ORIGINAL ARTICLE

SERUM LEAD LEVELS IN FEMALE AGRICULTURAL FARM-WORKERS FROM BAHAWALPUR, PAKISTAN

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Background: Lead (Pb) is a heavy metal present in our environment in soil, drinking water, air, petroleum products, insecticides and pesticides, and is excreted in body secretions like breast milk, saliva, semen, and sweat. We studied serum lead levels in lactating female farm workers of Bahawalpur who are exposed to various chemicals that contain lead arsenate. **Methods:** This study was conducted in the Department of Physiology, University of Health Sciences, Lahore after approval from the Ethical Review Committee. After informed consent, blood samples of 2.5 ml each from a total of 91 lactating mothers were collected. Serum lead levels were determined by Inductively Coupled Plasma Spectrophotometry (ICP). **Results:** High lead levels were detected in 90 out of 91 (98.90%) women. Mean serum lead levels were 61.05±29.59 µg/L. **Conclusion:** The serum lead level was considerably higher than the WHO allowable level in our study population.

Keywords: serum, lead, farm workers, female

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INTRODUCTION

Toxic heavy metals are ever persistent pollutants in the environment and can cause serious health hazards. Human contact with toxic metals and other environmental contaminants has increased significantly over the last few years because of industrialization, urbanization and other anthropogenic activities like food adulteration and refinement, and use of food additives.[1] In the third world and less developed countries, an additional source of metal contamination is the problem with cleanliness and removal of garbage and contamination of drinking water with sewer lines, use of cheaper cooking utensils and household metal containers used for food storage.[1]

Lead is a recognized neurotoxic heavy metal.[2] It exists as an elemental form in nature. Levels of lead in soil range between 50 and 400 ppm. However, WHO acceptable lead levels in drinking water is 10 µg/L or parts per billion (ppb).[3] Considerable rise in lead levels in the environment are due to mining, smelting and refining activities. Effective preventive measures are adopted to decrease adverse effects in primeval rural areas.[4]

Lead gets entry into the body mainly through inhalational and gastrointestinal routes.[5] The main route of lead exposure is inhalation of lead compounds in different occupational workers. Larger than 2.5 µm particles deposit in nasopharyngeal and tracheobronchial ciliated epithelium which can be transported to the oesophagus and are swallowed. Oral route is major route of exposure for the general population. Organic lead is well absorbed through the skin also.[6]

For young children <10 µg/dl of blood lead is considered safe. However, currently, there is no confirmed safe concentration of lead in blood. Adverse health effects can occur even at lower concentrations.[7]

Maximum amount of inhaled lead is absorbed. Absorption of lead through gastrointestinal tract is higher in children (40–50%) compared to adults (3–10%). Food present in GIT decreases absorption of lead. Lead accumulates first in blood and then makes its way to the bone. In children 73%, and in adults 94% of lead is present in bone. Half-life for inorganic lead in blood is 30 days and in bones it is 30 years.[8] The main routes of excretion of lead are urine and feces.[9] Lead is bio-accumulated in bones and resides in the body for a long period of time. Calcium from bone is released along with lead during pregnancy and lactation, causing higher lead levels in the blood.[10]

Levels of lead in human blood or serum have been studied around the globe. Farm workers of Southern Punjab, Pakistan are exposed to soil over which pesticides, insecticides and weed killers are sprayed. These chemicals contain lead in the form of lead arsenate[11] and that may cause higher levels of lead in the serum. Because of the importance of lead in human life, and as it is not studied in Southern Punjab, Pakistan, we designed this study for the rural population of Bahawalpur, Pakistan.

MATERIAL AND METHODS

This descriptive study was conducted in the Department of Physiology and Cell Biology, University of Health Sciences (UHS), Lahore in collaboration with the Chemistry Department, University of the Punjab, Lahore. The study was approved by the Ethical Review

Committee of University of Health Sciences, Lahore. Sample size was determined as 90 using the formula:

$$n = \frac{\sigma^2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

A total number of 91 lactating female farm workers working in the farms for at least 1 year in the last 3 years were included in the study. They were permanent residents of rural areas adjoining Bahawalpur City. Participants taking drugs that can chelate metals like Ethylenediaminetetraacetic acid (EDTA) and Dimercaptosuccinic acid (DMSA) etc., tobacco smokers and those taking any drug that can increase body metabolism were excluded from the study. After taking informed written consent, information was entered on a specially designed proforma.

Blood sample of 2.5 ml each was taken under aseptic conditions and serum was separated by centrifugation and stored till final analysis through Inductively Coupled Plasma Spectroscopy (ICP) on Optima 2100-DV, Perkin Elmer. For serum sample preparation for ICP analysis, 1 ml of serum was taken in a lead free polypropylene tube and it was diluted with distilled deionized water to make it up to 5 ml.

Standard solutions of lead with concentrations of 25, 50, 75 and 100 ppb were prepared. Prepared standard solutions and diluted serum samples were subjected to ICP-OES (Optical Emission Spectrometry) at wavelength of 220.353 nm for detection of serum lead. The minimum detection limit of ICP machine used was 0.10 ppb. The readings of serum samples were multiplied with dilution factors to get the final serum levels. The data was entered into and analyzed on SPSS-20. Normal distributions of data were checked with Shapiro-Wilk's statistics. Serum lead levels were compared with the recommended WHO serum lead levels.

RESULTS

The mean age of all participants was 25.55±4.91 years. Majority (79.10%) of them were illiterate. All of these women had been working at the agricultural farms for a mean duration of 5.79±2.95 years. Serum lead levels were estimated in all serum samples of the participants (n=91). Higher than WHO allowable lead levels were detected in 90 (98.90%) serum samples and the mean serum lead levels were 61.05±29.59 µg/L. (Table-1).

Table-1: Estimated levels of lead in serum of female agricultural farm-workers compared with WHO permissible values (n=91)

Participants having high lead in serum	Serum lead levels (Mean±SD)	WHO permissible serum lead levels[6]
90 (98.90%)	61.05±29.59* µg/L	<10 µg/L

*p<0.001

DISCUSSION

Some early investigators from various parts of United States of America (USA) reported different levels of serum lead, i.e., as low as 1.4 µg/L to as high as 119 µg/L.[12–14] Kovar *et al*[15] using 28 patients from Central London Maternity Hospital reported blood lead levels of 0.49 µg/L. Ong *et al*[16] reported lead concentrations 0.73 µg/L in blood in a multi-racial sample of women from Malaysia. They had a sample size of 114. These women were not occupationally exposed to lead. On the other hand, Li *et al*[17] reported lead levels of 132 µg/L in cord blood from Chinese women. The sample size in that study was 165 and women from Shanghai were occupationally non-exposed to lead. The Chinese found gradual rise in blood lead level during 1980 to 1996. After introduction of lead-free gasoline for use in vehicles the blood lead level dropped gradually after 2016. Kulkybaev *et al*[18] showed that the levels of lead were as low as 0.51 µg/L in the blood of a small sample from Russian natives. Khan *et al*[19] determined higher levels of lead in exposed population (industrial workers and traffic police constables) which was higher than their control group. Thus, it is clear that the blood lead levels in people excessively exposed to lead are higher than the WHO allowable levels.

In our study, the mean serum lead levels among the female farm workers were found as 61.05±29.59 µg/L. The samples taken were from that of an environmentally exposed population. Table-2 shows levels of serum lead in different parts of the world.

Table-2: Levels of lead in women's blood from different countries

Country	Reported Blood Pb levels
Pakistan (This study)	61.05±29.59 µg/L
USA[12–14]	1.4–119 µg/L*
UK[15]	0.49 µg/L*
Malaysia[16]	0.73 µg/L*
China[17]	132 µg/L*
Russia[18]	0.51 µg/L*

*Reported levels converted to µg/L

Mean serum lead levels in occupationally exposed female rural population of Bahawalpur was 61.05 ppb, which is far higher than the WHO permissible limits. This fact is of great concern as higher levels of serum lead in lactating mothers may affect the children of these workers and may cause heavy metal overload and poisoning in these breast-fed babies. It necessitates a specific probe into the adverse developmental effects of lead in children of this vulnerable population.

CONCLUSION

The serum lead level in female agricultural farm workers in Bahawalpur area is considerably higher than the established WHO permissible limits of <10 µg/L.

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