Evaluation of copper, calcium, lead, cadmium and chromium levels in serum, urine and stones in patients with renal failure compared to healthy subjects in Al-Sadr Teaching Hospital in Najaf.

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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 failureIt was observed in Al-Sadr Teaching Hospital in Al-Najaf Governorate and it is a major driver for measuring the concentration of heavy metals inHuman serum, urine, and gravel. 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, and stones, 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 ppm,), (64.8876 MG/KG - 0.0000 MG/KG) , Mean ±SD= 11.8699 ± 54.9193 MG/KG inKidney 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 and stones, 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,),(6.5469 MG/KG - 0.0000 MG/KG, Mean±SD = 0.9731 ± 5.4970 MG/KG 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 copper ranges from (0.4092 -0.7415 ppm, mean ± SD = 0.5362 ± 0.1023 ppm in the healthy group. It was found that the value of copper in blood serum, urine, and stones, respectively, ranged from (3.6553 – 0.1536 ppm, Mean ±SD = 1.6772 ± 1.5244 ppm), (1.2948 – 0.0523 mg/L, Mean ±SD = 1.6772 ± 1.5244 ppm), (65.8539 mg/kg – 0.0034 mg/kg, Mean±SD = 13.4887 ± 52.40 mg/kg in patients with renal failure) find the value of copper present (3.0410 – 0.2765 ppm, Mean ±SD = 1.447 ± 0.830 ppm) in the healthy group. It was found that the value of calcium in blood serum, urine and stones, respectively, ranged ((114.587 – 0.6347 ppm , Mean ±SD = 9.6044 ± 8.0777 ppm), ((0.3248 0.0000 mg/L , Mean ±SD = 9.6044 ± 8.0777 ppm),(114.587 MG/KG – 0.6347 MG/KG, Mean ±SD = 9.5762 ± 8.60 mg/k in patients with renal failure) found the value of calcium present (32.2354 – 1.2695 ppm , Mean ±SD = 4.514 ± 3.2759 ppm in the healthy group. It was found that the value of chromium in blood serum, urine and stones, 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), (9.4595 MG/KG – 0.0000 MG/KG, Mean ± SD = 1.8303 ± 7.60 mg/kg 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, then co, then cd, then pb and lowest in serum samples. It was found that average carbon dioxide concentrations were highest in urine samples, then lead, then copper, then CR, and lowest in blood serum samples.Average copper concentrations are highest in the stone, then lead, then calcium, then chromium samples and lowest in the CD serum samples. Mean heavy metal concentrations are higher in the Cr and pb serum samples of healthy subjects, whereas the mean heavy metal concentrations are present in the Ca and Pb serum samples of healthy subjects. Copper and cadmium are higher in patients.

Key words: copper, calcium ,lead , cadmium and chromium, blood serum, urine, stones – patients- renal failure, Healhy people, Najaf Governorate

INTRODUCTION

to Due 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 biomineralogy of human kidney stones (urinary calculi) has advanced quickly in recent years [12], since they are one of the most common biominerals. One of the most difficult medical problems, kidney stones have spread over the world and have been linked to irreversible kidney damage and a decline in renal function [13]. Some of the reasons why kidney stones occur, however, are still a mystery [14].The four most prevalent forms of kidney stones are calcium phosphate stones, calcium oxalate stones, uric acid stones, and struvite stones [15]. Kidney stones can be composed of a variety of substances, but the most frequent are calcium oxalate and calcium phosphate. Calcium, a necessary component of kidney stones, may combine with oxalate and phosphate, and it can also precipitate with white alkali and alkaline components. Geographic location, climate, ethnicity, and social and environmental features are all linked to the incidence of particular forms of kidney stones [16].This study analyzed the major and trace element compositions of kidney stones collected from Beijing patients and analyzed the possible effects of elements on nucleation or crystallization of the main components of kidney stone formation [17] to obtain more geochemically interpreted data of biogenic minerals. The purpose of this research is to use atomic absorption spectrometry for determination of the lead levels, copper, chromium, cadmium, and calcium in the blood serum, urine, and stones of patients with renal failure and to compare these readings to those of a control group of healthy individuals. Examining the associations between gender, smoking history, health, and heavy metal levels in blood, urine, and stones.

MATERIALS AND METHODS

Blood, urine and kidney stones 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, urine and stones 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 [18]. 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 [18]. Also, urine and gravel samples were taken for each group of patients and healthy individuals. The urine and gravel samples were placed in a urine cup. The urine sample was transferred to a cooling laboratory, while the gravel samples were placed at room temperature until the digestion process began. (Model AA-6300, Shimadzu, Japan) was used to determine levels of lead, copper, copper, calcium and chromium .The wavelength is (283.3, 324.8, 228.8, 240.2, 357.9) nm, respectively.

Digestion of serum, **urine, and gravel samples**: Dilute serum (2 mL) from blood samples with 1 mL of H2O2 + 2 mL of HNO3 [19], 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. Samples of gravel weighing (1 gram) were digested, and (20 ml) of concentrated nitric acid was added to them, then heated to burn the organic matter, and when the red fumes stopped appearing, (10 ml) of perchloric acid was added, and the digestion continued until it appeared white fumes. All samples were cooled to room temperature after digestion. Overseas experiments have been completed water (50 mL) [20], and filtered using filter paper (0.45 μm) washed with water and acid and dried in place [21], and a vacuum pump. Serum, urine (10 ml each) and kidney stone (25 ml) samples were frozen at −20 °C until the start date of analysis in a chelometer as in Figure 1.

Figure 1: Apparatus for measuring the heavy metals

RESULTS AND DISCUSSION

Table 1 shows heavy metals (lead, cadmium, copper, calcium, chromium) in serum samples of a group 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. Copper value range (3.6553 - 0.1536 ppm) mean ± SD = 1.6772 ± 1.5244 ppm). The highest value obtained for copper was 3.6553 ppm, and the lowest value obtained was 0.1536 ppm. The Ca value ranged (114.587–0.6347 ppm, mean ± SD = 9.6044 ± 8.0777 ppm). The highest obtained value was 114.587 ppm, and the lowest obtained value was 0.6347 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 Cu ranged (3.0410 - 0.2765 ppm, mean ± SD = 1.447 ± 0.830 ppm). The highest value obtained for copper was 3.0410 ppm, and the lowest value obtained was 0.2765 ppm. The Ca value ranges from (32.2354 - 1.2695 ppm, mean ± SD = 4.514 ± 3.2759 ppm). The highest value obtained for Ca was 32.2354 ppm, and the lowest value obtained was 1.2695 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 Healthy	27.399 128.186	0.468 0.3015	7.4731 ± 19.923 11.255 ± 10.923
Cu	Patients Healthy	3.6553 3.0410	0.1536 0.2765	1.6772±1.5244 1.447 ± 0.830
Cd	Patients Healthy	26.4340 22.7242	3.9280 0.2765	9.7437 ± 5.8836 8.322± 5.88
Ca	Patients Healthy	114.587 32.2354	0.6347 1.2695	9.6044 ± 8.0777 4.514± 3.2759

Cr	Patients Healthy	125.355 72.6293	4.9646 3.3157	22.7585 ± 21.673 24.69 ± 21.36

Table 2 shows heavy metals (lead, copper, cadmium, calcium, 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) Copper value range (1.2948 - 0.0523 mg/L, mean ± SD = 1.6772 ± 1.5244 ppm). The highest value obtained for copper was 1.2948 mg/L) and the lowest value obtained was (0.0523 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) Calcium value range (0.3248 ± 0.0000 mg/L) mean ± SD = 9.6044 ± 8.0777 ppm). The highest value obtained for Ca was (0.3248 mg/L) and the lowest value obtained was (0.0000 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 Cu ranged (3.0410 - 0.2765 ppm, mean ± SD = 1.447 ± 0.830 ppm). The highest value obtained for copper was 3.0410 ppm, and the lowest value obtained was 0.2765 ppm. The Ca value ranges from (32.2354 - 1.2695 ppm, mean ± SD = 4.514 ± 3.2759 ppm). The highest value obtained for Ca was 32.2354 ppm, and the lowest value obtained was 1.2695 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 Healthy	1.2978 128.186	0.0000 0.3015	4731 ± 19.923 11.255 ± 10.923
Cu	Patients Healthy	1.2948 3.0410	0.1536 0.2765	1.6772 ± 1.5244 1.447 ± 0.830
Cd	Patients Healthy	0.2439 22.7242	0.0004 0.2765	9.7437 ± 5.8836 8.322± 5.88
Ca	Patients Healthy	0.3248 32.2354	0.0000 1.2695	9.6044 ± 8.0777

				4.514± 3.2759
Cr	Patients Healthy	0.5676 72.6293	0.0000 3.3157	22.7585 ± 21.673 24.69 ± 21.36

Table 3 shows heavy metals (lead, copper, cadmium, calcium, chromium) in stone samples. Lead value between (64.8876 mg/kg - 0.0000 mg/kg), mean ± SD = 11.8699 ± 54.9193 mg/kg. The highest obtained value was 64.8876 mg/kg, and the lowest obtained value was 0.000 mg/kg. The copper value ranged from (65.8539 mg/kg - 0.0034 mg/kg) kg mean ± SD = 13.4887 ± 52.40 mg/kg The highest obtained value of copper for gravel samples was (65.8539 mg/kg) and the lowest value obtained was (0.0034 mg/kg) The value of cadmium ranged (6.5469 mg/kg - 0.0000 mg/kg) mean ± SD = 0.9731 ± 5.4970 mg/kg the highest value obtained for gravel samples was (6.5469 mg/kg) and the lowest value obtained was (0.0000 mg/kg), Ca value ranged from (114.587 mg/kg - 0.6347 mg/kg), mean ± SD = 9.5762 ± 8.60 mg./kg. The highest value obtained for gravel samples was 114.587 mg/kg and the lowest value obtained was 0.6347 mg/kg. The value of chromium CR ranged from (9.4595 mg/kg) - 0.0000 mg/kg, mean ± SD = 1.8303 ± 7.60 mg/kg. The highest value obtained for chromium for gravel samples was (9.4595 mg/kg and the lowest value obtained was (0.0000 MG/KG). The lead value ranges (128.186 ppm) - 0.3015 ppm, mean ± SD = 11.255 ± 10.923 ppm,). The highest value obtained was 128.186 ppm and the lowest value obtained was 0.3015 ppm. Copper value range (3.0410 - 0.2765 ppm, mean ± SD = 1.447 ± 0.830 ppm). The highest value obtained for copper was 3.0410 ppm, and the lowest value obtained was 0.2765 ppm. The value for cadmium ranges from (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 calcium value range is (32.2354 - 1.2695 ppm, mean ± SD = 4.514 ± 3.2759 ppm). The highest obtained value was 32.2354 ppm, and the lowest obtained value was 1.2695 ppm. The Cr value ranged (72.6293 - 3.3157 ppm) mean ± SD = 24.69 ± 21.36 ppm) The highest value obtained was 72.6293 ppm, and the lowest value obtained was (3.3157 ppm).

TABLE 3. 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 Healthy	64.8876 128.186	0.0000 0.3015	11.8699 ± 54.9193 11.255 ± 10.923
Cu	Patients Healthy	65.8539 32.2354	0.0034 0.2765	13.4887 ± 52.40 1.447 ±

				0.830
Cd	Patients Healthy	6.5469 22.7242	0.0000 2.3568	0.9731 ± 5.4970 8.322 ± 5.88
Ca	Patients Healthy	114.587 32.2354	0.6347 1.2695	9.5762 ± 8.60 4.514± 3.2759
Cr	Patients Healthy	9.4595 72.6293	0.0000 3.3157	1.8303 ± 7.60 24.69 ± 21.36

Figure 2: shows of average Heavy Metals Concentration (mg/kg) in Gravel 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 11.8699 ppm . Soil contamination as a cause of elevated lead levels in patients; this metal can enter the food chain via contaminated crops. Despite being banned from use in commercially available gasoline in 1995, lead is still added to aviation fuel. The mean of Concentration Cd in Heavy Metals groups higher than permissible limit at 0.9731 ppm . Cadmium and its compounds are highly toxic and exposure is known to cause cancer. It is primarily associated with human lung, prostate, and kidney cancers. The mean of Concentration Cu in Heavy Metals groups higher than permissible limit at 13.4887 ppm. Copper increase in malignancies may occur because of tissue death and necrosis, which releases copper into the bloodstream. The mechanism of copper elevation in Gravel patients could be due to the destruction and necrosis of the underlying tissues leading to the release of copper in the kidneys. The mean of Concentration Ca in Heavy Metals groups higher than permissible limit at 9.5762 ppm . The mean of Concentration Cr in Heavy Metals groups higher than permissible limit at 1.8303 ppm .

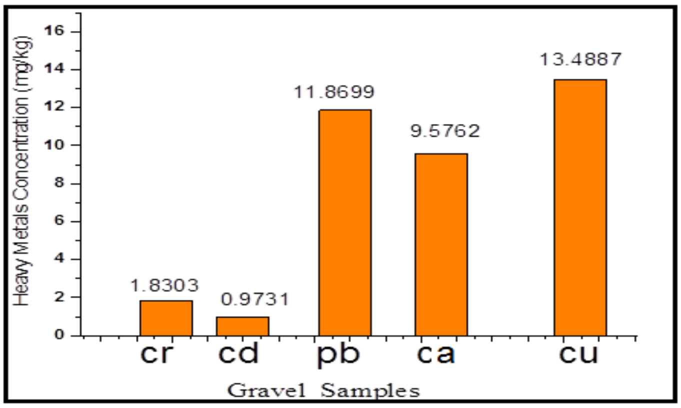

Figure 2: average Heavy Metals Concentration (mg/kg) in Gravel Samples and compared with permissible limit

Figure 3: 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 yet another route of 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 higher than permissible limit at 9.7437 ppm . Cadmium and its compounds are highly toxic and exposure is known to cause cancer. The mean of Concentration Cu in Heavy Metals groups higher than permissible limit at 9.7437 ppm .In this study, the result found a significant higher Cu ratio in the serum patients. The mean of Concentration Ca in Heavy Metals groups higher than permissible limit at 9.6044 ppm . The mean of Concentration Cr in Heavy Metals groups higher than permissible limit at 22.7585 ppm .

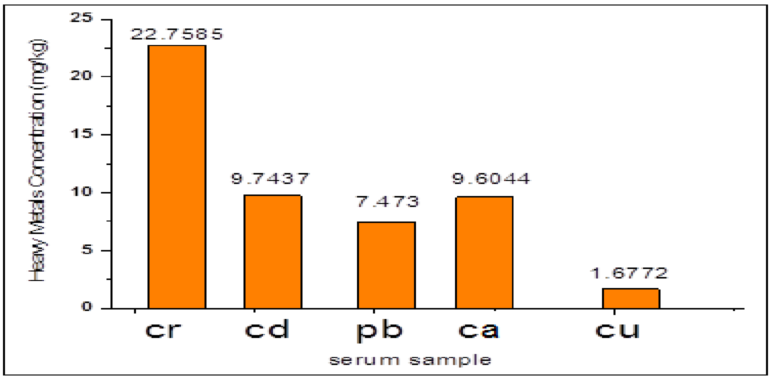

Figure 3: average Heavy Metals Concentration (ppm) in serum Samples and compared with permissible limit

Figure 4: 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 cancer. The mean of Concentration Cu in Heavy Metals groups higher than permissible limit at 0.382 mg/L .In this study, the result found a significant higher Cu ratio in the urine patients. The mean of Concentration Ca in Heavy Metals groups less than permissible limit at 0.992 mg/L . The mean of Concentration Cr in Heavy Metals groups higher than permissible limit at 0.142 mg/L.

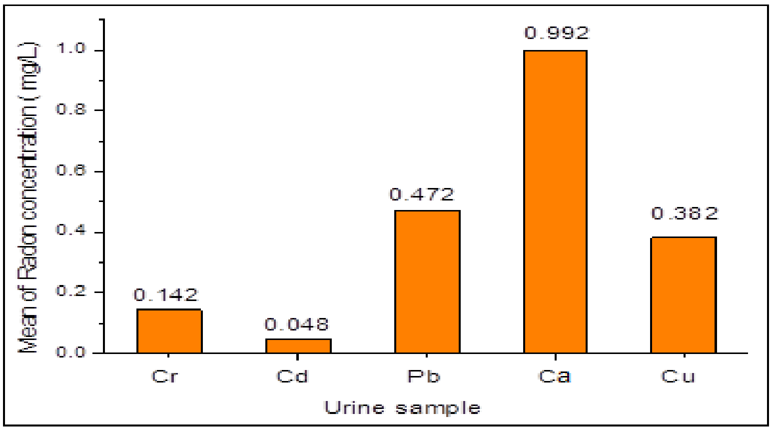

Figure 4: average Heavy Metals Concentration (mg/L) in urine Samples and compared with permissible limit

Figure 5: shows the analytic results of HMC (Pb, Cd, Ca, Cr and Cu) in Gravel Samples of study groups depending on the gender of the participants. The contents of Pb, Cd and Cu are more concentrated in male Gravel samples of comparing to females, which can be caused by the vocational exposure. While female gravel samples have a higher percentage of Ca and Cr concentration than male samples. While female gravel samples have a higher percentage of Ca and Cr concentration than male samples.

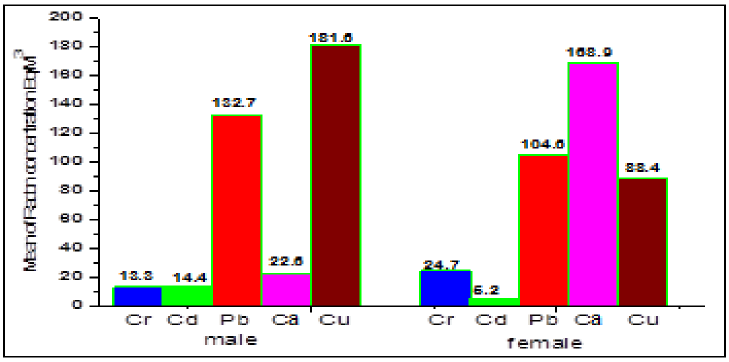

Figure 5: Mean Values of HMC in Gravel Samples of a study Groups as a Function of Gender

Figure 6: shows the analytic results of HMC (Pb, Cd, Ca, Cr and Cu) in serum Samples of study groups depending on the gender of the participants. The contents of Cr, Cd, Ca and Cu 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 do not.

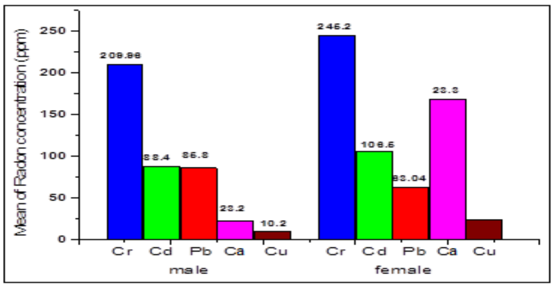

Figure 6: Mean Values of HMC in serum Samples of the Study Groups as a Function of Gender

Figure 7: shows the analytic results of HMC (Pb, Cd, Ca, Cr and Cu) in Samples of study groups depending on healthy and Patients people. The contents of Cu, Ca and 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

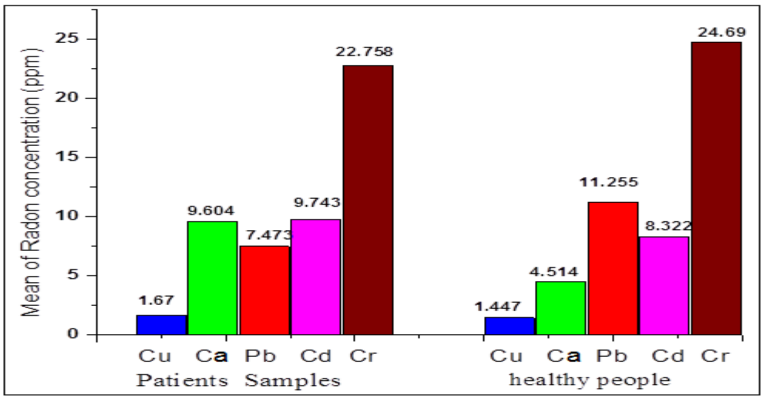

Figure 7: Mean HMC values in serum samples of healthy and Patients.

CONCLUSIONS

The findings indicated that the average the levels of heavy metals in patients with renal failure in the serum is that the average concentrations of cr are the highest in serum samples, then Ca, then Cd, then Pb and the lowest are the cu serum samples while in the average concentrations of Ca is the highest in urine samples, Then lead, then cu, then cr, the least of which are blood serum samples. The average concentrations of cu were highest in stone samples, then Pb, then Ca, then Cr, the lowest being in Cd serum samples.

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

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