Original Article

Blood Lead Level among Chronic Kidney Diseases Patients Attended Medical City Hospital in Baghdad 2022

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Abstract

Background: Lead is a highly toxic metal. Multiple lead exposures produce serious poisoning and sometimes fatality because lead builds up slowly in the exposed body. Signs of repeated exposure to lead are high blood pressure, numbness or tingling of the extremities, memory loss, anemia, and kidney dysfunction. **Methods:** A cross-sectional study was conducted involving patients with chronic kidney disease (CKD) who attended to medical city hospital. The study was conducted from January 2 to May 31, 2022. Inclusion criteria were by involved adults ≥30 years old with CKD of both genders. Glomerular filtration rate (GFR) was measured for all patients according to the Cockcroft-Gault equation. Whole blood samples were taken to measure lead levels in the Toxicology Center of Baghdad Medical City. The collection of data was done by interview using a special questionnaire. Verbal consent was taken as an ethical issue by each participant in the study. **Results:** A total of 315 CKD patients were involved. The mean blood lead level was 24.62 μg/dL, the range was between 15 μg/dL, and 33 μg/dL for both genders, which is higher than the cut point of 10 μg/dL depended in this study. About 38.4%, and 30.8% of patients had GFR (15–29 mL/min/1.73 m^2), and (<15) mL/min/1.73 m^2 and they were considered as stage 4 and 5 CKD patients, respectively. **Conclusions:** Lead level in blood and GFR had a significant association.

Keywords: Blood lead level, chronic kidney diseases, glomerular filtration rate

Introduction

In nature lead (pb), metal is found in small amounts in rock and soil, while industrially, it has been used in the production of petrol, ceramic products, paints, metal alloys, batteries, and solder. While lead arises from the combustion of leaded gasoline, which was a major source of exposure for decades, today's deteriorated lead-based paint, results in contaminated dust and soil, which are the primary sources of environmental lead exposure.[1] Household lead exposure is found in paints with lead, child-colored games, art materials, and dust contaminated with lead. Moreover, any petrol products sold outside of the highly lead control region of the United States and Canada.[2]

Different parts of the body may be affected after repeated exposures to small quantities of lead then slowly build up. While signs of repeated exposure include: elevated blood pressure, feeling of numbness or tingling in the extremities, memory impairment and loss, anemia, and urinary system affected by kidney dysfunction.[2]

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Low- and middle-income countries, where the informal economy is found, have high human exposure to many toxic metals such as lead (Pb).[3]

The definition of the term chronic kidney disease (CKD) depends on the presence of either decreased renal function or its damage for about ≥3 months, without relying on the cause.[4]

The five stages of CKD:[4]

- Stage 1: Normal or high glomerular filtration rate (GFR ≥90 mL/min)
- Stage 2: Mild CKD (GFR = [60–89] mL/min)
- Stage 3A: Moderate CKD (GFR = 45–59 mL/min)
- Stage 3B: Moderate CKD (GFR = 30–44 mL/min)

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- Stage 4: Severe CKD (GFR = 15–29 mL/min)
- Stage 5: End stage CKD (GFR <15 mL/min).

In 2017, about 1.2 million deaths were caused by CKD and it was the 12th leading cause of death worldwide. On the other hand, 7.6% of all cardiovascular disease (CVD) deaths (1.4 million) may be attributed to the impairment of kidney function. Furthermore, deaths due to CKD or CKD-attributable CVD accounted for 4.6% of the all-cause mortality. Globally, the CKD mortality rate for all ages increased by 41.5% between 1990 and 2017, while the age-standardized CKD mortality rate remained constant.[5]

The confirmed third most common noncommunicable disease in the whole world is CKD. Finally, many CKD patients terminate to end-stage renal disease when their life is not still ongoing unless hemodialysis is initiated.[6] CKD has been recognized as a worldwide leading public health problem. CKD estimated global prevalence is 13.4% (11.7%–15.1%).[7]

Lead is one of the risk factors for CKD, which are: impaired fasting plasma glucose accounting for 57·6%, high blood pressure (43·2%), high body mass index (BMI) (26·6%), a diet high in sodium (9·5%), and lead (3·6%).[8] Hence, chronic lead poisoning is a forgotten cause of renal disease.[9]

Lead concentration measured in whole blood is the biomarker that is most used widely for its exposure in both epidemiologic surveillance for the general population and the principal exposure metric in epidemiological studies that investigate the association between lead exposure and health outcomes. Blood lead levels (BLLs) reflect recent exposure and to certain extent chronic exposure because of the change of lead between blood and bone vice versa.[10]

Lead nephrotoxicity general pattern indicated severe deficit in renal function and pathological changes of renal tissue. If BLL measured >50 µg/dL proteinuria and enzymuria would be clear; if BLL measured ≥30 µg/dL GFR (measured as an increase in serum creatinine or a decrease in creatinine clearance) would be reduced, and if measured BLL ≥20 µg/dL so there would be a significant association between serum creatinine concentration and lead levels.[11]

Recently, in adults, abnormal BLL is considered elevated when the mean result is ≥5 µg/dL or 0.24 µmol/L.[12,13] The World Health Organization further issues a law that "there is no known level of lead exposure that is considered safe."[14]

Objectives of this study are

1. Assess the level of lead in blood among CKD of Iraqi people aged ≥30 years old
2. Find if there is an association between chronic lead exposure and renal impairment.

Methods

A cross-sectional study for patients who attended to medical city hospital outpatient with renal problems. The study was conducted from 2nd January to 31st of May 2022. All CKD patients above 30-year-old were included. Body anthropometric measures were done for each participant by using a seca weight scale; wall tape was used for height measure. Serum creatinine was done for all participants and according to the Cockcroft-Gault equation,[15] GFR was measured depending on serum creatinine, age, weight, height, and BMI (WT kg/HTm^2). Cockcroft-Gault creatinine clearance equation (ml/min) = (140 – age) × weight × (0.85 in female)/(72 × Cr, mg/dL).

The collection of data was done by interview using a special questionnaire. Verbal consent was taken as an ethical issue by each participant in the study. Permissions were taken from the medical city directorate and toxicity center to work on blood samples for lead levels in whole blood.

Sampling technique

All persons with the age of 30 years and above who attended to the hospital of both genders with CKD and with no history of drugs that change creatinine levels were involved in this study. Blood samples were taken to measure lead levels in the Toxicology center in Baghdad Medical City by using whole blood samples not <2.5 mL for all patients.

Ethical issues

1. Administrative approval and official approval were taken from Al Mustansiriyah College of Medicine to inform local health authorities (training and development unit of medical city directorate)
2. Verbal consent was taken as an ethical issue from each participant in the study
3. The collection of data was taken by interview using a special questionnaire. Anonymity and confidentiality were considered for all patients.

The collected data were kept in a password-protected computer and used only for research purposes.

Data analysis was performed using the Statistical Package for the Social Science (SPSS) version 23, (SPSS Inc., Chicago, IL, USA). Results were expressed by frequency and percentage, and the Chi-square test was used to find the association between the dependent (BLL) and independent (GFR) variables. Statistical significance was determined as $P < 0.05$.

Results

A total of 315 patients were involved in this study, BLL was highly elevated above the cut point which is 10 µg/dL in all participants.

Table 1 shows the sociodemographic characteristics of patients. The age groups 60–69 years old and 50–59 years old were the more frequent attendants to the hospital during the period of study (29.5%) and (25.4%), respectively. Forty-one percent of CKD patients had hypertension previously diagnosed, 22.5% of CKD patients had no other medical illness and were on treatment for CKD only, while 18.4% of CKD patients had both hypertension and diabetes mellitus. About 56.2% of CKD patients did not have a family history of CKD.

About 46.7% of participants had blood lead 15–24 µg/dL and 53.3% of them had BLL ≥25 µg/dL [Figure 1]. About 38.4% of CKD patients had 15–29 mL/min/1.73 m^2 GFR, while 30.8% of them had GFR <15 mL/min/1.73 m^2 [Figure 2].

As shown in Table 2, cross-tabulation was done to test the association between BLL and GFR, using Pearson Chi-square, there is a significant association (0.028) between the two variables (BLL and GFR).

Table 1: Distribution of adults according to frequency and percentage of sociodemographic characteristics

Variable	Groups	Frequency (%)
Age	30–39	50 (15.9)
	40–49	60 (19.0)
	50–59	80 (25.4)
	60–69	93 (29.5)
	70–79	27 (8.6)
	80–89	5 (1.6)
	Total	315 (100.0)
Medical history	HT only	129 (41.0)
	DM only	5 (1.6)
	CVD only	4 (1.3)
	No other medical dis	71 (22.5)
	HT + DM	58 (18.4)
	HT + CVD	23 (7.3)
	DM + HT + CVD	25 (7.9)
	Total	315 (100.0)
Family history of CKD	Yes	138 (43.8)
	No	177 (56.2)
	Total	315 (100.0)

CKD: Chronic kidney disease, HT: Hypertension, DM: Diabetes mellitus, CVD: Cardiovascular disease

Table 3 explains the descriptive statistics of variables used in the research including: mean, standard error of the mean, standard deviation, maximum and minimum values, and mean of variables as follows: BLL (24.62 µg/dL), weight (77.60 kg), height (168.46 cm), serum creatinine (4.49 mg/dL), and BMI (27.22 kg/m^2).

Discussion

Forty-one percent of CKD patients had hypertension, which agrees with Navas-Acien *et al*.'s study, which stated that "Lead exposure increases the frequency of high blood pressure, as well as cerebrovascular and CVD."[16]

In the current study, 56.2% of CKD patients had no family history of CKD, which agrees with a 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.[17]

Regarding blood level, this study found that 46.7% of participants had blood lead (15–24) µg/dL and 53.3% of them had BLL (≥25) µg/dL, which is abnormal. Center for disease control and prevention (CDC) issued 25 µg/dL as the minimum range of concern for the level of lead in adult blood.[18] At the end of 2010, about all countries in the world except nine countries had phased out lead from petrol. Three countries only used lead in petrol and six countries used dual petrol patterns like Iraq.[19]

A first step in reducing the concentration of lead in blood was by the phasing-out of lead from petrol which was worldwide and considered a major international public health achievement. This step was the most effective way of reducing exposure to

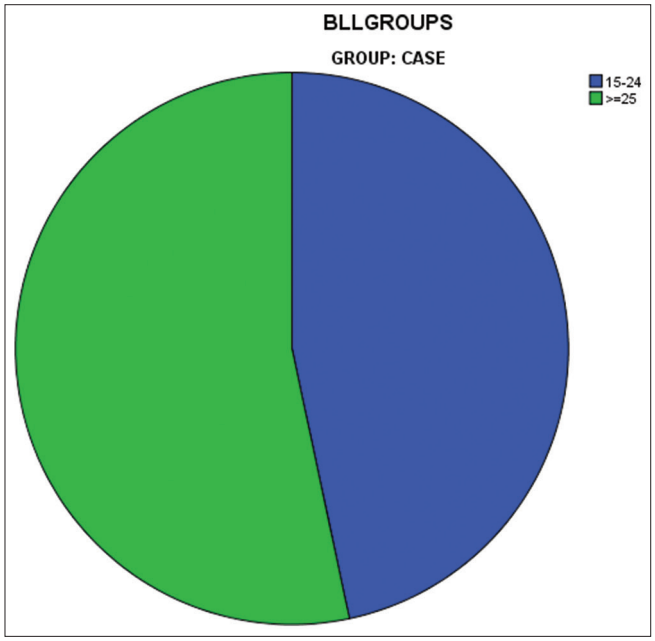

Figure 1: Blood lead level in all 315 chronic kidney disease patients (adult ≥30 years old) in Baghdad, 2022

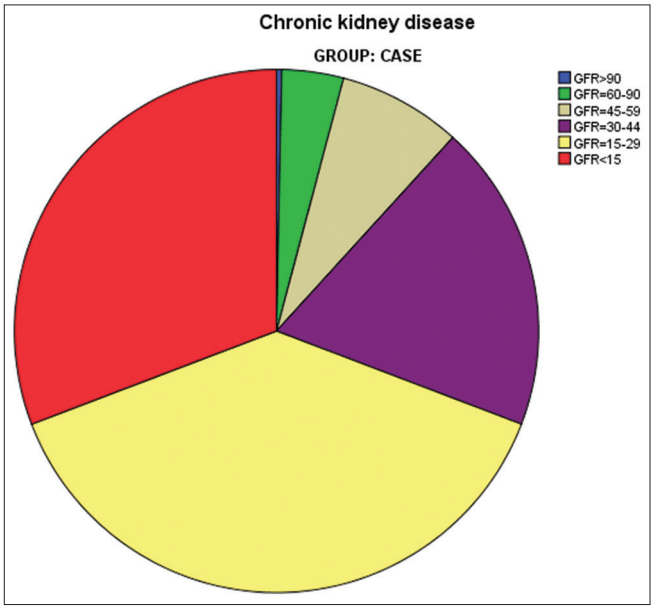

Figure 2: Glomerular filtration rate in all 315 chronic kidney disease patients (adults ≥30 years old) in Baghdad, 2022. GFR: Glomerular filtration rate

Table 2: Blood lead level and glomerular filtration rate cross-tabulation and its Chi-square test

Blood lead level groups × CKD cross-tabulation count							Total
BLL groups	CKD						
	GFR >90	GFR=60–90	GFR=45–59	GFR=30–44	GFR=15–29	GFR <15	
15–24	1	7	14	35	43	47	147
≥25	0	5	10	25	78	50	168
Total	1	12	24	60	121	97	315

Chi-square test=12.539, *P*=0.028. GFR: Glomerular filtration rate, BLL: Blood lead level, CKD: Chronic kidney disease

Table 3: The descriptive statistics of variables used in research

	GFR	Serum-creatine	Weight	Height	BLL	BMI
Number	315	315	315	315	315	315
Mean	25.04	4.4926	77.6000	168.4635	24.6254	27.2294
Median	22.00	3.5000	75.0000	169.0000	25.0000	26.4000
Mode	10	2.50	70.00	170.00	26.00	27.60
SD	15.928	2.82498	12.13979	4.51196	3.41213	3.98491
Minimum	3	0.70	50.00	152.00	15.00	17.71
Maximum	113	16.00	135.00	190.00	33.00	48.40
Percentiles						
25	13.00	2.4000	69.0000	167.0000	22.0000	24.5000
50	22.00	3.5000	75.0000	169.0000	25.0000	26.4000
75	33.00	6.1000	85.0000	170.0000	27.0000	29.7000

SD: Standard deviation, BMI: Body mass index, GFR: Glomerular filtration rate, BLL: Blood lead level

lead. This story illustrates that poisoning from lead is nearly 100% preventable.[20]

BLL of all participants between 15 µg/dL and 33 µg/dL for both genders, it is far from the 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 vary and may appear at different ranges according to the individual's characteristics.[21]

In this study, the mean value of lead is much higher than the mean BLLs of the general population reported in Basrah/Iraq at 11.20 µg/dL; this may be due to low occupational exposure, while in Duhok province/Iraq that measured during the year 2011 which was 7.3 µg/dL and this may be due to the origin of their sample which were taken mainly from rural and suburban regions and the nature of their geographical area as well as the low occupational exposure.[22]

The association between BLL and GFR agrees with Ahmed *et al.* study in 2010, which concluded that reduced GFR when BLL >20 µg/dL.[11] Nephropathy because of acute lead exposure may be reversible in some cases, while individuals exposed to chronic low levels of lead are most likely to end with a worse prognosis and the potential for renal decline progressively.[23]

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Conflicts of interest

There are no conflicts of interest.

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