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Assessment of Natural Radioactivity for Radon Gas in Certain Biological Samples for Pantients with Renal Failure in Al-Sadr Teaching Hospital in Najaf Governorate- Iraq

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Abstract

The objective of the current study is to assess the levels of radon in patients with renal failure in the Al-Najaf Governorate's blood, serum, urine, and kidney stones. And to contrast the measurements with those of healthy individuals. And to contrast the measured results with values of healthy individuals Radon (222Rn), which is a common emitter of alpha particles. Kidney illness, in especially kidney failure, has become more common in Najaf Governorate. Especially after the Gulf War in 1991 and the events in 2003 and what followed. Measurement of radon concentration in blood serum, urine and stones for patients with renal failure is important to know. The relationships between these cases are and the effects of successive wars. The CR-39 A detector was used for this investigation to measure the alpha particles that radon emits. One hndred samples of patients and healthy people (20) patients were collected, divided into (10) males and (10) females. (20) Healthy people were collected, divided between (10) males and (10) females. These samples were obtained from the Al-Sadr Teaching Hospital in Najaf. The route intensity was calculated using the TASLIMAGE system after the exposure period of 90 days. Results demonstrated that patients with renal failure had an average radon concentration in their serum was 8.709 ± 7.639Bq/m3. And in urine 6.4523 ± 0.77Bq / m3.and in gravel 5.751 ± 0.77Bq/m3. In addition to what was mentioned, People with kidney failure have much higher radon gas concentrations than do healthy people. The findings also revealed that all measured radon gas concentrations (both in ill and healthy people) were below the recommended levels. Within the permissibie limit (200Bq/m3) set by the International Atomic Energy Agency (IAEA) and the International Commission on Radiation Protection (ICRP), respectively.

Keywords: *Radon gas - Renal failure – radioactivity- biological samples - Najaf Governorate*

1. INTRODUCTION

The kidney is the first target organ of heavy metal toxicity due to its ability to reabsorb and accumulate divalent metals. Also, chronic kidney disease is a disease in which kidney function is gradually lost over a period of time, and it has a significant impact on the quality of life related to health and the use of medical services. [1] [2] [3]. CKD is a progressive disease that can be recognized by a diminished estimated glomerular filtration rate (less than 60 mL/min/1.73m2) that lasts for at least three months [4]. The main known causes of chronic kidney disease are diabetes, hypertension, hyperlipidemia, and skeletal disease. Although some studies reveal a possible association between CKD and heavy metals, it has not been demonstrated for low-level environmental exposures [5]. Thus, CKD of unknown etiology is termed CKDu, which has been considered as a matter of environmental selection. Health research and kidney disease research. Radon is a radioactive natural gas. The half-life is 3.85 days. This period is quite sufficient for radon to pass into the soil and atmosphere [6]. [7] I mentioned that radon gas has been identified as one of the health risks to humans, and it is one of the largest producers of this gas in closed areas. The decay of uranium that occurs

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naturally in soils and rocks is the source of radon, and thus people are exposed to this gas every day [8]. Inhalation of a high concentration of radon and its daughters for a long period of time can cause problems in respiratory functions or may cause lung and kidney cancer and failure [9]. The chain of decay of uranium-238U includes the formation of radon and ends with the formation of stable lead (206Pb). Both of these chemical elements (such as radon and 206 Pb) are heavy metals. Accordingly, exploring the relationship between radiation and heavy metals is crucial [10]. A high concentration of radon in an area under study is a sign of a high concentration of uranium, lead, and other heavy metals. Radioactive and toxic pollutants are one 2 of the environmental pollutants that can cause changes in human health and the living world in general such as kidney failure and cancers, and thus greatly affect changes in the environment [11] Measurements of radon concentrations and toxic elements in biological samples provide a clear picture of radioactive contamination And chemotherapy for exposed persons [12]. Due to the ability of the kidney to repair kidney injury, conventional tests are insensitive because they only show aberrations when a significant portion of the nephron mass has already been lost [13].Over the past few years, blood and tissue concentrations of TEs in patients with renal failure have been extensively studied [14].

2. MATERIALS AND METHODS

The research methodology deals with important aspects in this study, the area of study, collecting samples consisting of two groups including patients of renal failure and compared with healthy group human. The samples are collected from Al-Sadr teaching Hospital in Najaf-Iraq After that, blood, urine and renal calculi samples were collected for 20 patients (10 men and 10 women), as well as collecting blood and urine samples only for 20 healthy people (10 men and 10 women) for comparison between patients and healthy people. These samples are and for estimating Radon using different techniques prepared for testing. And the work of questionnaires paper for patients and healthy people. The results of the volunteers' basic questionnaire, which asked about their age and gender, smoking or no smoking and other or chronic diseases, within Tab.1.All the blood serum samples were prepared in the hospital laboratory.

Table 1: Statistical descriptions of the two groups

Classification	Healthy people	Renal failure Patients
Males no.	10	10
Females no.	10	10
Age range (years)	25-73	24-71
Males average age (years)	35.9	50.3
Females average age (years)	45.3	48
Average age total (years)	40.6	49.15

Blood samples were drawn 3 ml of blood from the patient through 5 ml syringe to draw blood, and it was placed in a gel tube of the type to save blood to measure Radon gas. From the same patient, a urine sample was taken and placed in a urine cup. And a sample of the renal calculi samples was taken from him. After a procedure for fragmentation in the lithotripsy device, and then the stones were analyzed in the gravel device. The analysis paper was withdrawn for each patient, and the sample was ground and placed in a Jorn cup. Healthy people, the same method as patients, except that there was no stone sample also for 20 patients (10 men and 10 women). Leaving the blood samples for about 10 min at room temperature to clot. The blood sample was placed in a centrifuge rotating at 6000 rpm for 5 min. After that, the separated serum is collected and placed in fresh, disposable test tubes. Once the serum has been collected, the test tubes are labeled such that each tube corresponds to a particular patient. Then, the blood samples are kept at 4°C using an icebox till are stored in the

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lab refrigerator, waiting to be analyzed. The detectors were placed to measure radon for a period of 90 days.

2. MEASUREMENT OF RADON

Gas Solid State Nuclear Track Detectors (SSNTDs) has been used, CR-39 , it's abbreviation for Columbia Resin-39 and most widely used in the measurement of the tracks of heavy charged particles, due to its sensitivity, efficiency and keep the tracks for long periods. The collision these particles with the detector creates damages in its bonds along their path called latent tracks, their image be seen under optical microscopes clearly. A plastic cup containing a serum sample had a CR-39 detector attached to the top end to measure the amount of radon present. This detector has a thickness of 1 mm and a surface area of 2.5 x 2.5 cm2. According to Fig. 1, the plastic cup has a 3.5 cm (diameter) and a 5 cm (length) measurement. The plastic cups hold the samples. After this time had passed, the detector was subjected to chemical etching by being placed in a beaker containing a chemical agent solution made by dissolving 100 gm of NaOH (6.25 N) in 400 ml of deionized water [15]. Alpha particles from the chemical solution have an impact on the damaged areas [17]. Equation (1), The beaker is heated in a water bath (type, HH-420, Germany) at a temperature of 85°C for 3 hours after the CR-39 detector has been submerged. To avoid any evaporation-related changes in NaOH concentrations, the beaker is tightly closed in this stage. The detectors are carefully rinsed with distilled water after the chemical etching procedure is complete, and they are then allowed to dry for 15 minutes. After that, distilled water was used to clean the detectors. TASLIMAGE system Fig.2 software (created by TASL) can scan the plastic at a greater magnification, differentiating between tracks and background characteristics with a high-quality image [17]. Track density as detected by CR-39 detector (track/cm2) was estimated using this system. System TASLIMAGE.

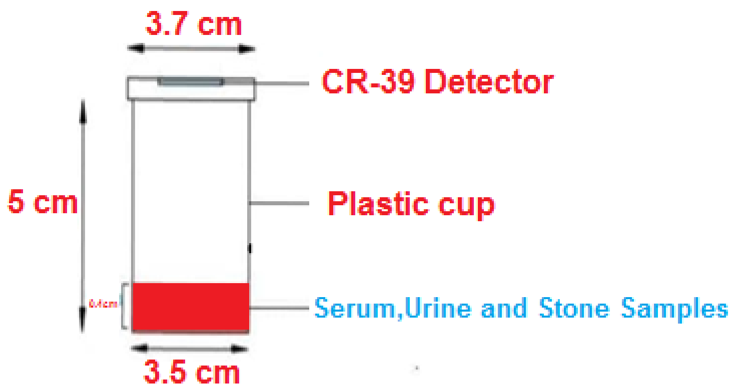

Figure 1: CR-39 Detector-Based Radon Gas Estimation

Figure 2: shows the TASLIMAGE system

The background was eliminated from the measured track density because it has an impact on the density of the tracks.

$$W = Weq \times N \times V \quad \dots \dots \dots . (1)$$

Where W is the weight of sodium hydroxide (NaOH) (100 gm), Weq is the equivalent mass of NaOH (40 gm/l), N is the normalcy of NaOH (6.25 N), and V is the volume of water (400 ml).

Incident Alpha particles on the detector generate circular etch pits. The bulk of etch pits will be elliptical, as a result of Alpha particles colliding with the detector surface at lesser dip angles .The widths and forms of etch pit "tracks" vary, of course: vertically . Then, any minor etch pits are continuously ignored, and any scratches are readily overlooked [18]. A microscopic treatment was used in this work to quantify radon concentrations in materials using the TASLIMAGE technology. The data will be statistically analyzed using the analysis of variance test and the Chi2 test to examine

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the incidences of the different studied variables for Radon levels using the computer software SPSSPC -version 22.

3. CALCULATIONS

This study measures the level of radon (Alpha particles) in biological samples from both healthy individuals and patients with renal failure. This can be accomplished by capturing the particle trails on the CR-39 surface and using these relationships [19]. The first relationship is the track density (ρ), which is measured in track/cm2s. The tracks of Radon particles that are released when the Radon is subjected to the extracted biological samples are what make up the density. Equation is used to determine this word. (2):

$$\rho\left(\frac{track}{cm^2}\right) = \frac{\text{Number of Track}}{\text{Area of veiw}} \qquad \dots\dots\dots (2)$$

Equation (3) can be used to specify the alpha particle concentration (C_Rn, inBq/m3) in blood serum [20].

$$C_{Rn}^{\alpha}\left(\frac{Bq}{m^3}\right) = \frac{\rho}{Kt} \qquad \dots\dots\dots (3)$$

Where ρ is the sample exposure time, which is assumed to be (90 days), is the track density expressed in Tr/cm2, K is the diffusion constant, and t is also the sample exposure duration. This value is referred to as the calibration factor or sensitivity factor. Using equ. (4), the following can be calculated numerically [21]:

$$k = 0.25\, r\left(2cos\theta_c - \frac{r}{r_a}\right) \qquad \dots\dots\dots (4)$$

Where the tube radius is 1.75 cm, the detector critical angle is 35°, and the alpha particle range in air is assumed to be 4.15 cm [22]. As a result, the theoretical K value is 0.5733 cm. It is vital to remember that the experimental K is measured in Track.cm2 /Bqm3day, whereas K value has a unit of cm. Since 1Bq = Disintegration/second = track/second, 1day = 86,400 seconds, and 1m3 = 106 cm, it follows that 1cm = 0.0864 (Track.cm2/Bqm3day) [23]. Therefore, 0.049 Tr.cm2 /Bqm 3.d is the diffusion constant for CR-39 detectors.d.

4. RESULTS AND CONVERSATION

The concentration of radon in serum samples was determined using the CR-39 reagent for patients with renal failure and healthy subjects. Table 2 reveals the concentration of radon in serum samples from healthy males and females. The radon concentration value ranged (27.4376 - 0.9070Bq/m3, mean ± SD = 12.351 ± 0.896Bq/m3). The highest obtained value was 27.4376Bq/m3 for Hsb 7 and Hsb 11 males and females, 38 and 33 years old, from Diwaniyah and Najaf, and the lowest value obtained was 0.9070Bq/m3 for 14 Hisbi females, 26 years old, from Najaf.

Table 2: Radon Concentration in blood serum samples for healthy individuals in Najaf governorate

SC	Age/Weight/Gende	ALocation	Smoking habit	C_{Rn}^{α} Bq/m^3

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Hsb 1	25,70,male	Najaf	No	2.3425
Hsb 2	35,82,male	Najaf	Yes	5.8956
Hsb 3	44,79,male	Diwaniyah	No	16.0997
Hsb 4	31,72,male	Najaf	No	9.9773
Hsb 5	51,80, male	Najaf	No	10.8843
Hsb 6	35,69 male	Karbala	No	22.2222
Hsb 7	38,75 male	Diwaniyah	No	27.4376
Hsb 8	33,73,male	Najaf	Yes	8.6167
Hsb 9	43,95,male	Najaf	Yes	11.1111
Hsb 10	24,68,male	Najaf	No	16.0997
Hsb 11	33,82, female	Najaf	No	27.4376
Hsb 12	71,65, female	Najaf	No	2.2675
Hsb 13	41,83, female	Najaf	No	4.7619
Hsb 14	26,79, female	Najaf	No	0.9070
Hsb 15	32,85, female	Najaf	No	18.8208
Hsb 16	45,88, female	Najaf	No	2.0408
Hsb 17	53,75, female	Najaf	No	23.1292
Hsb 18	48,67, female	Najaf	No	11.1111
Hsb 19	44,80, female	Najaf	No	8.1632
Hsb 20	60,69, female	Najaf	No	17.6870
Permissibie limit				200
Mean				12.351
Min.				0.9070
Max				27.4376

Table 3 shows the concentration of radon in urea samples from healthy males and females. The radon concentration value ranged (22.2222 - 0.2267Bq/m3, mean ± SD = 6.643 ± 0.981Bq/m3). The highest obtained value was 22.2222Bq/m3 for Hu 7, male, 38 years old, from Diwaniyah, and the lowest value obtained was 0.2267Bq/m3 for Hu 5, male, 51 years old. An old man from Najaf.

Table 3: Radon Concentration in urea samples for healthy individuals in Najaf governorate

SC	Age/Weight/Gende	ALocation	Smoking habit	C^{α}_{Rn} Bq/m^3
Hu 1	25,70,male	Najaf	No	5.3347
Hu 2	35,82,male	Najaf	Yes	4.1619
Hu 3	44,79,male	Diwaniyah	No	4.0816
Hu 4	31,72,male	Najaf	No	1.8140
Hu 5	51,80,male	Najaf	No	0.2267
Hu 6	35,69,male	Karbala	No	3.1756
Hu 7	38,75,male	Diwaniyah	No	22.2222
Hu 8	33,73,male	Najaf	Yes	12.0181
Hu 9	43,95,male	Najaf	No	13.6054
Hu 10	24,68,male	Najaf	No	2.4943
Hu 11	33,82, female	Najaf	No	6.5759
Hu 12	71,65, female	Najaf	No	10.2040
Hu 13	41,83, female	Najaf	No	1.5873
Hu 14	26,79, female	Najaf	No	7.7097
Hu 15	32,85, female	Najaf	No	4.5331
Hu 16	45,88, female	Najaf	No	8.1632
Hu 17	53,75, female	Najaf	No	6.3492
Hu 18	48,67, female	Najaf	No	9.977
Hu 19	44,80, female	Najaf	No	3.1746
Hu 20	60,69, female	Najaf	No	5.4421

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Permissibie limit	200
Mean	6.643
Min.	0.2267
Max	22.2222

Table 4. shows the concentration of radon gas in blood serum samples of male and female renal failure patients in Najaf Governorate. The radon concentration value in serum samples ranged from 29.7052 - 0.9070Bq/m3, mean ± SD = 8.709 ± 7.639Bq/m3. The highest value obtained was 29.7052Bq/m3 for Sb 10, male, 26 years old, from Babylon, and the lowest obtained value was 0.9070Bq/m3 for Sb4, male, 45 years, from Basra**.**

Table 4: shows the radon concentration in samples of kidney failure patients' stones from Al-Sadr Teaching Hospital in the governorate of Najaf.

SC	Age/Weight/Gende	ALocation	Smoking habit	C_{Rn}^{α} Bq/m^3
Sb1	48,77,male	Babylon	Yes	2.7210
Sb2	55,80,male	Najaf	Yes	2.2675
Sb3	48,72,male	Nazareth	Yes	5.4421
Sb4	45,98,male	Basra	No	16.3265
Sb5	32,70,male	Najaf	Yes	2.9478
Sb6	56,72,male	Najaf	Yes	2.7723
Sb7	62,88,male	Najaf	No	0.9070
Sb 8	63,75,male	Najaf	Yes	16.3265
Sb 9	68,72,male	Najaf	Yes	7.2562
Sb 10	26,68,male	Babylon	No	12.6984
Sb 11	41,85, female	Najaf	No	8.1632
Sb 12	24,68, female	Najaf	No	0
Sb 13	73,60, female	Najaf	Yes	12.6984
Sb 14	44,74, female	Diwaniyah	No	5.2154
Sb 15	38,80, female	Diwaniyah	No	0.6802
Sb 16	25,63, female	Najaf	No	8.1632
Sb 17	63,66, female	Najaf	Yes	0.9070
Sb 18	60,73, female	Najaf	No	8.1632
Sb 19	65,70, female	Najaf	Yes	4.9886
Sb 20	47,90, female	Najaf	No	4.5351
Permissibie limit				200
Mean				5.751
Min.				0
Max				16.3265

Table 5. Shows the level of radon concentration in urea samples of male and female renal failure patients. The value of radon concentration in urea samples ranged from (22.2222 - 0.2267)Bq/m3, mean ± SD = 6.4523 ± 0.77Bq/m3. The highest value obtained was 22.2222Bq/m3 for (u7) male ages (62) years from Najaf and the lowest value obtained was 0.2267Bq/m3 for u5 male 32 years from Najaf.

Table 5: Radon levels in blood serum samples from patients with renal failure at Al-Sadr Teaching Hospital in the governorate of Najaf

Sc	Age/Weight/Gende	ALocation	Smoking habit	C_{Rn}^{α} Bq /m^3
u1	48,77,male	Babylon	Yes	4.7619

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u2	55,80,male	Najaf	Yes	8.6167
u3	48,72,male	Nazareth	Yes	23.8095
u4	45,98,male	Basra	No	0.9070
u5	32,70,male	Najaf	Yes	11.5646
u6	56,72,male	Najaf	Yes	5.8956
u7	62,88,male	Najaf	No	14.5124
u8	63,75,male	Najaf	Yes	0.9370
u9	68,72,male	Najaf	Yes	12.2449
u10	26,68,male	Babylon	No	29.7052
u11	41,85, female	Najaf	No	8.1632
u12	24,68, female	Najaf	No	13.1519
u13	73,60, female	Najaf	Yes	2.2675
u14	44,74, female	Diwaniyah	No	1.8140
u15	38,80, female	Diwaniyah	No	5.6689
u16	25,63, female	Najaf	No	4.7619
u17	63,66, female	Najaf	Yes	4.0816
u18	60,73, female	Najaf	No	1.3605
u19	65,70, female	Najaf	Yes	7.02947
u20	47,90, female	Najaf	No	18.8208
Permissibie limit				200[]
Mean				8.709
Min.				0.9070
Max				29.7052

Table 6. Shows the level of radon concentration in stone samples of patients with and without renal failure. The value of radon concentration in urea samples ranged from (16.3265 - 0)Bq/m3, mean ± SD = 5.751 ± 0.77Bq/m3. The highest value obt highest measurement made ained was 16.3265Bq/m3 for males (63 and 45) years old Najaf and Basra, and the result with the lowest value was 0Bq/m3.m3 for s12 24-year- female from Najaf.

Table 6: Radon concentration in urea samples taken from patients with renal failure at Al-Sadr teaching hospital in the governorate of Najaf

SC	Age/Weight/Gende	ALocation	Smoking habit	C_{Rn}^{α} Bq /m^3
s1	48,77,male	Babylon	Yes	0.9070
s2	55,80,male	Najaf	Yes	4.7619
s3	48,72,male	Nazareth	Yes	4.0816
s4	45,98,male	Basra	No	1.8140
s5	32,70,male	Najaf	Yes	0.2267
s6	56,72,male	Najaf	Yes	3.1746
s7	62,88,male	Najaf	No	22.2222
s8	63,75,male	Najaf	Yes	12.01814
s9	68,72,male	Najaf	Yes	13.6054
s10	26,68,male	Babylon	No	2.4943
s11	41,85, female	Najaf	No	6.5759
s12	24,68, female	Najaf	No	10.2267
s13	73,60, female	Najaf	Yes	1.5873
s14	44,74, female	Diwaniyah	No	7.7097
s15	38,80, female	Diwaniyah	No	4.5351
s16	25,63, female	Najaf	No	8.1632
s17	63,66, female	Najaf	Yes	6.3492
s18	60,73, female	Najaf	No	9.9773
s19	65,70, female	Najaf	Yes	3.1746
s20	47,90, female	Najaf	No	5.4421
Permissible limit				200

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Mean	6.4523
Min.	0.2267
Max	22.2222

Figure (1) shows a comparison of the mean radon concentration of five different groups of patients and healthy with serum (s), urea (u) and gravel (g) samples for patients , serum (hs) and urea (hu) samples for healthy . The mean concentration radon in the s, u, g, hs and hu groups is below the limit at 200Bq/m^3 .[24]

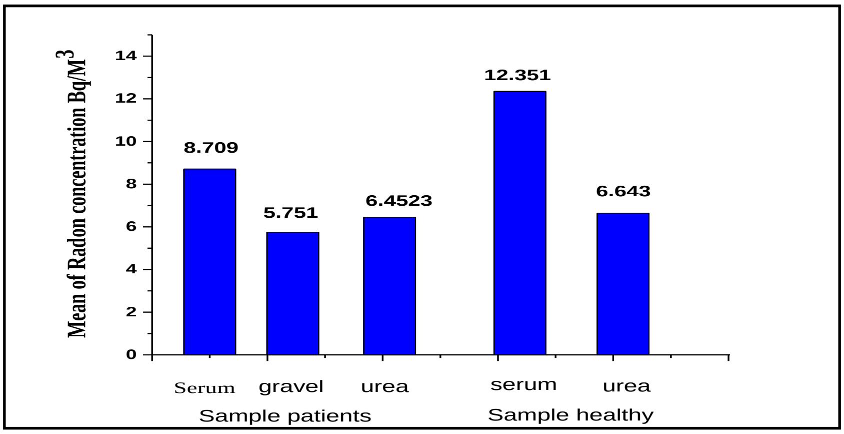

Figure 1: Mean value of Radon Concentration of five different Groups of patients and healthy people with serum (s), gravel (g), urea(u) for patients, urea (U), serum (S) for healthy people

Figure 4.2 shows a comparison of radon concentration emission from serum samples between healthy and patient subjects. The mean radon emission in healthy subjects (12,351 b/m^3) is slightly more than the average radon emission in patients people (8,709 b/m^3). This may be due to patients drinking deionized water, as they are told to drink this water while healthy people drink plain water, its potential for radon contamination, as well as the enriched food intake, type of food, and lifestyle.

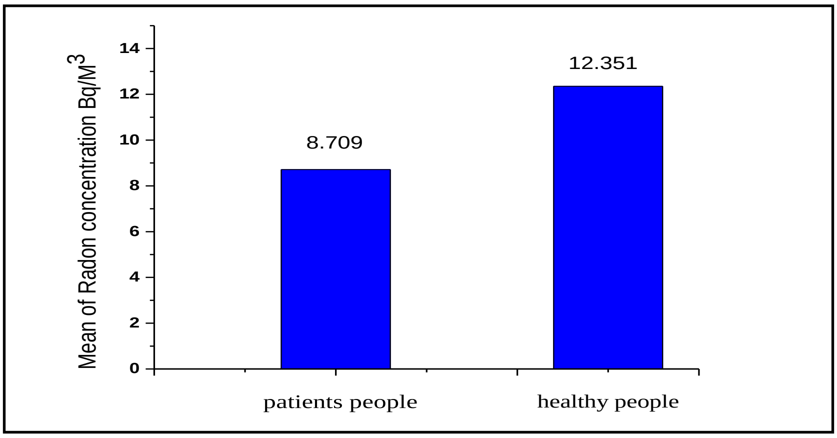

Figure 2: Comparison of the mean radon levels in serum samples from healthy and unwell patients

Figure 4.3 shows a comparison of the mean radon concentration between males and females from serum, gravel, and urine samples of patients, and serum and urine of healthy subjects. The level of radon gas concentration in male patients was higher than in females in the case of urine samples. The results in the patient's serum and gravel samples showed that the mean concentration of radon gas in males is higher than in females, and the reason for this may be attributed to the relative persistence of men in working outside the home compared to females, as the majority of them are housewives.

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As for healthy people, the concentration of radon gas in serum and urine samples in men is higher than in females. The results of the mean concentration of radon gas in serum samples of patients and healthy subjects indicated that the patients' samples were higher than the healthy samples. It is clear from the figure that the concentration of radon in serum samples is higher for patients than in urine and gravel samples. The highest average concentration of radon was found in patients' serum samples compared to patients with urine and gravel.

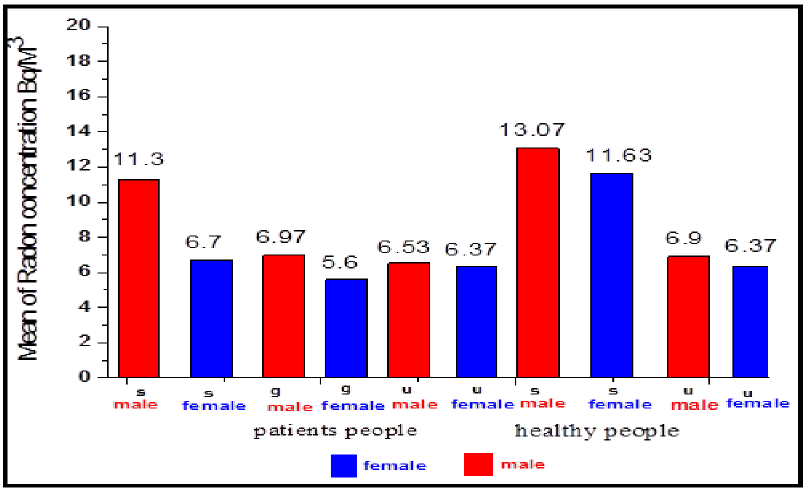

Figure 3: The comparison of average Radon levels concentration between male and female of Serum, gravel and urea for patient's people and Serum and urea samples for healthy people

Table 7 shows person correlation between (Rn, Age, and Weight) in healthy people. Radon has a weak inverse correlation with weight and Age. According to the person correlation test, analysis of the result of these study reached that Rn is affected by Weight more than Age. The concentration of radon in people with high weight is more than the concentration of people with light weight due to dietary habits.

Table 7: Shows the Pearson association between weight, age, and radon in healthy individuals.

correlation between people N =20	Rn	Weight	Age
Rn	1	-0.179	-0.15
Weight	-0.179	1	-0.401
Age	-0.15	-0.401	1

Table 8 shows the person correlation between (Rn, Age, and Weight) in patients people. Radon has a weak correlation with weight and Age. According to the person correlation test, analysis of the result of these study reached the Rn is affected by Age more than Weight, and the reason for this is that patients with age show more disease impact on them, and with age, it is more difficult for them to recover from the disease.

Table 8: Shows the Pearson association between weight, age, and radon in patient populations.

Correlation of individuals N=20	Rn	Weight	Age
Rn	1	0.019	0.11
Weight	0.019	1	0.321
Age	0.11	0.321	1

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Table 9: Alpha particles concentrations in different places in Iraq and other countries reported in the relevant literature

PLACE	Concentration of alpha particles (Bq/m3)	Reference
UNSCEAR	200	[25]
Malaysia	734.50	[26]
Karbala, Iraq	64.3	[27]
Iraq/ Babylon	19.2234	[28]
Iraq/ Najaf	8.709 , 6.4523	Present study

5. CONCLUSIONS

In this study, samples of blood, urine, and gravel are taken from both healthy volunteers and patients with renal failure .Governorate of Najaf. Utilizing a CR-39 detector, the concentrations of alpha particles in these samples are determined. According to the findings, renal failure patients had a higher concentration of alpha-V particles related to health, the mean concentrations were 6643 and 12531 and 5.751, 8.709, and 6.4523, respectively. Additional, According to the findings, radon concentrations in men were often greater than in women. Consider both the healthy and the patient-based measured samples. Last but not least, the data (average focus) with data published in the pertinent literature. In the province of Najaf, the concentration was less than 200Bq/m3. The limit exists. Described by the International Commission on Radiation Protection (ICRP) as well as the International Atomic Organization Energy Agency (IAEA).

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