INTERNATIONAL RESEARCH JOURNAL OF PHARMACY

www.irjponline.com

ISSN 2230 – 8407

Research Article

PILOT STUDY FOR DETERMINATION OF BLOOD LEAD LEVELS IN PRIMARY SCHOOL CHILDREN

Mahmud Arhima[1], Ramadan Elmozogi[2], Salah Suliman[1], Aisha Edrah[1], Abdurrauf Gusbi[3], Abdurrahim Elouzi[3]*, Ebtisam Benomran[4], Ebtesam Beshana[5], Mokhtar Gusbi[1]

[1]School of Medicine, Tripoli University, Tripoli- Libya

[2]Department of Pediatrics, Tajora Hospital, Tripoli- Libya

[3]Department of Pharmaceutics, Faculty of Pharmacy, Tripoli University, Tripoli - Libya

[4]Mergeb University School of Pharmacy, Elgomes-Libya

[5]Department of Pharmaceutics, Faculty of Pharmacy, Zawia University, Zawia, Libya

*Corresponding Author Email: abdurahim68@hotmail.com

Article Received on: 17/01/15 Revised on: 03/02/15 Approved for publication: 10/03/15

DOI: 10.7897/2230-8407.06339

ABSTRACT

Exposure to lead can damage the nervous, hematopoietic, and renal systems and is particularly harmful to the developing nervous systems of fetuses and children. Most children who have elevated blood lead levels do not have any symptoms. When symptoms, such as stomach ache, poor appetite, and irritability appear they are often confused with other childhood illnesses. The present study was initiated as a national pilot study in Libya to determine the blood lead concentration in primary school children in Tripoli. A total number of 379 children (198 males and 181 females) aged 6-8 years were included in the study. A venous blood sample was collected from each child in EDTA blood tubes and then the levels of lead in whole blood were determined spectrophotometry by graphite electro thermal atomic absorption. The results showed that 213out of 379 tested children (56 %) of the children have a BLLs ≤ 10 µg/dl and 166 children (43.79 %) have high BLLs (> 10 µg/dl); with males representing 51 % (n = 85) and females 49 % (n = 81). 61 of children (16 %) have BLLs between 10-14 µg/dl from which 8.4 % was infected males and 7.79 % was infected females The results also illustrated that 48 out of total 379 children (12.66 %) have a BLLs between 20-44 µg/dl. Interestingly this percentage was equally divided between both genders (6.33 % each). Finally, four out of 379 tested children have BLLs above 45 µg/dl (1.06 %). Our results drawn to the conclusion those BLLs were elevated above the safe level in about 44 % of the tested children. Such children should be evaluated and treated in accordance with CDC guidelines for follow-up care, including care coordination and public health, medical and environmental management. The child will need regular medical follow-up and re-testing to see if the level of lead has lowered

Keywords: Lead, BLLs, Children toxicity, Heavy Metal, Lead poisoning

INTRODUCTION

Long-term exposure to lead, a naturally occurring metal used in everything from construction materials to batteries, can cause serious health problems, particularly in children. Blood lead concentrations are quite low in the absence of industrial activities[1]. There were 2 major sources of industrially derived lead for children: airborne lead, mostly from the combustion of gasoline containing tetraethyl lead; and leaded chips and dust, mostly from deteriorating lead paint. Both contribute to soil lead. Children also may be exposed to lead through drinking water contaminated by pipes and fixtures containing lead[2]. Extremely elevated blood lead levels (BLLs) >70 µg/dl can cause severe neurologic problems (e.g., seizure, coma, and death)[5]. The long-term effects of elevated blood lead levels in children may include slow development, reduced Intelligence Quotient (IQ) scores and learning disabilities, hearing loss and reduced height and hyperactivity. However, no threshold has been determined regarding lead's harmful effects on children's learning and behavior. In 1990, the U.S. Department of Health and Human Services established a national goal to eliminate BLLs > 25 µg/dl by 2000; a new goal targets elimination of BLLs >10 mcg/dl in children aged < 6 years by 2010. Determination of blood lead concentration is a widely accepted biological marker of exposure to lead. The Centers for Disease Control and Prevention (CDC), World Health organization (WHO) and the American Academy of Pediatrics (AAP) currently use 10 µg/dl as the blood lead concentration of concern (8, 9, 26). However, recent epidemiological studies suggest impairment of cognition at blood lead levels even below 10 mcg/dl[9]. Because children with elevated BLLs in the 10-25 µg/dl range do not develop clinical symptoms, screening is necessary to identify children who need environmental or medical intervention to reduce their BLLs. Interestingly it is renowned that exposure to lead causes damage in different tissues, including the immune system but there was no information in the literature about the effect of both, acute and chronic exposures to lead in Libya. To this end, the goal of this study was to initiate a national pilot study in Libya to investigate the blood lead concentration in primary school children in Tripoli, Libya.

MATERIALS AND METHODS

Human Participant Protection

Even though childhood lead monitoring is a critical public health tool, a remedial action objectives (RAOs) based on child blood lead levels raises ethical concerns: public health efforts that are more reactive than preventive. Institutional review board (IRB) approval was not required for this analysis as there was no contact with human subjects for the ethics paper. However the authors did have IRB approval to study blood lead levels of primary school children in Tripoli, Libya and this paper resulted from that investigation.

Preparation of Samples

A total number of 379 children school (198 males and 181 females) aged 6-8 years were included in this study. The schools were located in Tripoli city, Libya. The parents of the children were informed about the aims of the study and were asked to sign an informed consent. A venous blood sample was collected from each child by specialized nurses and in presence of a pediatricin. Blood sampling was performed in the school that the children attended. The samples were then placed in EDTA blood tubes, closed tightly, labeled appropriately and immediately transferred to the laboratory, where they processed. All the materials used for this study including chemicals and reagents were purchased from Sigma, United Kingdom unless otherwise stated.

Experimental design

The frozen blood samples collected were thawed at room temperature for 3 hours. The levels of lead in whole blood were determined by graphite electrothermal atomic absorption spectrophotometry by Biocientia Laboratory (Germany) on an ANALYST 600/Perkin Elmer. Lead values were calculated as the means of 3 analyses of each sample. The limit of detection was 10 µg /dL, and values below this limit were set to < 10 µg /dL.

RESULTS AND DISCUSSION

Table 1: Blood lead level (BBL) in µg/dl was measured in children school aged 6-8 years

BLLs (µg/dl)	Total No. of infected children	percentage
5-9	213	56.20
10-14	061	16.10
15-19	053	13.98
20-44	048	12.66
>45	004	01.06
Total	379	100

Experiments were performed in triplicate and the results are expressed as mean ± standard deviation

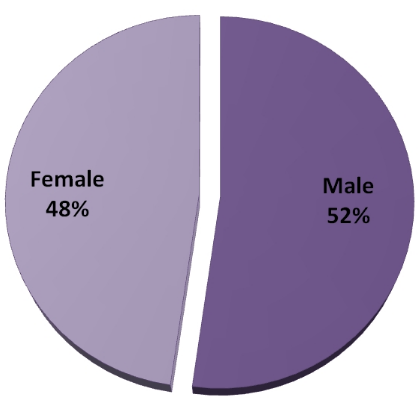

Figure 1: Scheme illustrates percentage of males and females contributed in this study

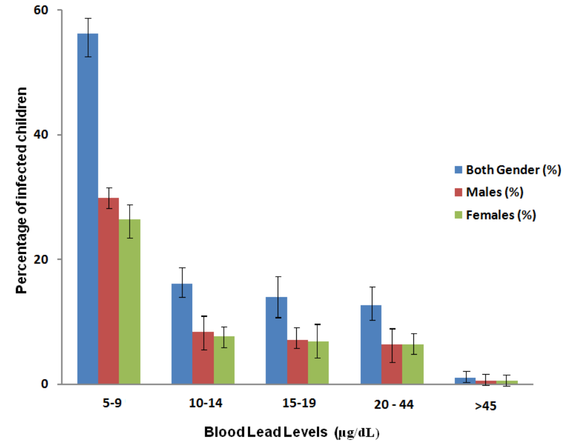

Figure 2: The percentage of infected children with lead pollution at different concentration of blood lead levels

The experiments were performed in triplicate, and the results are expressed as mean ± standard deviation (n = 379)

It is well-known that the lead is most heavy metals commonly cited as being of the greatest public health concern[3-5], the revelation to lead can harm the nervous, hematopoietic and renal systems (6x, 7x). Elevated blood lead levels (BLLs) as low as 10 µg/dl have been associated with adverse effects on cognitive development, growth and behavior among children aged 1-5 years[4,5]. In this work 379 children school (198 males and 181 females) aged 6-8 years (Figure 1) were tested to determine lead concentrations in their blood. Our results demonstrated, for the first time, that 213 out of 379 tested children have a BLLs ≤ 10 µg/dl (56 %) (Table 1) from which 29.8 % was infected males and 26.4 % was infected females. The Committee on Environmental Health mentioned that the children do not need any medical management when BLLs at ≤ 10 µg/dl but parents should take steps to identify possible sources of lead in their child's environment in order to prevent any further exposure. The children foods should be high in calcium, iron and vitamin C and low in fat[11]; However, there no totally safe level of lead for children. Many recent studies have shown that lead level below 10 µg/dl can lower intelligence[10,12]. The most common effects at these sub-clinical concentrations are on the CNS. The best-studied effect is cognitive impairment, measured by IQ tests. In most countries, blood lead concentrations peak at approximately 2 years of age and then decrease without intervention. Blood lead concentration is associated with lower IQ scores measured at approximately 5 years of age[12]. It is worth mentioning that the strength of the association is similar from study to study; as blood lead concentrations increase by 10 µg/dl; the IQ at 5 years of age and later decreases by 2 to 3 points[12]. With BLLs less than 10 µg/dl; a decrease in IQ of more than 7 points was reported[13]. Our results also showed that 166 of the children (43.8 %) have an elevated BLLs (> 10 µg/dl); with males representing 51 % (n = 85) and females 49 % (n = 81). Most of the reported effects of lead occur at levels above 10 µg/dl. These include a reduction in children IQ, changes in brain and nerve function (especially behavior). Teachers report that more inattentive, hyperactive, disorganized and less able to follow directions were observed on students with elevated tooth lead concentrations[14,15]. Furthermore follow-up of some of those children[14] showed higher rates of failure to graduate from high school, reading disabilities, and greater absenteeism in the final year of high school[16]. Elevated bone lead concentrations are associated with increased intentional dysfunction, aggression and delinquency[17]. At these levels the children need a special management depending on the BLLs. Children with concentrations 10 µg/dl or greater should have their BLLs concentrations rechecked; if many children in a community have concentrations greater than 10 µg/dl, the situation requires investigation for some controllable source of lead exposure. Children who ever have a concentration greater than 20 µg/dl or persistently (for more than 3 months) have a concentration greater than 15 µg/dl require environmental and medical evaluation. Generally, the parents have to identify and remove possible lead hazards and feed the child with a diet that will help protect them from lead. Sources of lead can be found in the home, school, yard or places a child frequently visits. Lead absorption is increased when there is not enough iron or calcium in a child's diet. In this regard, the children foods should be high in calcium, iron, and vitamin C and low in fat. Figure 2 and Table 1 clarified that 61 out of 379 tested children (16 %) have BLLs between 10-14 µg/dl from which 8.4 % were infected males and 7.79 % were infected females. At this level, the test has to be repeated within 3 months to confirm the blood lead level. The parents have to identify and remove possible lead hazards and feed the child with a diet that will help protect them from lead. The child will need another blood test in 3 months to see if the level of lead has lowered. Moreover, a 53 (14 %) of children have BLLs between 15-19 µg/dl from which 7.2 % was infected males and 6.88 % was infected females (Figure 2). At this level there is a greater risk for problems with growth and learning. Children can be hurt by lead and may not look or act sick. Management includes parent education about lead and dietary and environmental changes. The child will need another blood test in 3 months to see if the level of lead has lowered. If the BLL is not lowered, medical management can be started, with a follow up of the blood lead concentration at 3 month period. The results also illustrated that 48 out of total 379 children (12.66 %) have a BLLs between 20-44 µg/dl. Interestingly this percentage was equally divided between both genders (6.33 % each). A child with a confirmed venous draw in this range has a high lead level and needs to be seen by a doctor for a medical exam. Other measures include complete history and physical examination, determination of hemoglobin or hematocrit and iron status and neurodevelopmental monitoring. The child's medical provider should be involved in helping bring this blood lead level down by managing the child's diet and providing vitamin supplements if needed. The child will need another blood test within a month to see if the level of lead has lowered. It seems reasonable to manage children whose blood lead concentration is 20 µg/dl or greater as having a higher risk of developmental delay and behavior abnormalities[20]. However, it has been reported that although chelation therapy for children with blood lead concentrations of 20 to 44 µg/dl can be expected to lower blood lead concentrations, it does not reverse or diminish cognitive impairment or other behavioral or neuropsychological effects of lead[19]. There was no data supporting the use of chelation by succimer in children whose blood lead concentrations are less than 45 µg/dl if the goal is to improve cognitive test scores. From Table 1 and Figure 2 it can also seen that four out of 379 tested children have BLLs above 45 µg/dl (1.06 %). Children with blood lead concentrations greater than 45 µg/dl may complain of headaches, abdominal pain, loss of appetite and constipation and display clumsiness, agitation and/or decreased activity and somnolence. These are premonitory symptoms of CNS involvement and may rapidly proceed to vomiting, stupor and convulsions[18]. Symptomatic lead toxicity should be treated as an emergency. At this level, the test has to be taken immediately or within 48 hours to confirm the blood lead level. A child with a confirmed venous draw in this range has a dangerous lead level and may need medical treatment. Medical treatment with chelation therapy using succimer should begin and a pediatrician experienced in managing children with lead poisoning should be consulted. Very high levels of lead can damage the brain and kidneys. The child will need regular medical follow-up and re-testing to see if the level of lead has lowered. The mechanisms by which lead affects CNS function are not known. Lead alters very basic nervous system functions, such as calcium-modulated signaling, at very low concentrations *in vitro*[21], but it is not yet clear whether this process or some other one yet to be examined is the crucial one. Lead interferes with heme synthesis beginning at blood lead concentrations of approximately 25 µg/dl[22]. Both aminolevulinate dehydratase, an early step enzyme, and ferrochelatase are inhibited. Ferrochelatase inhibition is the basis of a previous screening test for lead poisoning that measures erythrocyte protoporphyrin (EP), the immediate heme precursor. Because it is insensitive to the lower concentrations of blood lead that are of concern now, the test is obsolete for that use; however, EP measurement is still used clinically in managing children with higher blood lead concentrations.

CONCLUSION

The conclusions drawn from this study that BLLs were elevated above the safe level in about 44 % of the children tested. These children should be evaluated and treated in accordance with CDC guidelines for follow-up care, including care coordination and public health, medical and environmental management[23-25]. Few children (1 %) have BLLs high enough to warrant intensive medical treatment (e.g., chelation therapy). However, all children with elevated BLLs < 10 µg/dl will need follow-up services, including more frequent blood lead testing, environmental investigation, case management, and lead hazard control. A wide national survey for lead blood levels among children aged 6-7 years should be performed, and if possibly the children with elevated BLLs should be followed with regular checkups.

Recommendations

The recommended approach to environmental investigation of a child with an elevated blood lead concentration consists of

- An environmental history and an inspection of the child's primary residence and any building in which they spend time regularly.
- Measurement of lead in deteriorated paint, dust, bare soil or water as appropriate.
- Control of any immediate hazard.
- Remediation of the house, which may require temporary relocation of the child.

REFERENCES

1. Patterson CC, Ericson J, Manea Krichten M, Shirahata H. Natural skeletal levels of lead in Homo sapiens sapiens uncontaminated by technological lead. Sci Total Environ 1991; 107: 205 –236. http://dx.doi.org/10.1016/0048-9697(91)90260-L
2. Lanphear BP, Matte TD, Rogers J, Clickner RP, Dietz B, Bornschein RL, Succop P, Mahaffey KR, Dixon S, Galke W, Rabinowitz M, Farfel M, Rohde C, Schwartz J, Ashley P, Jacobs DE. The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. A pooled analysis of 12 epidemiologic studies. Environ Res 1998; 79: 51–68. http://dx.doi.org/10.1006/enrs.1998.3859
3. Agency for Toxic Substances and Disease Registry. The nature and extent of lead poisoning in children in the United States: a report to Congress. Atlanta, GA: Agency for Toxic Substances and Disease Registry; 1988.
4. Lidsky TI, Schneider JS. Lead neurotoxicity in children: basic mechanisms and clinical correlates. Brain 2003; 126: 5-19. http://dx.doi.org/10.1093/brain/awg014
5. Abdurrahim A Elouzi1, Abdulrhman A Akasha, Ali M Elgerbi, Mokhtar El Baseir, Bassam A. El Gammudi. Removal of Heavy Metals Contamination by Bio-Surfactants (Rhamnolipids). Journal of Chemical and Pharmaceutical Research 2012; 4(9): 4337-4341.

6. Maheswari C, Venkatnarayanan R. Protective effect of *Orthosiphon stamineus* leaves against lead acetate and cadmium chloride induced renal dysfunction in rats, Int. Res. J. Pharm 2013; 4(4): 232-235. http://dx.doi.org/10.7897/2230-8407.4447.
7. Hemalatha K, Pugazhendy K, Meenambal M, Jayanthi C. Sequestration property of *Spirulina* against lead induced histological changes in male albino wister rat *Rattus norvegicus,* Int. Res. J. Pharm 2013; 4(3): 153-155. http://dx.doi.org/10.7897/2230-8407.04330
8. Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations From the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta, GA: Centers for Disease Control and Prevention; 2004.
9. American Academy of Pediatrics, Committee on Environmental Health. Screening for elevated blood lead levels. Pediatrics 1998; 101: 1072 –1078. http://dx.doi.org /10.1542/peds.101.6.1072
10. Canfield RL, Henderson CR Jr, Cory Slechta DA, Cox C, Jusko TA, Lanphear BP. Intellectual impairment in children with blood lead concentrations below 10 µg per deciliter. N Engl J Med 2003; 348: 1517-1526. http://dx.doi.org/10.1056/ NEJMoa022848
11. Committee on Environmental Health. American academy of pediatrics Lead Exposure in Children: Prevention, Detection and Management. Pediatrics 2005; 116: 1036-1046. http://dx.doi.org/10.1542/peds.2005-1947
12. Pocock SJ, Smith M, Baghurst P. Environmental lead and children's intelligence: a systematic review of the epidemiological evidence. British Medical Journal 1994; 309: 1189-1197. http://dx.doi.org/10.1136/ bmj.309.6963.1189
13. Bellinger DC, Needleman HL. Intellectual impairment and blood lead levels. N Engl J Med 2003; 349: 500 –502. http://dx.doi.org/10.1056/NEJM200307313490515
14. Needleman HL, Gunnoe C, Leviton A, Reed R, Peresie H, Maher C, Barrett P. Deficits in psychologic and classroom performance of children with elevated dentine lead levels. N Engl J Med 1994; 33: 616–617. http://dx.doi.org/10.1056/ NEJM199409013310915
15. Sciarillo WG, Alexander G, Farrell KP. Lead exposure and child behavior. Am J Public Health 1992; 82: 1356 –1360. http://dx.doi.org/10.2105/AJPH.82.10.1356
16. Needleman HL, Schell A, Bellinger D, Leviton A, Allred EN. The long-term effects of exposure to low doses of lead in childhood: an 11-year follow-up report. N Engl J Med 1990; 322: 83-88. http://dx.doi.org/10.1056/ NEJM199001113220203
17. Needleman HL, Riess JA, Tobin MJ, Biesecker GE, Greenhouse JB. Bone lead levels and delinquent behavior. The Journal of the American Medical Association 1996; 275: 363-369. http://dx.doi.org/10.1001/jama.1996.03530460029026
18. Chisolm JJ Jr, Kaplan E. Lead poisoning in childhood—comprehensive management and prevention. J Pediatr 1968; 73: 942-950. http://dx.doi.org/10.1016/S0022-3476(68)80255-0
19. Rogan WJ, Dietrich KN, Ware JH, *et al.* The effect of chelation therapy with succimer on neuropsychological development in children exposed to lead. N. Engl J Med. 2001; 344: 1421-1426. http://dx.doi.org/10.1056/NEJM200 105103441902
20. Centers for Disease Control and Prevention. Managing Elevated Blood Lead Levels Among Young Children: Recommendations From the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta, GA: Centers for Disease Control and Prevention; 2002.
21. Markovac J, Goldstein GW. Picomolar concentrations of lead stimulate brain protein kinase C. Nature 1988; 334: 71-73. http://dx.doi.org/10.1038/334071a0
22. McIntire MS, Wolf GL, Angle CR. Red cell lead and δ-amino levulinic acid dehydratase. Clin. Toxicol 1973; 6: 183-188. http://dx.doi.org/10.3109/15563657308990516
23. CDC. Screening young children for lead poisoning: guidance for state and local public health officials. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC; 1997.
24. CDC. Preventing lead poisoning in young children: a statement by CDC. Atlanta, GA: US Department of Health and Human Services, Public Health Service, CDC; 1991.
25. American Academy of Pediatrics. Treatment guidelines for lead exposure in children. Pediatrics 1995; 96: 891-6.
26. International Program on Chemical Safety. Inorganic lead. Environmental health criteria 165. Geneva: World Health Organization; 1995.

Cite this article as:
Mahmud Arhima, Ramadan Elmozogi, Salah Suliman, Aisha Edrah, Abdurrauf Gusbi, Abdurrahim Elouzi, Ebtisam Benomran, Ebtesam Beshana, Mokhtar Gusbi. Pilot study for determination of blood lead levels in primary school children. Int. Res. J. Pharm. 2015; 6(3): 179-182 http://dx.doi.org/10.7897/2230-8407.06339

Source of support: Nil, Conflict of interest: None Declared