Original Article

Blood Lead Level and Renal Function: Sample of Iraqi Patients Attending Baghdad Teaching Hospital in 2022

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Abstract

Background: Lead is a highly toxic metal and a very strong poison. Most of the time, lead poisoning builds up slowly. It follows repeated exposures to small quantities of lead. Signs of repeated lead include high blood pressure, numbness or tingling in the extremities, memory loss, anemia, and kidney dysfunction. **Objectives:** The objectives of the study were to measure the blood lead level (BLL) among sample of adult patients attending Baghdad Teaching Hospital aged ≥30 years old and to find if there is any association between BLL and renal impairment. **Subjects and Methods:** Across sectional study was conducted from January 2 to May 31, 2022. Sample involved selection of adults of both sexes who attend Baghdad Teaching Hospital outpatient clinic for nonrenal medical problems. Inclusion criteria include adults aged ≥30 years old, with no history of drugs that change creatinine level and not malnourished. Glomerular filtration rate (GFR) was measured for all participants according to the Cockcroft equation depending on serum creatinine, age, gender, weight, height, and body mass index. Blood sample was taken for measure lead level in toxicology center in Baghdad medical city using whole blood samples not <2.5 ml for each participant, and the collection of data was taken by interview using especial questionnaire. Verbal consent was taken as ethical issue from each participant in the study. **Results:** A total of 239 participants were involved in this study. The mean BLL was 23.57 μg/dl. BLL for all was ranged between the values 17 μg/dl and 33 μg/dl for both sexes. The study showed a significant association between BLL and GFR rate. **Conclusions:** BLL was higher than normal cut point used in the study which is 10 μg/dl. About one-third of participants had risk of kidney disease with GFR (60–90) ml/min/1.73 m^2; they were considered asymptomatic renal impairment.

Keywords: Blood lead level, body mass index, chronic kidney diseases

Introduction

Lead (Pb) is a naturally occurring metal found in small amounts in rock and soil. It has been used industrially in the production of gasoline, ceramic products, paints, metal alloys, batteries, and solder. While lead arising from the combustion of leaded gasoline which was a major source of exposure for decades, today deteriorated lead-based paint and resulting dust and soil contamination are the primary sources of environmental lead exposure.[1] Lead is a highly toxic metal and a very strong poison. Lead poisoning is a serious and sometimes fatal condition. It occurs when lead builds up in the body. Household lead is found in lead-based paints, including paint on the walls of old houses and toys.[2]

Symptoms of lead poisoning are varied. They may affect many parts of the body. Most of the time, lead poisoning builds up slowly. It follows repeated exposures to small quantities of lead. Signs of repeated lead exposure are high blood pressure, numbness or tingling in the extremities, memory loss, anemia, and kidney dysfunction.[2]

In low- and middle-income countries, the presence of an informal economy can lead to human exposure to toxic metals such as lead (Pb).[3] Chronic kidney disease (CKD) is defined based on the presence of either kidney damage or decreased kidney function for 3 or more months, irrespective of cause.[4]

In 2017, CKD resulted in 1.2 million deaths and was the 12th leading cause of death worldwide. Global all-age CKD mortality increased by 41.5% between 1990 and 2017.[5] CKD

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Submitted: 16-Feb-2023 **Revised:** 09-May-2023 **Accepted:** 10-May-2023 **Published:** 07-Aug-2023

How to cite this article: Fadhil AH, Al-Rubaey MG. Blood lead level and renal function: Sample of Iraqi patients attending Baghdad Teaching Hospital in 2022. Mustansiriya Med J 2023;22:124-7.

Access this article online

Quick Response Code:

Website: http://www.mmjonweb.org

DOI: 10.4103/mj.mj_15_23

is the third most common noncommunicable disease globally. Many of these CKD patients ultimately terminate to end-stage renal disease when life is not sustainable unless hemodialysis is initiated.[6] CKD has been recognized as a leading public health problem worldwide. The global estimated prevalence of CKD is 13.4% (11.7%–15.1%).[7]

Lead is one of the risk factors for CKD which are accounting for 3·6% (95% confidence interval 2·3–5·1).[8] Hence, chronic lead poisoning is a forgotten cause of renal disease.[9] The concentration of lead in whole blood is the most widely used biomarker of exposure both for general population surveillance and as the principal exposure metric in epidemiological studies investigating associations between lead exposure and health outcome. Blood lead levels (BLLs) reflect a combination of recent exposure and, to some extent, chronic exposure due to the transfer of lead between bone and blood.[10]

The general pattern of lead nephrotoxicity indicates severe deficits in function and pathological changes of the kidney when BLLs >50 μg/dl. While enzymuria and proteinuria becoming evident when BLLs >30 μg/dl, reduced glomerular filtration rate (GFR) (measured as a decrease in creatinine clearance or increase in serum creatinine) will occur when BLLs >20 μg/dl. A significant association between serum creatinine concentration and lead levels was found in diabetic and hypertensive peoples, which suggests the possibility of interactions between lead exposure, glomerular function, and diabetes or hypertension.[11]

Recently, in adults, abnormal BLL mean results 5 μg/dl or 0.24 μmol/L or above are considered elevated.[12,13] The World Health Organization (WHO) recognizes lead paint as a major source of "lead-caused mental retardation. The WHO further states that "there is no known level of lead exposure that is considered safe.[14]

Objectives of this study are

- To measure the BLL among sample of Iraqi people aged ≥30 years old
- To find if there is any association between chronic lead exposure with BLLs >10 μg/dl and risk of renal impairment.

Subjects and Methods

Across sectional study for persons who were attending to Baghdad Teaching Hospital outpatient with different nonrenal medical conditions. All persons whose their age was 30 and above who attended to the hospital of both sexes for medical conditions other than renal problems and with no history of drugs that affect creatinine level (such as aminoglycoside and fluoroquinolones) and not malnourished. The study was conducted from January 2 to May 31, 2022, body anthropometric measures were done for each participant using Seca weight scale, wall tape were used for height measure.

The collection of data was taken by direct interview using special questionnaire. Verbal consent was taken as an ethical issue from each participant in the study. Permissions were taken from medical city directorate and toxicity center to work on blood samples for lead level in whole blood. The data were kept in password-protected computer and not used only for research purpose. The individuals were told that the participation in the study is voluntary and the refuse to participate will not affect the health services admitted to them.

Sampling of blood for lead measurement and glomerular filtration rate

Blood sample was taken to measure lead level in toxicology center in Baghdad medical city by using whole blood samples not <2.5 ml for all participants.

Serum creatinine was done for all participants and according to the Cockcroft–Gault equation; we measure GFR depending on creatinine, age, weight, height, and body mass index (BMI) (WT kg/Htm^2). The Cockcroft–Gault (CrCl, mL/min) = (140– age) × (weight, kg) × (0.85 if female)/ (72 × Cr, mg/dl).[15,16]

Data analysis was done using statistical package for social science (SPSS) version 23 (Corp, Armonk, NY, USA). Results were expressed by frequency and percentage, and the Chi-square test was used to find the association between dependent (BLL) and independent (GFR) variables. Statistical significance was considered when $P < 0.05$.

Results

A total of 239 participants were involved in this study, BLL was highly elevated above cut point which is 10 μg/dl in all of them.

Table 1 shows the sociodemographic characteristics of the participants. The age groups 50–59 years and 60–69 years were the more frequent attendants to the hospital during the period of study, 24.7% and 29.3%, respectively. About 43.5% of the participants had no previous medical history of chronic illness, 29.7% of them had hypertension only and were on treatment, 12.1% of participants had both hypertension and cardiovascular diseases, and 95.8% of participants did not have family history of CKD.

About 61. 5% (147) of participants had blood lead (15–24) μg/dl and 38.5% (92) of them had BLL (≥25) μg/dl [Figure 1]. About 64.9% (155) of participants had normal GFR (>90 mL/min/1.73 m^2), while 35.1% (84) of them had low GFR (60–90 mL/min/1.73 m^2 which mean mild CKD [Figure 2].

Table 2 shows that there is a statistically significant association ($P = 0.014$) between BLL and GFR, 84 adults with low GFR (60–90) mL/min/1.73 m^2.

Table 3 explains the descriptive statistics of variables used in the research included: mean, standard error of the mean, standard deviation, and maximum and minimum values as follow mean BLL is 23.5732 μg/dl, mean weight is 78.6067 kg, mean height is 167.5146 cm, mean serum creatinine is 0.8148 mg/dl, and mean BMI is 27.9477.

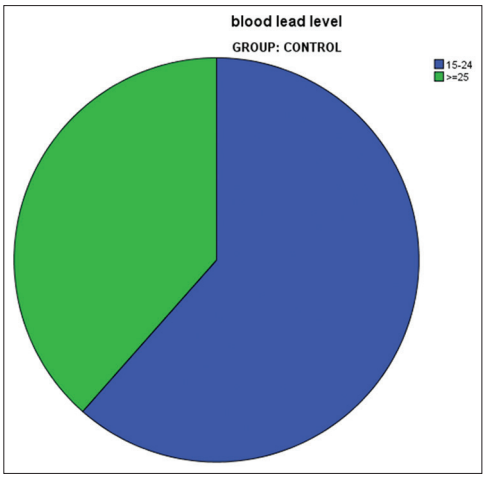

Figure 1: BLL in all 239 studied samples (adults ≥30 years old) in Baghdad, 2022. BLL: Blood lead level

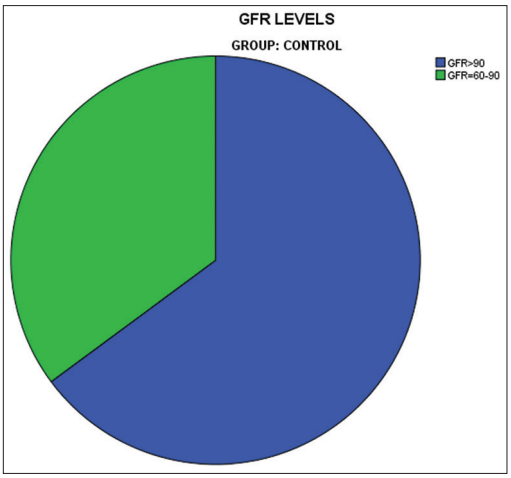

Figure 2: GFR in all 239 studied samples (adults ≥30 years old) in Baghdad, 2022. GFR: Glomerular filtration rate

Table 1: Distribution of the studied sample according to sociodemographic characteristics

Variable	Groups	Frequency (%)
Age (years)	30–39	40 (16.7)
	40–49	46 (19.2)
	50–59	59 (24.7)
	60–69	70 (29.3)
	70–79	18 (7.5)
	80–89	4 (1.7)
	≥90	2 (0.8)
	Total	239 (100.0)
Medical history	HT only	71 (29.7)
	DM only	9 (3.8)
	CVD only	5 (2.1)
	No disease	104 (43.5)
	HT + DM	13 (5.4)
	HT + CVD	29 (12.1)
	DM + HT + CVD	5 (2.1)
	Other like SLE	3 (1.3)
	Total	239 (100.0)
Family history of CKD	Yes	10 (4.2)
	No	229 (95.8)
	Total	239 (100.0)

DM: Diabetes mellitus, CVD: Cardiovascular disease, CKD: Chronic kidney disease, HT: Hypertension, SLE: Systemic lupus erythematosus

Discussion

About 29.7% of non-CKD adults having medical illness agree with Navas-Acien *et al*. study, which stated that lead exposure increases the frequency of high blood pressure, as well as cerebrovascular and cardiovascular disease.[17]

In the current study, 95.8% of participants had no family history of CKD, and 35.1% of all participants had impaired kidney function but most of them had no family history of CKD which agree with the study of environmental lead exposure that reported that low-level lead exposure was associated with decreased kidney function and incident CKD. Study findings suggest lead nephrotoxicity even at low levels of exposure.[18]

About 61.5% of participants had blood lead of 15–24 µg/dl and 38.5% of them had BLL (≥25) µg/dl which is abnormal level. The center for disease control and prevention has identified 25 µg/dl as the lower bound for the range of concern for adult BLLs.[19] By late 2010, almost all countries had phased out leaded petrol, leaving nine countries with leaded petrol. Three countries used only leaded petrol, and six countries used both leaded and unleaded petrol include Iraq.[20]

The phasing out of lead from petrol was regarding as a critical first step in reducing the concentration of lead in blood worldwide and is considered a major international public health achievement.[21] This action alone was one of the most effective ways of reducing the general population's exposure to lead. This story illustrates the key point that lead poisoning is nearly 100% preventable.[20]

BLL of all participants in our study was between 15 µg/dl and 33 µg/dl for both genders, it is far from cut point of lead level in blood which is 10 µg/dl; however, symptoms manifest when BLLs exceed 20–39 µg/dl in adults. Symptoms may appear at different ranges depending on the individual's characteristics.[22] In this study, the mean value is much higher than the mean BLLs of the general population reported in Basrah/Iraq which was 11.20 µg/dl, while in Duhok province/Iraq during the year 2011, the mean was 7.3 µg/dl, this may be due to the origin of their sample which was taken mainly from rural and suburban regions and the nature of their geographical area as well as the low occupational exposure.[23]

The association between BLL and GFR in our study agrees with Agency for Toxic Substances and Disease Registry (ATSDR) study in 2010 which conclude that reduced GFR (measured as a decrease in creatinine clearance or increase in serum creatinine) when BLLs >20 µg/dl.[11] Nephropathy due to acute lead exposure may be reversible in some cases. Individuals

Table 2: The association between blood lead level and glomerular filtration rate level

Blood lead level and GFR levels cross-tabulation			
BLL (μg/dL)	GFR levels (mL/min/1.73 m²)		Total
	GFR >90	GFR=60–90	
15–24	87	60	147
≥25	68	24	92
Total	155	84	239

Chi-square test=5.386, *P*=0.014. GFR: Glomerular filtration rate, BLL: Blood lead level

Table 3: The descriptive statistics of variables used in research

	BLL (μg/dL)	Weight (kg)	Height (cm)	Serum creatine (mg/dL)	BMI
Mean	23.5732	78.6067	167.5146	0.8148	27.9477
SEM	0.22814	0.80176	0.34011	0.01193	0.26623
SD	3.52689	12.39494	5.25793	0.18444	4.11578
Minimum	15.00	52.00	150.00	0.19	20.76
Maximum	33.00	110.00	185.00	1.30	40.40

SEM: Standard error of the mean, SD: Standard deviation, BMI: Body mass index, BLL: Blood lead level

exposed to chronic low levels of lead are likely to exhibit worse prognosis, with the potential for progressive renal decline.[24]

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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