Blood lead level in the Jordanian population

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ABSTRACT

Objective: To determine the blood lead level in the non-occupationally exposed Jordanian population as a baseline for comparative studies.

Methods: Seven hundred and forty six blood samples were collected and analyzed using Graphic Furnace Atomic Absorption Spectrophotometry. A representative sample for the Jordanian community was selected.

Results: The arithmetic mean for blood lead level in the whole sample was 1.96 µg/d1 which was lower than the other means determined by international studies.

Conclusion: The blood lead level among the Jordanian population was found to be less than the levels in other countries, this may be partly explained by the low levels of lead in air and water.

Keywords: Blood lead level, spectrophotometry.

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Lead metal has been used for at least 6000 years, and is an attractive metal for cultures which employ simple technology. It is easy to extract from its ores, has a low melting point, so that it can be cast and moulded with ease and it can easily be jointed together with moderate heat.[1] Lead poisoning has been recognized for 2000 years or more. Its clinical features, such as anemia, colic, neuropathy, nephropathy, sterility, coma, and convulsions, were described by Hippocrates and Nikander in ancient times, and by Romazzini, Thackrah, Hamilton and Lilis in the modern era, cited by Landrigen.[2] Water, food and air contribute to the total non-occupational lead exposure. The diet is generally considered to be the largest component of background exposure to lead. Under normal conditions, the lead content of food stuff ranges from 0.02 to 3 mg/kg by weight, and forms 0.01 to 0.03 mg/1 in drinking water, while it ranges from 0.01 to 0.03 µg/m3 in air.[3] The lead in food has several origins, for example some is directly absorbed by plants from the air, this lead is ultimately transferred through the food chain to humans, food may also be contaminated with lead directly from water used in food processing, or from solders on processing machinery, cooking utensils, and those used to seal cans. Lead may also leak into the food from the storage containers.[4] The lead in air may originate from automobile exhausts and a number of industrial sources. In urban areas, approximately one 3rd of the lead absorbed into the body of an adult comes from inhalation of air with lead, derived primarily from motor vehicle emissions.[5] Workers that handle lead are an unusual source of lead exposure to their families, resulting from the lead they carry home on their clothing.[6,7] Lead is an electropositive metal, with a high affinity for the negatively charged sulphydryl group (SH-group). This is manifested by the capability of lead to inhibit sulphydryl dependent enzymes in several organs such as delta-aminolevulinic acid dehydratase (ALAD), and ferrochelatase which are involved in the biosynthetic pathway heme.[8]

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The ability of lead to interact with cell membranes had been suggested as the biochemical basis for a variety of lead related health effects.[9] Environmental exposure to low levels of lead has been associated with a wide range of toxic effects. The recognition has been widespread that lead can cause toxic injury to man, at levels of exposure, that only a decade ago were thought to be safe,[10] and lead has become the subclinical toxin. These subclinical effects have recently been termed biological markers of toxicity.[11] The resulting subclinical toxicity involves inhibition of heme biosynthetic enzymes, and delayed blood regeneration,[12] impairment of the function of renal tubular cells, inhibition of sperm formation,[13] slowing of motor nerve conduction velocity,[14] and dysfunction of the central nervous system.[15] Blood lead level has long been evaluated as a biological indicator of exposure to lead in occupational settings and also reflects the environmental exposure of a population.[16-18] There are many tests available to assess this biological exposure, but the most useful test to assess exposure is the blood lead level.[19] The objectives of this study were to determine the blood lead level among the Jordanian population, to compare blood lead concentration between male and female Jordanians and to compare blood lead concentration between children and adults in the Jordanian population.

Methods.

Study design. Between October 1995 and June 1996 a cross-sectional study was performed to achieve the previously mentioned objectives.

Study population. The estimated sample size was 775 healthy individuals selected from the total Jordanian population (4.5 million) using a multi-stage random clustering sample, according to the population density in Kingdom governorates, with a confidence level of (95%) and a relative precision of 4%. Eight persons were excluded from the study because of a history of occupational exposure to lead. The overall responses was 95% (21 non-respondents). Personal interviews of all participants were carried out. Interviewers were trained and the questionnaire was field tested in a pilot study. The questionnaires were completed by the same interviewer to minimize observer variation. Collected data involved demographic set up, occupational history, smoking habits, khal usage and hobbies such as painting.

Blood sampling. Venous blood samples drawn from the antecubital vein by using lead free vacutainer needles which are collected directly in heparinized lead free tubes (sterile lithium heparin vacutainer). All necessary precautions were adopted to avoid possible contamination of the samples. Blood samples were stored in ice boxes until arrival at the laboratory where they were stored in a freezer until analysis. All blood samples were analyzed within 3 days of collection and analyzed by the same laboratory examiner, who was not informed of the sources of the samples. Blood lead levels were determined by Graphic Furnace Atomic Absorption Spectrophotometer in the laboratory of Environmental Health Directorate (Ministry of Health), using atomic absorption spectophotometer type Shimadzu model AA680, Graphite Furnace GRA-4b, Shimadzu, and auto sampler type Shimadzu model GF60. Quality control for the laboratory analysis procedure was conducted using the Standard Addition Method. The measurements were made at a wavelength of 283.3nm. At least 3 replicate determinations were made for each sample until the coefficient of variation was less than 4% (precision). The mean recovery rate obtained for lead was 96% (accuracy). The detection limit was 0.007 microgram/ liter.

Statistical analysis. Logarithmic transformations of blood lead concentration were carried out using natural logarithms to overcome skewness of distribution of values of blood lead level. Arithmetic mean, geometric mean, median, and standard deviation of blood lead levels were calculated. The significance of the difference between 2 means was tested using t-test. A NOVA was used to determine whether there is a difference in more than 2 means, but it will not show which of these means affect the results. So, another statistical method named Scheffe test was used to determine which of these affect the results. The level of significance used in this study was an alpha level of 0.05. Collected data was entered into a computer using SPSS version 6.0 for windows. The data was checked for errors by performing frequency distribution for study variables. Detected errors and inconsistencies were corrected by returning to the original data.

Results.

Table 1 represents the total number of blood samples tested. Seven hundred and forty six samples were analyzed, 40% males and 60% females. The arithmetic mean blood lead level was 2.18 µg/ 100 ml as shown in table 1. Table 1 also represents the mean blood lead levels which were higher in males than females. Table 2 shows the mean blood lead level according to sex in adults and children. Adult males constitute 175 persons (59%) while adult females totalled 313 (70%). Male and female children <15 years old were 35% of the total population sample. Table 2 also shows that geometric mean blood level for both adults and children ranges between 1.32-1.65 µg/100ml. There is no statistically significant difference in blood lead between the 2 age groups as shown in Table 3. Table 4 shows a comparison between the mean blood lead levels in the different age groups. The highest mean blood level was in the under 5 years old age group (3.35 µg/ 100ml) while the lowest mean blood lead level was in the 35-45 years old age group. A statistically significant difference in the mean blood lead levels in

Table 1 - Blood lead concentration (microgram/dl) for study population.

Sex	Number	Arithmetic mean ± SD	Geometric mean ± SD	Median
Male	297	1.76 ± 2.26	1.57 ± 2.64	1.80
Female	449	2.10 ± 2.13	1.36 ± 2.83	1.47
TOTAL	**746**	**1.96 ± 2.18**	**1.43 ± 2.77**	**1.64**
SD - Standard deviation				

Table 2 - Average blood lead (microgram/dl) for males and females.

Sex	Age	Number	Arithmetic mean + SD	Geometric mean + SD	Median
Male	<15	122	1.99 ± 2.34	1.51 ± 2.91	1.78
	15+	175	1.58 ± 2.22	1.65 ± 2.46	1.81
Female	<15	136	2.30 ± 2.24	1.39 ± 2.91	1.48
	15+	313	1.95 ± 2.05	1.32 ± 2.80	1.45
Total		**746**	**1.96 ± 2.18**	**1.43 ± 2.77**	**1.64**
SD - Standard deviation					

Table 3 - Blood lead concentration (microgram/dl) for adults and children.

Age	Number	Arithmetic mean ± SD	Geometric mean ± SD	Median
< 15	258	2.16 ± 2.29	1.45 ± 2.90	1.64
15+	488	1.83 ± 2.11	1.43 ± 2.69	1.63
	746	**1.96 ± 2.18**	**1.43 ± 2.77**	**1.64**
SD - Standard deviation				

Table 4 - Blood lead concentration (microgram/dl) for Jordanian people according to age group.

Age	Number	Arithmetic mean ± SD	Geometric mean ± SD	Median
<5	56	2.84 ± 3.35	2.27 ± 2.72	2.92
5-15	202	1.93 ± 2.00	1.27 ± 2.82	1.46
15-25	193	1.96 + 1.83	1.13 ± 2.86	1.21
25-35	115	1.97 + 2.42	1.65 ± 2.80	1.94
35-45	67	1.17 + 1.76	1.46 ± 1.99	1.45
45+	113	1.66 + 2.48	1.86 ± 2.46	2.19
TOTAL	**746**	**1.96 ± 2.18**	**1.43 ± 2.77**	**1.64**
SD - Standard deviation ANOVA Test P<0.001				

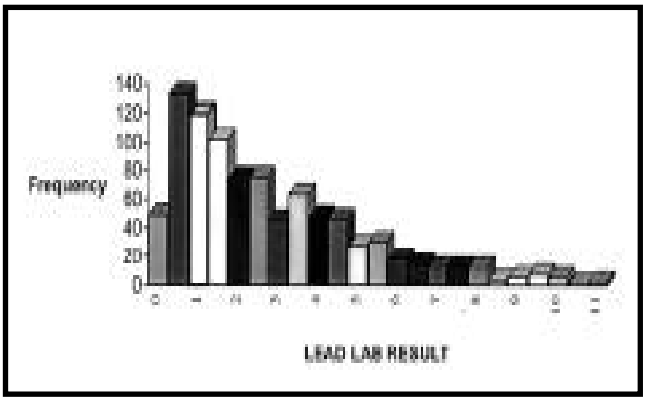

Figure 1 - Distribution of the blood lead level in the study group before logarithmic distribution.

the different age groups was demonstrated by using ANOVA test ($p<0.001$) as shown in Table 4. Using Scheffe test, a statistically significant difference was shown in the under 5 years old group, the 15-25 years old age group and the 5-15 years old age group. While in the other age groups the differences in mean blood levels were not significant. Figure 1 shows the mean blood lead level in the study population before logarithmic conversion. Where the mean blood lead level was 2.18 µg/100ml with a standard deviation of 1.96 and there is a skewness to the right which means that the values were not normally distributed. Figure 2 shows the conversion of Figure 1 to normal distribution after logarithmic conversion for all individual values of blood lead level in the study population.

Discussion. The purpose of this study was to establish a reference value for blood lead levels in the Jordanian people as baseline data for comparative studies in other countries in the present and future. The results of this study showed that the arithmetic mean of the blood lead level among the non-

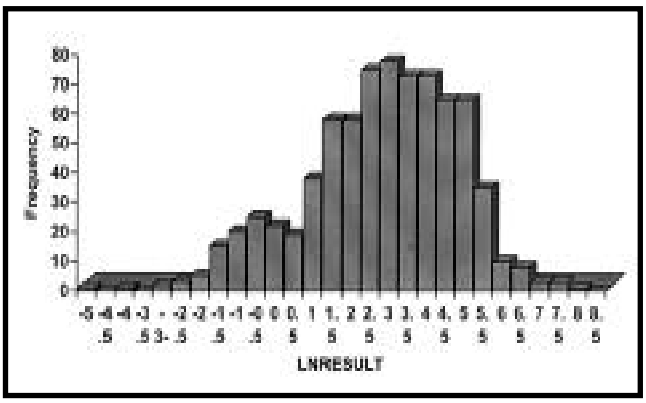

Figure 2 - Distribution of the blood lead level in the study group after logarithmic distribution.

occupationally exposed Jordanian individuals was 1.96 µg/100ml. The arithmetic blood lead level among Jordanian individuals in this study was found to be lower than that in the developed countries.[20] In Sweden, Schuts et al reported an arithmetic blood level of 5.96 µg/100ml in 1978 and a level of 3.29 µg/100ml in 1988.[21] During the period 1978-1988 marked decreases (approximately 30-40%) in the average blood lead levels (PbB) levels of adults were noted in Belgium, Germany, New Zealand, Sweden, United Kingdom and United States of America (USA),[22] which was explained by strict regulations for controlling the sources of lead contamination and the substitution of ordinary fuel with lead free fuel used in automobiles. The low mean blood lead level among Jordanian individuals can be explained by the low air lead concentration in Jordan. The highest mean of air lead concentration in the Amman area (0.422 µg/m^3) was recorded during the summer period,[23] and this was less than the annual average guidelines values of 0.5-1µg/m^3 for ambient lead as proposed by the World Health Organization (WHO).[24] Also, the lead concentration in water is less than 10µg/L, which is the level proposed by the WHO in 1993.[25] The sources of non-occupational exposure to lead in Jordan (air, water) are less than the other developed countries. The blood level in this study was found to be higher among males which is consistent with the results found by other studies.[26] The highest blood lead level in this study was found to be among the under 5 years age group. However, this level is lower than that in children in the same age group as reported by the studies conducted in USA,[26] Finland[27]. Blood lead levels may be misinterpreted, because the characteristics of a safe range of PbB are not precisely established and all actual biological threshold limit value (TLV) values of blood lead established are based on clinical effects, and no consideration for the sub-clinical effects of lead were taken into account. The WHO TLV of lead for the occupational group is 40µg/d1 and the standard of blood lead level for the general population is ranged between 10-25 µg/d1 as found by several studies in many developed countries.[28]

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