50000000 Rials (5000 Dollars). The mean monthly family income was 2582571.40±5565917.36 Rials (258.25±556.59 Dollars). According to spearman correlation, there was a significant relation between monthly family income and blood lead level of children (r_s=-0.238, p=0.042). It means that children of families with better economic situation have lower blood lead levels. The mean number of family members was 4.1±0.99, and according to spearman correlation, there was no significant relation between number of family members and blood lead level. (r_s=-0.055, p=0.644).

Discussion

The median (IQR) blood lead level was 72.5(27)µg/Lit. In 13.5% of children, the blood lead levels were more than 100µg/Lit. Iran is a developing country, so we compare the results of this study with some other developing countries. In Cape Province, South Africa, over 90% of the children in some urban and rural communities have blood lead levels more than 100µg/Lit. In Mexico City, 44% of children aged 1.5-5 have blood lead levels more than 100µg/Lit.[5] In a study carried out in Uruguay, 36% of children aged less than 14, had blood lead levels more than 100µg/Lit. In a study in Waxy City, China 27.3% of children had blood lead levels more than 100µg/Lit.[10] In a study carried out in Visayas region in the central Philippines, the lead level was more than 100µg/Lit in 21% of children.[10] In a study carried out in Jakarta, Indonesia, 35% of children had blood lead levels more than 100µg/Lit.[11] In a study performed in India, 29% of children had blood lead levels more than 100µg/Lit.[12] This study showed BLL of children in Mashhad is less than other developing countries.

In most developed countries, concerted efforts have led to a reduction in the introduction of lead into the ambient environment in recent years.[5] In a study carried out in California on 1-6years old children, 7.25% of children had blood lead levels more than 100µg/Lit. In 22% of six mount to 6years old children in Massachusetts the lead levels were more than 100µg/Lit. In a study carried out on 2-3 years old children in Vancouver, Canada 8.1% of children had blood lead levels more than 100µg/Lit.[9] These results indicate that the lead levels of children in Mashhad are similar to developed countries. There was a meaningful relation between low monthly family income and blood lead level of children. Socioeconomic situations are major determinants of public health and low family income is significant predictors of having higher BLLs.

In conclusion, blood lead level of children who live in houses with older painting are higher, so the flakes of house paints, are a potential source of lead poisoning for children, however we can not easily remove lead paint from children's environment. We should teach parents how to establish a lead-safe environment for their children, like proper housecleaning and hand washing. Some authors have achieved a 34% decline in blood lead levels by simple environmental interventions alone.[4,17]

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Authors' contributions

Conception and design, analysis and interpretation of the data, statistical expertise: MRK

Obtaining of funding, collection and assembly of the data: AMR

Provision of study materials, drafting of the article: MHS

Critical revision of the article: HA

Final approval of the article: ZB

Administrative, technical, or logistic support: HS

Declaration of interest

The authors declare no conflict of interest.

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