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Assessment the Effects of Alpha Particles on Women's Urine using CR-39 NTDs

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Abstract
This research describes the results that have been obtained from the alpha particles after carrying out the present study. The study was conducted on 60 urine samples taken from women, who were either infertile, had weak fertility with 30 urine samples of normal women. The age of those women ranged between (18-47) years. They further belonged to different locations in Iraqi Kurdistan region. values calculated in 20 ml of female urine samples was noted that the average values of concentrations of alpha emitters in 20 ml of urine of women's problem with fertility were 0.371 ppm in Erbil, 0.330 ppm in Sulaymania, and 0.199 for normal women, respectively, The results showed that the concentration of alpha emitters in Erbil > Sulaymania> normal, the number of areas do represent a source of danger to human life. This denotes that there is evidence of health problems. Significant difference found in participants' laboratory outcomes between Erbil, Sulaymania and normal. Significant correlations ($p < 0.001$) found between participants' demographic data and their laboratory outcomes. Also the range of alpha particles in the surface of urine samples and CR-39NTDs was calculated using SRIM program
Keywords: infertility in women, Urine, Iraqi Kurdistan region, CR- 39NTDs, Alpha particles

1. Introduction

The parts of our environment are the radiation and radioactive materials. Such materials have been produced by many human activities. Today, the common and valuable tool in medicine is radiation though hazards of ionizing radiation usually come from certain levels of radiation. Radon is the most important source for natural radiation that affects human bodies (Dua et al. 2011). The concentrations of radon are determined by measuring the emitted alpha particles. Which cause damage (latent track) in the surface of the detector (Pires et al. 2007). Solid state nuclear track detector (SSNTDs) is one of alpha particle detectors that is used to measure radon's progeny.

In the present work, the technique of SSNTDs has been utilized for examining the samples of urine (Akoto et al. 2011). A special type of this technique is CR-39 NTDs, this detector has many advantageous characteristics, like, good sensitivity, stability against various environmental factors, and high degree of optical clarity. Accordingly, the researchers opined using it (Pires et al. 2007).

The measurement of uranium can be done in different environments, such as (air, soil, water) and on different biological samples, such as (lichens, urine, blood) (Zhu et al. 2009). Inhalation, ingestion, or dermal absorption are facilities through which the radioactive materials can enter the body. Inhalation is the primary exposure mode for gaseous radionuclide's, as in radon. The fractional amount of the inhaled radionuclide is usually transferred from the lungs to the blood; a matter which causes a small part of the emitted alpha to enter into the blood. Then, it distributes itself to other organs and is carried via blood to all the body. Radon under goes alpha decay with a half-life of 3.8 days. Because the half-life of radon is short, the measurement will be conducted in biological samples, such as serum, urine, blood. Urine is the best sample for the detection of excessive intake of uranium. It detects the existence of radiation regardless of its concentration and determine the potentially exposed subject, depending on age, gender and their residential area (Žunić et al**.** 2009). Urine analysis and whole body counting have been used to measure levels of radon progeny in humans (Hussein A. S. 2008). Radon in human tissues is not detectable by adopting the routine medical testing. Testing such products is not generally and publically available (Tyburski et al. 2008). This process can be done by using the alpha particles detector, especially CR-39 NTD. Such a detector can be used in two different ways, the passive method (long term) and irradiation (short term) (Crawford et al 2008).

Blood and urine samples are the most widely used in environmental toxicology (Gil et al. 2011). The energy of alpha particle depends on many parameters, such as the distance between the samples (urine) and the standard source ^{226}Ra, the range of alpha particles and on the scattered energy loss. Therefore, SRIM program has been used to evaluate and analyses this relation. Recently, scientists evidently stated certain pollutants in the environment may contribute at least to some cases of fertility problems in both males and females. Because fertility issues are so prominent, it has become important to understand infertility, its causes and risk factors. The reproductive capacities of men and women are damaged by the environment radiation. It was suggested that

urine sample detects radiation regardless of the percentage of its concentration. The CR-39 plastic detector and the long-tube (PVC) technique were used in this work, in order to measure the hazards of radon concentration in fresh urine. Many pieces of equipment were used to carry out this work. Moreover, the urine samples were collected from women that were of weak in fertility and that belonged to different locations in Iraqi Kurdistan region. These samples have been prepared in a suitable to be worked on under the supervision of the medical authority and institutions. Then, a physical study was conducted to investigate the concentrations of the absorbed Radon. Later, the results were compared with that of the health standards to see to what extent the effects can be reduced. Accordingly, it has been proven that the examination of urine remains one of the most commonly performed tests in most of the laboratories (Delanghea et al. 2000).

2-Materials and Research methodologies

2. 1. Materials

• Urine

Urine is a liquid that is secreted by the kidneys through a process called urination. This process is very rich in nitrogen, and require elimination from the bloodstream. It represents the primary method for excreting water-soluble chemicals from the body. The kidneys extract the soluble wastes from the bloodstream. If the blood contains a radiation, it filters in the kidneys. Accordingly, the urine contain the radiation after the process of filtration. The density values of urine varies between 1.003-1.035 gcm^{-3} (Wikipedia, 2009). Urine is normally yellow-amber in color, though it depends on diet and the concentration of the urine. The smell or "odour" of urine may provide information about the health of an individual. Fresh urine typically has a mild smell while aged urine has a stronger smell similar to ammonia (Shaima′a 2009). The pH of normal urine is generally in the range 4.6 - 8, and an average of 6.0. The disparity in ph value is due to food nutrition. For instance, high protein diets leads to more acidic urine while vegetarian diets generally produce more alkaline urine both within the typical range 4.6 - 8. The density of normal urine is in the range of 1.001 to 1.035g/m3. (Shaima′a 2009).

• CR-39NTDs

The CR-39 plastic track detector is a $C_{12}H_{18}O_7$ polymer with a density of 1.31 g cm^{-3}, which is Columbia Resin (Zhu et al. 2009). The detector used in the present study is the ideal detector; it is produced by the Intercast Europe SRL (43100 Parma, Italy), as it is shown in Figure 1. The rectangular piece of the NTD is 10×15×0.7 mm^3 in size. The efficiency of CR-39NTDs in the previous study was 79.5%. (Salih et al.2012). The sensibility of CR-39 is such that it is physically able to register the low energy alphas. The latter gives an accurate estimate of the actual radon concentration (Obed et al. 2011)

• Tube technique (PVC)

PVC tube is a plastic cylinder, made from PVC (Poly Vinyl Chloride). It is a cylinder that is 2mm thick, of 2.1cm diameter and 10.5 cm long. It has been used in this work to determine the concentration of alpha emitter in the urine samples.

2.2. Area under study

The study area is located in the Northern part of Iraq including some location from two big governorates of Kurdistan region (Erbil, Sulaymania) This study covered most parts of Iraqi Kurdistan and Kurdish provinces and the suburbs including Erbil and Sulyamania. This region has cold atmosphere and is snow mountainous, and this part contains the uranium series and emit the alpha particles at the decay, and lives in there, a lot of women had problems in infertility. Iraqi Kurdistan is contain comprise around 40,000 square and have a population of around 4 million.

2. 3. Research methodologies

• Samples collection

Urine samples have been collected from two selected governorate states in Iraqi Kurdistan. The sample consisted of 60 women, who have weak fertility, are infertile, or have tumor in uterus. The age of these women ranged between 21-43 years, with 30 normal women (control). An amount of 20 mL of urine has been obtained from each of sixty women using clean plastic containers. The whole process was done in the hospital of Doctor Shahed Khaled in Koya. This hospital represents the medical authority in Kurdistan region in Iraq. Then, the collected samples have been brought to the research clinic at the end of the study to be labeled. Later, they were stored at 4 °C (Tsivouet et al. 2009), in the refrigerator of the hospital, particularly, then, each container was analyzed separately**.**

• Sample preparation

These samples have been weighted before being analyzed, each was 20 g /20 ml. Later, there were put in PVC containers of the volume 36.349 cm^3. Sample preparation was done after bringing the urine sample in ambient temperature (Agata 2009). Urine was used in this work with 90 detectors of the type CR-39NTDs. The sizes of the detectors were 10×15×0.7 $mm^{3.}$ Then, the radon dosimeters were placed inside a PVC tube has 10.5 cm

height and 1.05 cm radius. The detectors were immersed in the urine samples and hung inside the PVC tube. Then, the tubes that contained the urine samples with detectors were stored for 60 days in the fridge of the hospital. The purpose behind the storage was to ensure the samples reach an equilibrium state for the radionuclides that exist in the samples. From (11 June 2011 to 11 August 2011), the samples were sealed and were kept unshaken under 4 °C as shows in Figure 2

• Etching process and scanning process

After completing the exposure time of 60 days, the detectors were removed from the PVC tube. All the dosimeters were collected at the end of the time exposure, etched chemically in a 6.25N NaOH solution at 70 ± 0.5 ◦C for 8 hours (salih et al. 2012, Milenkovi 2010). A water bath Gotecg test in G machines Inc. of the model GT-7039-M, 220 V, 50 Hz was used to display and enlarge the latent alpha tracks due to radon decay (Saad et al. 2010). Chemical etching is the simplest and the most widely used technique in revealing the latent damage trails, resulted from ionizing the particles in solids. After that, the detectors were washed in distilled water; an optical microscope at 400X was used for scanning each detector (Saad et al. 2010).

2.4 Calibration Curve

A standard urine sample of different uranium concentrations was prepared for calibrating the samples under study by using known concentrations of different volume of standard uranium mixing with urine samples and using Equ. 1 and put the detectors CR-39NTDs in the standard urine samples for 60days. After then the detectors were subjected to chemical etching and then scanned under the microscope to measure the track densities (Shaima 2009)..

$$V_1 \times C_1 = V_2 \times C_2 \quad \text{.....(1)}$$

Where

V_1 : volume of urine standard sample (l).

C_1 : uranium concentration in standard sample (ppm).

V_2: volume of urine unknown sample (l).

C_2: uranium concentration in urine sample which prepared (ppm).

The density of the alpha tracks (ρ) in the samples was calculated using

$$\text{Track density } (\rho) = \text{Average of total tracks / Area of field view..... 2}$$

The concentrations of alpha emitters in the urine samples were measured by comparison between track densities registered on the detectors and that of the standard urine sample from the relation (Shaima 2009).

$$C_X \text{ (sample)} / \rho_X \text{ (sample)} = C_S \text{ (standard)} / \rho_S \text{ (standard) ..... (3)}$$

$$C_X = C_S \cdot (\rho_X / \rho_S) \text{ ..... (4)}$$

Where :

C_X : uranium concentration of urine in unknown sample (ppm).

C_S : uranium concentration of urine in standard sample (ppm).

ρ_X: track density of unknown sample (tracks/mm^2).

ρ_S: track density of standard sample (tracks/mm^2).

The range of alpha particles in the surface of urine samples and CR-39NTDs was calculated using SRIM program, as illustrated in Tables 1 and 2.

3. Results and discussion

Urine assay is the preferred method for monitoring alpha particles that emit into the human body from the radon decay and progeny. It is a valuable technique that helps evaluate the levels of alpha naturally in urine samples.

Table 1 shows the range of alpha particles with energies (1–5) MeV in urine (the average density of urine samples is 1.0200 g cm^{-3}) and CR-39NTD (the density of CR-39 is 1.31 g cm^{-3}). The range of alpha particle varied depending on the target density such as (Urine, CR-39NTD). The range of alpha particles in the target decreases with the increasing density. Therefore, the range of alpha particle in CR-39NTDs is less than that of in urine. This is because the density of CR-39NTDs is greater than the density of urine. The same thing applied to the result of the restricted energy loss

Urine as part of an epidemiological Survey is used to determine public exposure to natural radiation and to estimate radionuclide level, in a high level back ground radiation, it is important to use urine to determine the extent of the public exposure to natural radiation. It further helps estimate the radionuclide levels in the highly radiated area of Kurdistan in Iraq, therefore, it is used in this study. The ^{222}Rn concentrations were determined in 30 urine samples by using the CR-39 NTDs counting technique. It was noted that the average values of concentrations of alpha emitters in 20 ml of urine of women's problem with fertility were 0.371 ppm in

Erbil, 0.330 ppm in Sulaymania, and 0.199 for normal women, respectively, as shown in Tables 2, 3 and 4.

The results showed that the concentration of alpha emitters in Erbil > Sulaymania> normal. Also the results showed that the concentration of alpha emitters varied from woman to another, depending on the extent to which women's bodies were allergic to the radiation, the age of women, the geological formation of the area being studied, and the exposure period (Rafique et al, 2010).

Statistical analysis

All statistical calculations were performed using SPSS for Windows, Standard version 20.0. The data of the research were saved in Microsoft excel spread sheet and analyzed on the computer using Microsoft excel program, post-hoc LSD, One way a nova and Independent t test methods used in this analysis. Also the result of the study was explained by statistical SPSS analysis, as shown in the Tables (5-9).

The results of statistical SPSS analysis

Urine in Erbil and Sulaymania

1- Demographic characteristics of participant in Erbil and Sulaymania

There were 60 women from Erbil and Sulaymania, 30 in each governorate, enrolled in current study. The participants' mean age, years of marriage, weight was 33.23 ± 5.759 years, 10.37 ± 4.529, and 61.833 ± 5.198 respectively. Majority of them were functionary, with low incidences of smoking. The characteristics of other laboratory results were found in Table 5

2- Correlation between participants' demographic data and their laboratory outcomes

Significant correlations found between participants' demographic data and their laboratory outcomes, unfortunately no significant in any variables to the weight of participants, as shown in Table 6

3- Differences in participants' laboratory outcomes between Erbil and Sulaymania

Significant difference found in participants' laboratory outcomes between Erbil and Sulaymania. The difference significantly revealed higher means of track density of fresh urine Erbil compared to Sulaymania, as shown in Table 7

4- Differences between cases of governorates and normal cases

There was significant difference in all laboratory data between 2 governorates and normal cases, Erbil cases got the highest mean of laboratory data compared to others, as shown in Table 8.

To find out the significant difference in laboratory data between each governorates' cases versus normal cases, post-hoc LSD used for parametric variables. Erbil cases had significantly higher means of all laboratory data than Sulaymania and normal cases. Sulaymania cases significantly had lower means of track density of fresh urine and fresh urine conc. of alpha emitters than cases of Erbil, but were higher than means of normal cases as shown in Table 9.

Most health risks have come from the alpha particles that have been deposited in the body. Accordingly, it is highly recommended to keep the environment as secure and safe as possible. On the contrary, the high availability of uranium in some regions makes it a source of danger to the health of the public.

4. Conclusion

Most of the studied areas show the low level of alpha emitters and the higher level of alpha emitters, values calculated in 20 ml of female urine samples Noticed that the alpha-emitters concentration in urine samples for all different locations at different ages increases with age. The relation between concentration and age and was higher (Sedakan, 0.7376 ppm, 45years) Erbil than in (Khurmal, 0.0478 ppm, 44 year) Sulaymania The results showed that the concentration of alpha emitters varied from woman to another, depending on the extent to which women's bodies were allergic to the radiation, the age of women,

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Figure.1: CR-39 NTDs produced by Intercast Europe SRL (43100 Parma, Italy)

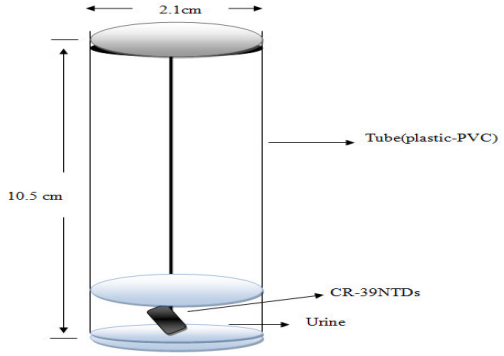

Figure. 2: PVC tube containing in urine and detector CR-39.

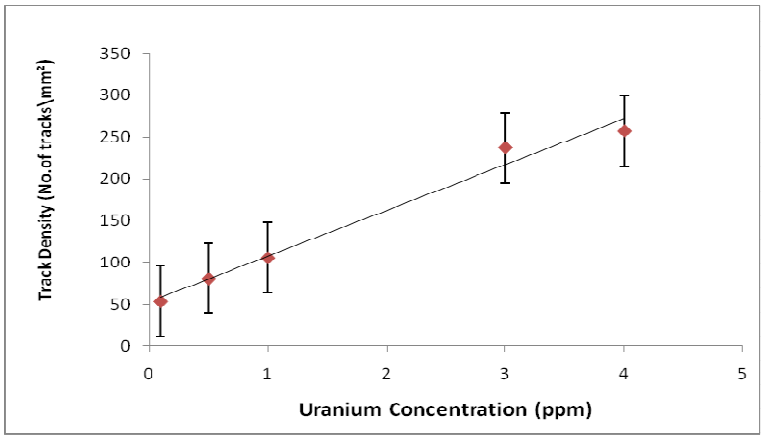

Figure 3: The relation between track density and uranium concentration (ppm) for standard urine samples.

Table 1 Range of alpha particles in CR-39 and urine samples of women in Iraqi Kurdistan region with energy loss at different energies.

Energy (MeV)	Range of α particles in CR-39	$\frac{dE}{dx}$ in CR-39	Range of α particles in Urine	$\frac{dE}{dx}$ in Urine
1	170 A^0	1.973E	199A^0	2.228E
2	306 A^0	1.683E	363A^0	1.639E
3	457 A^0	1.454E	552A^0	1.443E
4	608 A^0	1.287E	745A^0	1.300E
5	757 A^0	1.160E	938A^0	1.241E

Table 2 Evaluation of concentration of alpha emitters and radium concentration in fresh urine for women in Sulaymania governorate

N.S	Code Loc.	Location	Age/ Years	Track density of alpha emitters track /mm^2	Con. of alpha emitters (PPm)
1	000	Eiskan	22	15.302	0.239
2	001	Khurmal	26	15.520	0.245
3	002	Chamchamal	27	15.835	0.251
4	003	Shekhan	28	16.888	0.267
5	004	Darbandikhan	28	17.159	0.271
6	005	Rzgary	29	17.316	0.274
7	006	Bakhteary	30	17.373	0.275
8	007	Reaea	31	17.759	0.281
9	008	Takea	33	18.288	0.290
10	009	Kalar	33	18.602	0.294
11	010	Khalakan	34	19.216	0.304
12	011	Bazean	34	19.431	0.308
13	012	Kfry	35	19.588	0.310
14	013	Sharawany	36	19.873	0.314
15	014	Zaraeen	36	20.045	0.317
16	015	Toymalek	36	20.816	0.330
17	016	Said sadiq	36	21.173	0.335
18	017	Penjween	36	21.445	0.339
19	018	khormal	37	21.731	0.344
20	019	Zargata	39	21.831	0.346
21	020	Bardarash	38	22.316	0.353
22	021	Mawat	39	22.331	0.354
23	022	Dukan	39	23.616	0.373
24	023	Qaladza	39	24.102	0.381
25	024	Halabjay taza	40	24.573	0.389
26	025	Rania	40	24.873	0.394
27	026	Mamostayan	41	25.130	0.398
28	027	Sulaymania	41	25.931	0.411
29	028	Arbat	42	29.002	0.459
30	029	Halabjay kon	43	29.459	0.467
**				20.884	0.330

**=Mean

Table 3 Evaluation of alpha emitter's concentration and radium concentration in fresh urine for Women in Erbil governorate

N.S.	Code Loc.	Location	Age/ Years	Track density of alpha emitters track /mm^2	Con. of alpha emitters (PPm)
31	030	Shorsh	21	4.281	0.065
32	031	Kas-Nazan	22	5.629	0.089
33	032	Shaqlawa	25	8.293	0.130
34	033	Salahadden	26	12.364	0.196
35	034	Nazanen	26	15.640	0.248
36	035	Holy- Zatd	27	16.657	0.264
37	036	Kareat- Zanko	27	17.546	0.278
38	037	Nawato dw	27	18.711	0.296
39	038	Erbil Center	28	19.062	0.302
40	039	Khalefan	28	20.950	0.332
41	040	Rzgary	29	21.321	0.338
42	041	Aeen-Kawa	29	21.599	0.342
43	042	Saed -Taqan	29	21.857	0.346
44	042	Sarsang	30	22.894	0.363
45	044	Qshtapa	31	23.449	0.372
46	045	Makhmur	31	23.578	0.374
47	046	Shaqlawa	32	23.634	0.375
48	047	Haji-Omaran	33	23.726	0.376
49	048	Rawanduz	34	25.225	0.400
50	049	Barzan	34	25.688	0.407
51	050	Harer	35	27.261	0.432
52	051	Taq-Taq	36	29.056	0.461
53	052	Shekholla	37	30.129	0.478
54	053	Prdea	38	30.622	0.485
55	054	Ronaki	28	31.147	0.494
56	055	Koya	38	31.332	0.497
57	056	Barsren	40	31.406	0.498
58	057	Deana	41	34.829	0.552
59	058	Eiskan	42	40.084	0.636
60	059	Sedakan	42	45.766	0.726
**				23.457	0.371

**=Mean

Table 4 Evaluation of concentration of alpha emitters in fresh urine for Normal(control) women by passive method

No.	Location	Age/ Years	Track density of alpha emitters track /mm^2	Alpha emitters Con.(ppm)
91	Sharawany	18	4.899	0.0772
92	Shekhan	18	6.188	0.0976
93	Shaqlawa	20	6.815	0.1075
94	Said sadiq	21	7.582	0.1196
95	Chanchamal	22	7.583	0.1196
96	Kalar	22	7.86	0.1239
97	Zaweta	23	8.755	0.1381
98	Kfry	23	9.938	0.1567
99	Halabjay taza	24	10.328	0.1629
100	Sulaymania	25	10.687	0.1685
101	Rawanduz	25	10.714	0.1690
102	Erbil center	26	10.756	0.1696
103	Taqtaq	26	11.282	0.1779
104	Deana	27	11.465	0.1808
105	Khurmal	28	11.821	0.1864
106	Koya	28	12.622	0.1991
107	Khalakan	28	13.069	0.2061
108	Penjween	30	13.095	0.2065
109	Qaladza	31	13.157	0.2075
100	Harer	32	13.712	0.2163
111	Bardarash	32	13.769	0.2172
112	Chwarqurna	33	13.912	0.2194
113	Dihuk	33	14.013	0.2210
114	Takea	33	14.069	0.2219
115	Dukan	35	15.303	0.2414
116	Arbat	38	16.5	0.2602
117	Sedakan	39	16.855	0.2658
118	Rania	42	17.56	0.2770
119	Darbandikhan	44	17.629	0.2781
120	Halabjay kon	47	17.642	0.2783
**			12.65474	0.1996

**=Mean

Table 5 demographic and laboratory characteristics of women in Erbil and Sulaymania

Variables (60 participants)		% (no.) / Mean (± SD)
Age (years)		33.23 ± 5.759
Years of marriage (years)		10.37 ± 4.529
Weight (kg)		61.833 ± 5.198
Track density of fresh urine		22.171 ± 7.111
Conc. of alpha emitters in fresh urine		0.351 ± 0.113
Governorate	Erbil	50 % (30)
	Sulaymania	50 % (30)
Smoking	Yes	10 % (6)
	No	90 % (54)
Occupation	Housewife	38.3 % (23)
	Functionary	61.7 % (37)

Table 6 correlations between participants' demographic data and laboratory outcomes

Variables		Age (years)	Years of marriage	Weight (kg)
Track density of fresh urine	Pearson correlation	**0.761**	**0.642**	0.137
	p value	**<0.001**	**<0.001**	0.295
Conc. of alpha emitters in fresh urine	Pearson correlation	**0.760**	**0.642**	0.139
	p value	**<0.001**	**<0.001**	0.291

Correlation is significant at the 0.01 level (2-tailed)

Table 7differences of participants' laboratory outcomes between Erbil and Sulaymania

Variables		Mean ± SD	Mean difference	*p* value
Track density of fresh urine	Sulaymania	20.884 ±3.745	-2.574	0.166
	Erbil	23.458 ±9.243		
Conc. of alpha emitters in fresh urine	Sulaymania	0.33 ±0.060	-0.041	0.162
	Erbil	0.372 ±0.147		

Independent t test

Table 8 difference between governorates and normal cases in blood and urine laboratory data

Variable	Governorate	N	Mean	F	*p* value
Track density of fresh urine	Sulaymania	30	20.884 ± 3.745	17.283	**< 0.001**
	Erbil	30	23.458 ± 9.243		
	normal	30	14.456 ± 3.532		
Conc. of alpha emitter in fresh urine	Sulaymania	30	0.33 ± 0.06	17.190	**< 0.001**
	Erbil	30	0.372 ± 0.147		
	normal	30	0.229 ± 0.056		

One Way ANOVA

Table 9 Differences between governorates' and normal cases in urine data

Dependent Variable	Difference		Mean Difference	*p* value
Track density of fresh urine	Sulaymania	Erbil	- 2.574	0.106
		Normal	6.428	**<0.001**
	Erbil	Sulaymania	2.574	0.106
		Normal	9.002	**<0.001**
Conc. of alpha emitter in fresh urine	Sulaymania	Erbil	- 0.041	0.103
		Normal	0.102	**<0.001**
	Erbil	Sulaymania	0.041	0.103
		Normal	0.143	**<0.001**

LSD difference: the mean difference is significant at 0.05

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