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Evaluation of Lead, Cadmium and Chromium Levels in the Serum and Urine of Patients with Renal Failure using the Atomic Absorption Spectrophotometer

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Abstract

Exposure to heavy metals is the most serious threat to human health and biological system, too much and too little of it does a great deal of harm, including toxicity. Recently, an increase in the incidence of renal failure. It was observed in Al-Sadr Teaching Hospital in Al-Najaf Governorate and it is a major driver for measuring the concentration of heavy metals in Human serum, urine. In this study, 20 (10 men and 10 women) patients with renal failure were taken against 20 (10 men and 10 women) healthy subjects. Peoples Volunteers. It was found that the level of lead in blood serum, urine, respectively, ranged between (27.3992 PPM - 0.4689 PPM ppm, Mean ±SD = 7.4731 ± 19.923 ppm), (1.2978 - 0.0000 mg/L), Mean ±SD = 7.4731 ± 19.923 mg/L,), in Kidney failure patients were found (128.186 ppm - 0.3015 ppm, Mean ±SD = 11.255 ± 10.923 ppm,) in the healthy group. It was found that the value of cadmium in blood serum, urine, respectively, ranged (26.4340 - 3.9280 PPM, Mean ±SD = 9.7437 ± 5.8836 ppm), (0.2439 - 0.0004 mg/ L, Mean ±SD = 9.7437 ± 5.8836 ppm,), in patients with renal failure) but on her (22.7242 - 2.3568 PPM, Mean ±SD = 8.322 ± 5.88 ppm, in the healthy group). It was found that the value of chromium in blood serum, urine, respectively, ranged (72.6293-3.3157 ppm, Mean ±SD = 24.69 ± 21.36 ppm), (0.5676-0.0000 mg/L, Mean ±SD = 22.7585 ± 21.673 ppm), in patients with renal failure) Find the value of chromium present (72.6293 – 3.3157 ppm, Mean ±SD = 24.69 ± 21.36 ppm) in the healthy group. This study concluded that the mean chromium concentrations are highest in serum samples, cd, then pb lowest in serum samples. It was found that average lead concentrations were highest in urine samples then chromium was lowest in cd. Mean concentrations of heavy metals are higher in serum Cr and pb samples of healthy subjects, while mean concentrations of heavy metals are higher in urine samples of Pb of healthy subjects.

Keywords: Copper, Cadmium, Chromium, Blood Serum, Urine, Patients-Renal Failure, Atomic Absorption Spectrophotometer

Introduction

Due to its high divalent metal reabsorption and accumulation capability, the kidney is the primary organ affected by heavy metal poisoning. Also, Loss of kidney function over time is the hallmark of chronic renal disease, which has a devastating effect on both quality of life and the need for medical care [1, 2, 3]. Chronic renal disease is linked to exposure to heavy metals. [4]. People with renal failure can benefit from hemodialysis therapy, which involves the removal of waste products from the blood. Pollution of the air, water, and soil by a wide variety of chemicals has far-reaching consequences because of the fast expansion of human activity across many sectors in the absence of adequate planning and management. Heavy metals and radioactive pollutants in the natural environment are a worldwide issue due to the harmful impact they may have on living beings [5]. For at least three months, an individual's glomerular filtration (eGFR) must be <60 mL/min/1.73m^2 in order to be diagnosed with chronic kidney disease [6]. Heavy metals are a type of inorganic pollution that accumulates in the soil rather than dissolving and becoming innocuous products as happens with organic pollutants [7]. Heavy metal concentrations fluctuate with changes in the environment caused by factors like urbanization, global warming, industrial output, etc. [8] Heavy metals with nephrotoxic qualities have been found in abundance in fertilizers [9], which may lead to permanent damage or loss of kidney function [10, 11].

The purpose of this research is to use atomic absorption spectrometry to determine the levels of lead, chromium and cadmium in the serum and urine of patients with renal failure and to compare these readings with those of a control group. A group of healthy individuals. Examined the associations between sex, age, weight, health, and levels of heavy metals in blood and urine.

Materials and Methods

Blood and urine samples were collected from Al-Sadr Teaching Hospital in Al-Najaf. And healthy blood and urine samples from different regions of the province and other regions. Serum and urine samples were taken from patients with renal failure and healthy individuals for each type of 20 patients. The age of patients with renal failure (24-71 years) and the number of males 10 and females 10, while the healthy subjects ranged from 25 to 73 years old and the number of males 10 and females 10. (2 ml) of blood was collected for each group separately by a disposable syringe and the sample was placed in Clean and dry test tube without any anti-coagulant and allowed to clot for 10 minutes at room temperature. Serum was separated and transferred to new disposable test tubes after centrifugation at 6000 rpm for 10 minutes [12]. The tubes are labeled with Patient icon and corresponding healthy subjects. Thereafter, serum samples were kept in an ice box (4 °C) and then it was transferred to a laboratory for cooling until the digestion process begins [13]. Also, urine samples were taken for each group of patients and healthy individuals. The urine samples were placed in a urine cup. The urine sample was transferred to a cooling laboratory, until the digestion process began. (Model AA-6300, Shimadzu, Japan) was used to determine levels of lead, pb, cd, and cr. The wavelength is (283.3, 228.8357.9) nm, respectively.

Digestion of Serum and Urine Samples: Dilute serum (2 mL) from blood samples with 1 mL of H2O2 + 2 mL of HNO3 [13], and (10 mL) of deionized water. The mixture was then added to 25 mL of deionized water to prepare the samples for digestion Samples were digested to 2 ml using a heating digester (VELP SCINTIFICA, DK6, Europe) at 200 °C for 1 hour. Also, urine samples were digested with a dilution of (10 ml) and (5 ml) concentrated nitric acid was added to it, then heated at 80-90 degrees Celsius, near dehydration, and a small amount of deionized water was added. All samples were cooled to room temperature after digestion. Overseas experiments have been completed water (50 mL) [14], and filtered using filter paper (0.45 µm) washed with water and acid and dried in place [15], and a vacuum pump. Serum and urine (10 ml each) samples were frozen at −20 °C until the start date of analysis in a chelometer as in Fig 1.

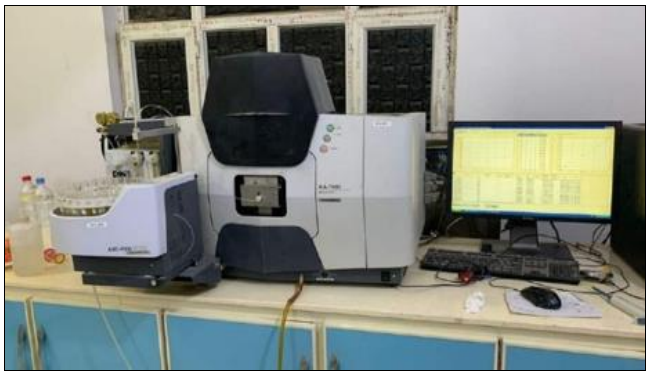

Fig 1: Apparatus for measuring the heavy metals

Results and Discussion

Table 1 shows heavy metals (lead, cadmium, chromium) in serum samples of patients. The Pb value ranged (27.3992 ppm–0.4689 ppm, mean ± SD = 7.4731 ± 19.923 ppm,). The highest value obtained for lead was 27.3992 ppm. The lowest value obtained was 0.4689 ppm. The Cd value ranged (26.4340–3.9280 ppm, mean ± SD = 9.7437 ± 5.8836 ppm,). The highest obtained value was 26.4340 ppm, and the lowest obtained value was 3.9280 ppm. The Cr value found ranges from (125.355 − 4.9646 ppm, mean ± SD = 22.7585 ± 21.673 ppm). The highest obtained value was 125.355 ppm, and the lowest obtained value was 4.9646 ppm. Health group. The Pb value range is (128.186 ppm–0.3015 ppm, mean ± SD = 11.255 ± 10.923 ppm,). The highest obtained value was 128.186 ppm, and the lowest obtained value was 0.3015 ppm. The Cd value ranged (22.7242 - 2.3568 ppm, mean ± SD = 8.322 ± 5.88 ppm,). The highest value obtained for Cd was 22.7242 ppm, and the lowest value obtained was 2.3568 ppm. The value for Cr ranged (72.6293 - 3.3157 ppm, mean ± SD = 24.69 ± 21.36 ppm) the highest value obtained for chromium was 72.6293 ppm, and the lowest obtained value was 3.3157 ppm.

Table 1: Comparison between patients and healthy subjects for heavy metals in blood serum samples

Heavy Metals	Type of Group	Upper Limit	Lower Limit	Mean ± SD
Pb	Patients	27.399	0.468	7.4731 ± 19.923
	Healthy	128.186	0.3015	11.255 ± 10.923
Cd	Patients	***26.4340***	***3.9280***	9.7437 ± 5.8836
	Healthy	22.7242	0.2765	***8.322***± 5.88
Cr	Patients	***125.355***	***4.9646***	***22***.7585 ± 21.673
	Healthy	72.6293	3.3157	***24.69*** ± 21.36

Table 2 shows heavy metals (lead, cadmium, chromium) in urine samples of a group of patients. Lead value range (1.2978 - 0.0000 mg/L, mean ± SD = 7.4731 ± 19.923 ppm,). The highest value obtained for lead was (1.2978 mg/L) and the lowest value obtained was (0.0000 mg/L). The value for cadmium ranged from (0.2439 - 0.0004 mg/L, mean ± SD = 9.7437 ± 5.8836 ppm,). The highest value obtained for Cd was (0.2439 mg/L) and the lowest value observed was (0.0004 mg/L). The value of chromium found ranges from (0.5676 - 0.0000). mg/L, mean ± SD (22.7585 ± 21.673 ppm). The highest value observed was (0.5676 mg/L) and the lowest value observed was (0.0000. mg/L) Health group. The Pb value range is (128.186 ppm–0.3015 ppm, mean ± SD = 11.255 ± 10.923 ppm,). The highest obtained value was 128.186 ppm, and the lowest obtained value was 0.3015 ppm. The Cd value ranged (22.7242 - 2.3568 ppm, mean ± SD = 8.322 ± 5.88 ppm,). The highest value obtained for Cd was 22.7242 ppm, and the lowest value obtained was 2.3568 ppm. The value for Cr ranged (72.6293 - 3.3157 ppm, mean ± SD = 24.69 ± 21.36 ppm) the highest value obtained for chromium was 72.6293 ppm, and the lowest obtained value was 3.3157 ppm.

Table 2: Comparison of patients and healthy subjects for heavy metals in urine samples

Heavy Metals	Type of Group	Upper Limit	Lower Limit	Mean ± SD
Pb	Patients	1.2978	0.0000	4731 ± 19.923
	Healthy	128.186	0.3015	11.255 ± 10.923
Cd	Patients	0.2439	0.0004	9.7437 ± 5.8836
	Healthy	22.7242	0.2765	***8.322***± 5.88
Cr	Patients	0.5676	0.0000	***22***.7585 ± 21.673
	Healthy	72.6293	3.3157	***24.69*** ± 21.36

Fig 2 shows of average Heavy Metals Concentration (ppm) in Patients serum Samples and compare with permissible

limit according global organizations concerned with standard values of elements. The mean of Concentration pb in Heavy Metals groups higher than permissible limit at 7.473 ppm. Lead is still added to aviation fuel despite being outlawed in 1995 from usage in commercially available gasoline. Lead emissions from this source are very high, and this is a known contributor to environmental contamination. It was also shown that smokers' blood lead levels were much higher than nonsmokers', suggesting another route of exposure. Lead exposure is also affected by the jobs people hold, such as those in the mining industry. The average concentration of cadmium in the heavy metal groups is above the permissible limit at 9.7437 ppm. Cadmium and its compounds are highly toxic and exposure is known to cause kidney failure. The average concentration of chromium in the heavy metal groups is above the permissible limit at 22.7585 ppm.

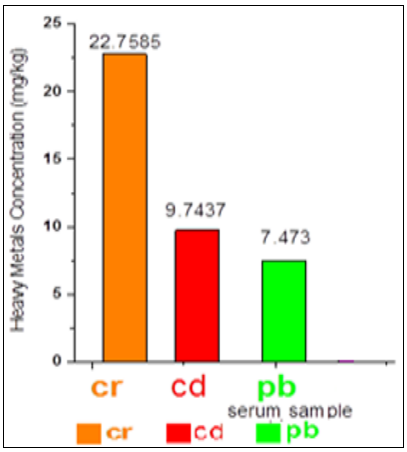

Fig 2: Average Heavy Metals Concentration (ppm) in serum Samples and compared with permissible limit

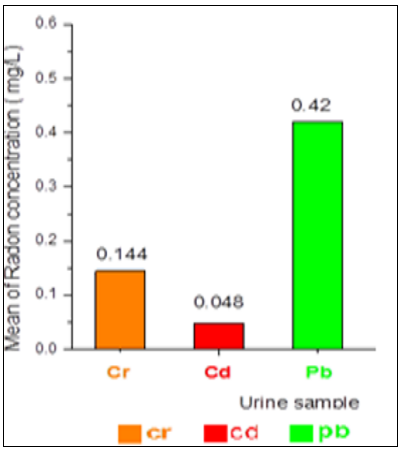

Fig 3: Average Heavy Metals Concentration (mg/L) in urine Samples and compared with permissible limit

Fig 3 shows of average Heavy Metals Concentration (mg/L) in Patients urine Samples and compare with permissible limit according global organizations concerned with standard values of elements. The mean of Concentration pb in Heavy Metals groups higher than permissible limit at 0.472 mg/L. Aviation gasoline still contains lead. Lead emissions from this source are very high, and this is a known contributor to environmental contamination. It was also shown that smokers' urine had much higher concentrations of lead, suggesting that tobacco use is a significant contributor to lead exposure. Lead exposure is also affected by the jobs people have, such as those in the mining industry. The mean of Concentration Cd in Heavy Metals groups less than permissible limit at 0.048 mg/L. Cadmium and its compounds are highly toxic and exposure is known to cause kidney failure. The mean of Concentration Cr in Heavy Metals groups higher than permissible limit at 0.142 mg/L.

Fig 4 shows the analytic results of HMC (Pb, Cd, Cr) in serum Samples of study groups depending on the gender of participants. The contents of Cr, Cd, are more concentrated in female serum samples of comparing to male, which can be caused by the vocational exposure While male serum samples with higher Pb concentrations than female samples.

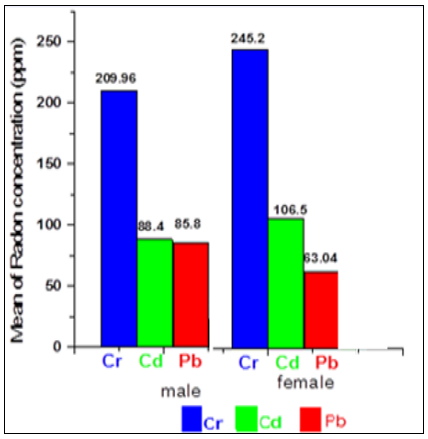

Fig 4: Mean Values of HMC in serum Samples of the Study Groups as a Function of Gender

Fig 5 shows the analytic results of HMC (Pb, Cd, Cr) in Samples of study groups depending on healthy and Patients people. The contents of Cd are more concentrated in Patients people serum samples of comparing to healthy people. While, the concentration of Pb and Cr in serum samples of healthy people more percentage of Patients people.

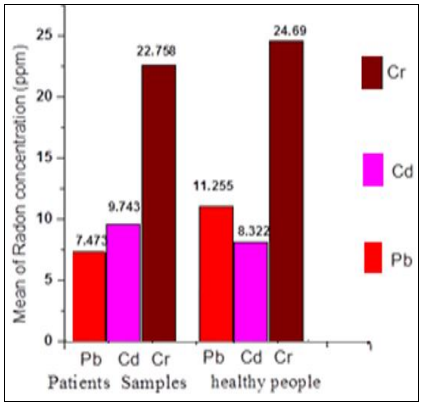

Fig 5: Mean HMC values in serum samples of healthy and Patients

Fig 6 shows the analytic results of HMC (Pb, Cd, Cr) in urine Samples of study groups depending on healthy and Patients people. The contents Cr are more concentrated in Patients' urine samples of comparing to healthy people. While, the concentration of Pb and Cd in urine samples of healthy people more percentage of Patients people.

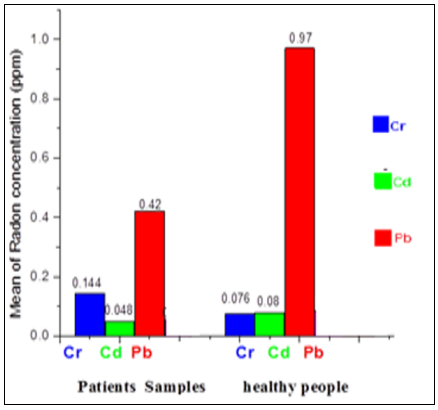

Fig 6: Mean HMC values in urine samples of healthy and Patients

Conclusions

The results indicated that the average levels of heavy metals in patients with renal failure in the blood serum is that the average concentrations of chromium are the highest in the serum samples then cadmium and the lowest are the lead serum samples while in the average concentrations of lead is the highest in the urine samples, then cr, and the least of them are cadmium samples

The study concluded that the average concentrations of metals in chromium and lead samples are higher than in the serum of healthy subjects, while the average concentrations of minerals in cadmium serum samples are higher in patients. Based on the findings, polluted air in the Middle East Center is responsible for the elevated levels of heavy metals found in healthy people. Determining the role of these components in the pathogenesis of renal failure will require further research.

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