ORIGINAL STUDY

Screening for Blood Lead Levels in Basrah, Southern Iraq

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Abstract:

A prospective study over six months (from 1 July to 31 December 2002) measured the level of blood lead in individuals attending Primary Health Centers in the center District of Basrah Governorate. Six hundred and two individuals were selected randomly from those attending seventeen Primary Health Centers in the center of Basrah. Their ages ranged from 9-79 years. Of 602, Twenty six, 15 years of age or younger had mean blood lead levels (BLL) of 12.62+ 3.85µg/dl, those older than 15 years had levels of 11.20 + 3.4 µg /dl, ($p<0.05$). Males of different age groups showed a statistically significantly higher BLL compared to females (13.25+3.25 and 10.10+2.96 µg/dl respectively), $p<0.0001$. The center of Basrah was divided into 11 main areas; there was a statistically significant difference in BLL among individuals living in different areas, ranging from 7.26+2.81 µg/ dl to 12.76+ 3.63 µg/dl. Individuals with higher education and smokers showed higher BLL (12.10+3.54 µg/dl, 13.81+3.57 µg/dl respectively) compared to those of lower education and non-smokers (11.11+3.23 µg/dl, 10.93+3.26 µg/dl respectively), the differences were statistically significant. The sources of drinking water and frequency and amount of milk consumed/week did not show a significant correlation with BLL. History of lead exposure (occupational) was statistically significantly associated with BLL (15.3+4.85 µg/dl) for those exposed to higher concentration of lead compared to others (11.12+3.3 µg/dl), $p<0.0001$. Amongst females using kohl (25.6%), the mean BLL was significantly higher (13.91+4.42 µg/dl), compared to non-users (9.88+2.68 µg/dl), $p<0.0001$. No significant difference was observed among those exposed to paints. As adequate data on BLL in our country do not exist, especially for children, and as the number of children in this study was small, further studies are warranted to recognize the extent and risk factors for lead poisoning in children.

Key word: Blood lead level, children, adult, occupational exposure

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Introduction:

Environmental contamination patterns give a good indication of the sources of exposure that put populations at risk.[1] Lead is an environmental contaminant that originates from a variety of sources such as plumbing, paints, and gasoline additives.[2,3] Measurement of blood lead levels is the most accurate method of determining the actual current exposure in individuals and populations.[1,4] Any blood lead level above the designated threshold is recognized as a cause of concern. For children the threshold is 10 µg /dl;[1, 5, 6] for adults, the threshold considered is 25 µg /dl,[1, 7, 8] because many researchers believe that adverse effects begin to occur in adults at least at this level (If not lower levels).[1, 9]

Lead is a poison that affects virtually every system in the body[10] and can cause an array of adverse health effects. For individuals with lead levels of 15-20µg/dl, blood pressure may be increased. Exposure to higher levels of lead can cause anemia, irreversible brain and kidney damage, especially in children and in men, sperm count and quality may be affected by high lead levels.[3,8] Lead poisoning is a continuing health concern.[11] Public health and medical recommendation on prevention of lead toxicity rely on the use of blood lead concentration to assess lead exposure and predict onset of adverse health effects.[4]

Throughout the world, many populations have been studied to identify individuals and groups with high and low exposure.[1] In most cases researchers have tended to concentrate on identifying populations believed to be exposed to excessive amounts of lead from specific sources in the environment. In fact, 90% of studies were carried out on populations exposed to a known or suspected source of lead. For this reason, excessive lead exposure tends to be over emphasized in these studies, while the range of exposure in the general population remains largely unknown.[1] Screening is mandatory in some

countries. Evidence that lead is toxic at lower levels than previously thought, make it increasingly important for physicians to have an understanding of this problem.[11]

As data on the current blood lead levels in Basrah Governorate (among children and adults) are lacking, this study was carried out to estimate the blood lead levels in different age groups and for both sexes, and to look for risk factors associated with high blood lead levels.

Subjects and Methods:

This study was carried out over a six month-period (from 1 July to 31 December 2002). Subjects investigated were individuals attending primary health centers in the center District of Basrah Governorate. The sample size for different regions of Basrah center was determined before starting the study, according to the last census in 1997, accordingly the representative number of subjects to participate from each region was calculated. The center of Basrah was divided into 11 areas, Al Jazaer, Old Basrah, Al Junina, Hi-Alhussein, Al Ashar, Internal Security, 5-miles, Al Bradaya, Al Kebla, Al Jumhoria and Al Ma'akal.

A questionnaire for each individual, included age, sex, address, social class, educational level, history of smoking, source of drinking water, milk consumption (more or less than seven glasses per week), exposure to lead from gasoline automobile, paper products, discarded rubber, battery casings, lead cosmetics like kohl use by females, history of higher traffic density near home, and residence in new or old house with old painting. The importance of the test was explained to the subjects and an informed consent was obtained before recruitment in the study. Six hundred and sixty-four individual were randomly selected from individuals attending 17 primary health centers in the center of Basrah: Sixty-two were excluded because the information given was not complete or the blood sample was too small for analysis. The remaining 602, with ages ranging from 9-79 years were included in the study.

A blood sample (approximately 3 ml) was collected from each subject into disposable plastic tubes containing EDTA and delivered to the laboratory for immediate acid digestion. Lead estimation was carried out by the method of Dale et al, 1976[12] with the use of Atomic Absorption Spectrophotometery, (Pye Unicam model SP 2900). A blood lead level ≤10µg/dl was considered elevated for individuals aged ≤15 years, while a level of ≥25 µg/dl for those older than 15 years was used (1,5-9).

Statistical analysis was carried out using ANOVA one–way analysis of variance to compare two groups; $p<0.05$ was considered significant.

Results:

Children under 10 years of age had the highest mean BLL following by elderly (51-60 years) and those older than 60 years (**Table 1**). The difference in the mean BLL of the different age groups was statistically highly significant. The lowest BLL reported was 4 µg/dl and the highest was 23 µg/dl indicating that no adults had a high BLL (defined as ≥ 25µg/dl) but the three children under ten years of age had a high BLL ≥10 µg/dl. The mean BLL for children ≤15 years was 12.62±3.85 µg/dl, while for participants older than 15 years it was 11.20±3.40 µg/dl ($p<0.05$).

Table 1: The mean BLL (µg/dl) for participants in relation to age.

Age (Year)	Number of participants	Mean BLL ± SD
≤ 10	3	16.33 ± 6.50
11- 20	123	11.08 ± 3.42
21- 30	265	10.77 ± 3.24
31- 40	142	11.68 ± 3.48
41- 50	49	12.04 ± 3.06
51- 60	15	13.26 ± 4.36
> 60	5	12.40 ± 4.27
Total	602	11.26 ± 3.42
$p < 0.0001$		

Males of different ages reported a statistically significantly higher BLL compared with females (**Table 2**). The mean BLL of participants residing in the 11 areas of Central Basrah show statistically significant differences ranging from 7.26±2.81 µg/dl to 12.76±3.63 µg/dl (**Table 3**).

Table 2: Mean BLL (µg/dl) among children and adults in relation to sex

Age (Year)	Sex		p value
	Male	Female	
≤ 15	(n = 13) 15.07± 3.09	(n =13) 9.73 ± 2.37	<0.0001
>15	(n = 209) 13.14 ± 3.24	(n = 369) 10.12 ± 2.98	<0.0001
Total	13.25 ± 3.25	10.10± 2.96	<0.0001

Selected individual and community characteristics that may contribute to BLL include educational level, smoking, drinking water, milk consumption, lead exposure in the community from working with paper products, discarded rubber, or battery casings were studied in addition to a history of kohl use in females as and residence in new or old house with old paintwork (**Table 4**).

Four hundred (66.2%) participants were of low education (illiterate and primary school), 20.4% had gradu-

Table 3: Blood lead levels (BLL) (µg/dl) by geographic distribution

Area	Number of participants	Mean BLL ± SD
Al Jazaer	15	7.26 ± 2.81
Old Basrah	43	10.53 ± 3.23
Al Junina	39	11.05± 3.15
Hi Al Hussein	131	11.94 ± 3.51
Ashar	77	12.02 ± 3.35
Internal security	42	12.76 ± 3.63
5- miles	67	10.98 ± 3.43
Al Bradayia	41	9.60 ± 2.71
Al Kebla	47	11.51 ± 3.24
Al Jumhoria	72	10.55 ± 2.95
Al Amaakel	28	11.71 ± 3.45
Total:	602	11.26 ± 3.42
p < 0.0001		

Table 4: Blood lead levels (BLL) (µg/dl) in relation to community characteristics

Variable	Number of participants	Mean BLL ± SD	p value
Education			
Primary and Illiterate	400	11.11 ± 3.23	< 0.05
Intermediate and Secondary	123	11.20 ± 3.53	
Higher education	79	12.10 ± 3.54	
Smoking			
No	533	10.93 ± 3.26	<0.0001
Yes	69	13.81 ± 3.57	
Drinking water			
Tap	467	11.13 ± 3.31	>0.05
Tankers	134	11.70 ± 3.77	
River	1	8	
Milk consumption			
≥ 7 glasses/wk	256	11.12 ± 3.36	>0.05
< 7 glasses/wk	346	11.36 ± 3.47	
Lead exposure			
-ve	574	11.12 ± 3.3	<0.0001
+ve	20	15.30 ± 4.73	
House paint			
New	262	10.97+3.23	>0.05
Old	340	11.48+3.55	
Kohl use			
Yes	98	13.91 ± 4.42	<0.000
No	284	9.88 ± 2.68	

ated from intermediate and secondary schools and only 13.4% had received higher education. The mean BLL amongst the three groups was significantly different; those with higher education having the highest mean BLL. Only 69 participants were smokers (11.5%), the mean BLL for smokers was statistically significantly higher than non- smokers. Most participants (77.5%) were drinking tap water, followed by water from tankers (22.3%); there was statistically no significant difference in mean BLL in individuals drinking water from different sources. A similar result was obtained concerning the mean BLL among participants in relation to frequency and amount of milk consumed / week (whether more or less than 7 glasses/week); $p > 0.05$.

A history of occupational exposure to lead was significantly associated with BLL; the mean BLL being significantly higher (15.30±4.85 µg /dl) in those dealing with or exposed to higher concentration of lead from batteries or gasoline compared to others (11.12 ± 3.3 µg /dl); $p<0.0001$ but exposure to house paint (both old and new) showed no significant difference. In 98 females (25.6%) using kohl as a cosmetic the mean BLL was highly significant compared to kohl non- users, $p < 0.0001$.

Discussion:

Lead in the environment is still a major risk factor and its effects are mainly concentrated in developing countries. The disease burden associated with environmental exposure to lead could be almost eliminated through interventions that have proven successful in developed countries.[13] The burden of disease due to environmental lead exposure is likely to be underestimated because of a lack of data, the exclusion of geographical "hot spots", the adoption of conservative assumptions, or because of a number of health outcomes and social consequences of lead exposure could not be qualified due to insufficient evidence (e.g. increased risk of criminality and drug abuse).[13]

The population studied was stratified by age, sex, educational level and level of exposure to lead. Children had a significantly higher BLL compared to adults, a result in agreement with other studies,[1,14,15] which reported that children younger than 15 years of age are the most susceptible group especially young children. Children are considered at a greater risk for both lead exposure and toxicity, the accepted explanations including that lead absorption is greater in children compared to adults because of their physiological and metabolic characteristics, and because of hand–to–mouth behavior (especially for young children).[1,15,16] The mean BLL (12.62±3.85 µg/dl) for children ≤15 years was lower than that reported in other neighboring and developing countries such as Egypt (18.8±6.9 µg/dl)[16] but higher than that reported in China (7.59 µg/dl);[15] similar to the contrast between Mexican-American children living in the USA (3.45±3.87 µg/dl)[17] and those in Mexico (7.4 µg/dl).[18]

The mean BLL for adults reported in this study was higher than that reported in Turkey (3.65±1.66 µg/dl) [19], Switzerland (6.3±2.7 µg/dl for men and 4.4±1.9 µg/dl for women)[20] and France (7.4 µg/dl for men and 4.9 µg/dl for women).[21]

Blood lead levels that previously were considered safe are now known to cause subtle, chronic health effects. The BLL should be less than 5.0 µg/dl, with adverse effects likely to occur at greater levels.[22] Levels between 3-5 µg/dl are above the Canadian average, and any blood level of 5 µg/dl or higher requires repeat measurement immediately and in 3-6 months.[22]

For all age groups, males had a significantly higher BLL compared to females, similar results were obtained by other researchers[17,20,21,23] but a study in China did not reveal a significant sex difference.[15] Different areas in the district of the center of Basrah demonstrated a significant difference in mean BLL, possibly due to to population density, socio-economic status and high traffic density.

Participants with higher education had higher mean BLL in comparison with participants of lower education and educational level has been shown by many studies to be a risk factor for high BLL.[20,23,24] Smoking was also found to be a risk factor for high BLL, a result in agreement with other studies.[16,19-21,23-25] Sources of drinking water and milk consumption did not show any significant association with high BLL although studies in Taiwan and USA have reported a significant association between BLL and sources of drinking water[17,23,24] and milk consumption.[20,23,24] Use of kohl (as a cosmetic) by females was significantly associated with high BLL, a similar result obtained in Saudia Arabian school girls.[26]

Exposure level was a significant factor determining BLL, a result proved by most of the studies.[6,13,19,23,24,27] Although people living in houses with old paint had a higher BLL compared to those living in houses with new paint, the difference was statistically not significant. It has been reported that intact paint is not considered a lead hazard[6] although studies in different countries have reported that lead hazards are expected if the home includes interior lead paint applied before 1950;[21,22] this was not found to be so in this study. Most lead exposure is preventable and diagnosing lead poisoning is relatively simple compared to diagnosing. health effects of exposure to other environmental toxins [22] There is no evidence for a threshold below which lead has no adverse effects. The precautionary principle when applied to lead exposure means that any reduction in exposure is beneficial to health.

In addition to identifying people with elevated blood lead levels, physicians play an important role in educating patients to minimize the exposure to lead.[22] Adequate data on blood lead levels in our locality do not exist, especially for children. In addition there is no country–representative studies characterizing the extent and severity of lead poisoning in the general population and so further studies are needed to determine the extent and risk factors for lead poisoning especially in children, including young children.

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The Editorial Board would like to express sincere thanks to all the reviewers who have cooperated in making this endeavour such a great success. We appreciate the feedback from them, the valuable contributions that they have made. We hope for their continued support.

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