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Determination Of Uranium Concentration In Workers Urine In An Iraqi Flooring Materials' Factories

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Abstract: *Precisethe measurement of uranium concentration in human urine is quite important in assessment of occupational and public exposure to uranium. In the present work, the fission track technique was used to determine uranium in urine of Iraqi workers of flooring materials factories. The uranium concentration values in urine samples ranged between 0.96 μg/L to 1.7 μg/L, while the control results were ranged 0.91 μg/L to 1.49 μg/L. The some parameters used to explain the results of uranium concentration. The results show the uranium concentration increase with increase duration of work, the smokers people are very close to non-smokers people and the uranium concentration increase when increase age.*

Keywords: *Uranium,Urine, Flooring Materials ,Fission Track Techniqu*

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I. Introduction

Uranium is a naturally occurring radioactive element. In its pure form, it is a silver-white, lustrous, dense and weakly radioactive metal [1,2]. Metallic uranium has a high density of 19 g/cm^3. It is present in the earth's crust at an average concentration of about 2 ppm (approximately 1 pCi/g) [3]. Because all isotopes unstable and half-lives varied between 159,200 years and 4.5 billion years the uranium is weakly radioactive. Naturally occurring uranium consists of three isotopes (^{234}U, ^{235}U and ^{238}U), all of which decay by both alpha and gamma emissions [4]. The ^{238}U isotope is the most abundant by weight (99.28%) with the ^{235}U and ^{234}U isotopes constituting about (0.72%) and (0.0054%), respectively [5]. ^{238}U is the longest-lived member of (4n+2) series (n varying from 59 to 51) which includes ^{234}U as a member. ^{235}U is the longest-lived member of the naturally existing parent of (4n+3) series (n varying from 58 to 51). This series ending up to ^{206}Pb after 8 alpha and 6 beta emissions along with many gamma decays. The amount of ^{238}U series on the earth's crust depends upon the rock type and geological formations [6].

The fate of uranium in the human body that enters the systemic tissues and blood stream cannot be easily measured or observed. Therefore, models are used to represent the movement of material around the body. These models can be used to calculate radiation doses to the tissues and to predict the retention and excretion of the element [7].

II. Materials and Method

2.1Sample Collection of Urine

Thirty five (35) samples of workers' urine were collected from several factories and a group of random people as a control from Baghdad city. Detailed information were also recorded from all participant regarding their age, smoking habits, working in the factories (employment duration), their daily working hours, and according to this information the samples were classified in the following Table (1) :

Table 1: The symbol, Age, Smoking, Work duration(Years), Daily work(Hours) flooring materials.

12	Age	Smoking	Work duration (Years)	Daily work (Hours)
U1	19	No	11 M	7.5
U2	32	Yes	5	7
U3	36	Yes	1.5	7
U4	50	Yes	30	10
U5	22	Yes	4	7.5
U6	21	No	3.5	8
U7	27	Yes	4	7
U8	46	No	23	7.5
U9	44	Yes	20	7
U10	26	Yes	7	8

U11	18	Yes	1	9
U12	33	No	11	8.5
U13	35	Yes	1	9
U14	16	Yes	2	8
U15	23	Yes	4	7
U16	28	No	3	8
U17	39	Yes	9	9
U18	25	Yes	2	8
U19	21	Yes	7 M	8
U20	26	Yes	3	9
U21	26	Yes	4 D	8
U22	37	No	2	8
U23	30	No	5	7
U24	29	No	3	8
U25	34	No	10	9
U26	31	Yes	13	8
U27	48	Yes	5 M	10
U28	28	Yes	6 M	10
C29	57	No	C	No
C30	31	No	C	No
C31	32	Yes	C	No
C32	28	Yes	C	No
C33	44	No	C	No
C34	59	No	C	No
C35	24	No	C	No

***M = Month**
***D = Day**
***C = Control**

2.2 Preparation of Samples

The sheets CR-39 detector of 500 µm thick were used and cut into small pieces each of 1 ×1 cm2 area, In this technique two drops of urine of known volume 100 µl were dried on a square CR-39 piece in a dust free atmosphere at a normally room temperature. A non-volatile constituent of the sample was left over the detector in the form of a thin film. It was then covered with another piece of detector to make it a pair as shown as in Figure (1) .

2.2 Preparation of Standard Samples

The standard solution was prepared using uranyl acetate $(CH3COO)^2$ UO_2. Four standard uranium samples of concentration 0.5, 1, 3 and 5 µg/L were prepared by diluting 1 mg/L stock solution with distilled water. Uranium standard samples were prepared in the same procedure of urine samples.

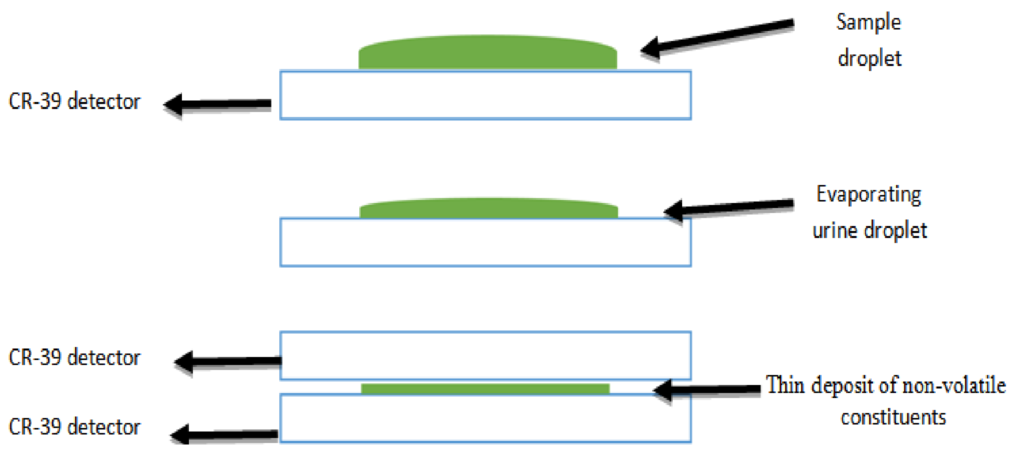

Figure 1: Evaporation of the sample droplet and the formation of a thin deposit [2].

2.3 Irradiation Method

A. Irradiation source

ToIrradiation sample was used an Am-Be neutron source with neutron flux of 10^5 $n.cm^{-2}.s^{-1}$. It emits fast neutrons by (α , n) reaction[8].

The irradiation system consists of a rod of (Am-Be) source surrounded by a paraffin wax. The paraffin wax was used to moderating the fast neutrons to thermal neutrons ${}^1_0n_{thermal}$ energies (0.025 eV)-.

B.Irradiation sample

After and then put pairs in a plate of paraffin wax at a distance of (5 cm) from the neutron source (Am-Be) for one week with the total thermal neutron flounce was 3.024×10^{9} $n.cm^{-2}$. This was done to register fission tracks in the detectors due to ^{235}U (n, f) reaction as shown in Figure (2). Neutrons emitted from the source were captured by the ^{235}U nuclei, which in turn underwent fission to produce different fragments including alpha particles using Equation [8,9]

$$^{235}U + {}^{1}_{0}n_{\ thermal} \longrightarrow {}^{236}U^{*} \longrightarrow {}^{141}Br + {}^{92}Kr + 3\,{}^{1}_{0}n$$

A blank CR-39 detector was also irradiated along with the sample pair in order to calculate the background.'

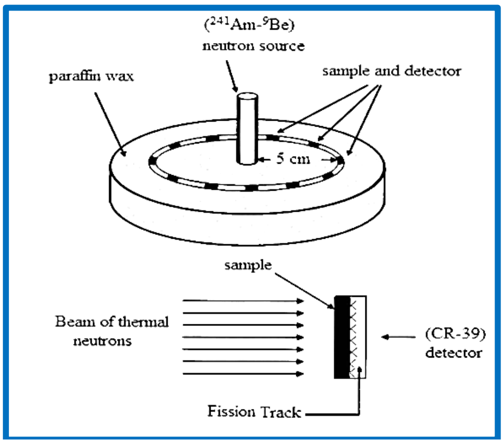

Figure 2: Irradiation of the detectors and urine samples by the neutron source [9].

After the irradiation time for seven days, the (CR-39) track detectors were etched in (6.25 N) (NaOH) solution at a temperature of (60 °C) for (5h), After etching, the detectors were washed by distilling water then dried and count the number of tracks under an optical microscope.

The densities of the fission tracks (ρ) in the samples were calculated according to equation [2]:

$$\text{Tracks density } (\rho) = \frac{\text{Average number of total pits(track)}}{\text{Area of field view}}$$

2.4 Calculations of uranium concentrations

By plotting the standard concentration (C_s) of the urine samples against the track densityρ_s , the slope of the resulted was equal to (ρ_s/C_s) as shown in Figure(3). The uranium concentration in the samples was measured by comparing between track density registered on the detectors and that of the standard solutionsfrom the equation [9]:

C_x(sample)/ρ_x(sample)= C_s(standard)/ρ_s(standard)

i.e. $C_x=C_s(\rho_x/ \rho_s)$,where:

ρ_x and ρ_s are the induced fission track densities for the unknown sample and standard solution (in tracks/mm^2) respectively, while C_x and C_s denote the uranium concentration for unknown sample and standard solution (in μg/L).

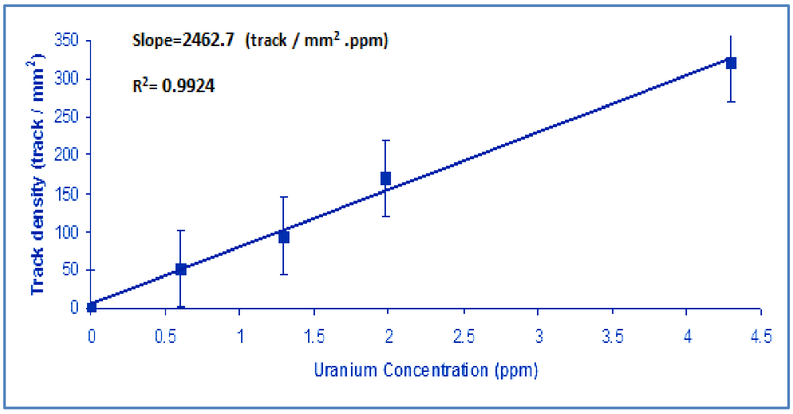

Figure 3: The relation between track density and uranium concentration in (μg/L) for standard samples.

2.5 A Parameter related to uranium concentration

To explain the results, the samples were presented and discussed according to following important parameters, namely; employment duration, smoking habits and age.

1. Employment duration

To discuss the effect of work duration on the workers. They were divided into three groups according to the work duration: (A) less than 5 years, (B) 5 – 10 years, (C) more than 10 years.

2. Smoking habits

To discuss the effect of smoking habits on the workers, they were divided into two groups according to the smoking habits: smoking worker and non smoking workers.

3. Age

The age groups were divided into three groups according age: (A) less than 30, (B) 30 – 40 and (C) more than 40.

III. Results and dissection

3.1Uranium Concentrations

The uranium concentration results in urine samples collected from the worker at flooring materials factories were ranged value between 0.96 to 1.7 µg/L. The highest value of uranium concentration (1.7 µg/L) was recorded in sample 1 (U4) while the lowest value (0.96 µg/L) was recorded in sample 4 (U1), In comparison, the control results of uranium concentration values were ranged 0.91 to 1.49 µg/L, Table (2) Figure (4). The results of statistical analysis refer that non-significant differences between control groups and worker Table (3).

The results show the uranium concentration in the urine of the worker were close to the control groups. These results were not significant because the materials have not effective radioactive source [9], and due to the Iraqi environment were effected and contaminated with radiation during three great destructive wars which saw the use of radioactive weapons against the population and environment in Iraq from 1980 until today [10, 11, 12,13]

The uranium concentration found in this study was likely due to uranium that was being slowly released from bone and other tissue storage sites in the body [2,9].

Table 2: The uranium concentration in workers and control groups.

Symbol	Uranium
U1	0.96
U2	1.43
U3	1.39
U4	1.7
U5	1.32
U6	1.18
U7	1.35
U8	1.59
U9	1.65
U10	1.39
U11	1.21
U12	1.51
U13	1.37
U14	1.22
U15	1.31
U16	1.23
U17	1.53
U18	1.29
U19	1.21
U20	1.33
U21	1.22
U22	1.35
U23	1.3
U24	1.25
U25	1.43
U26	1.54
U27	1.47
U28	1.27
C29	1.49

C30	1.16
C31	1.29
C32	1.24
C33	1.41
C34	1.46
C35	0.91

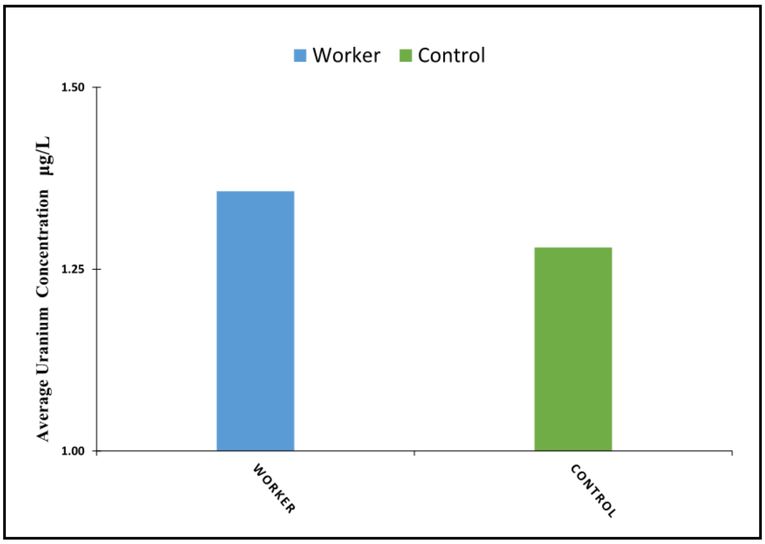

Figure 4: The average uranium concentration in workers and control groups.

Table 3: Compare between patients (exposed) and control group in uranium concentration

The Group	No.	Mean ± SE
Patients (exposed)	28	1.357 ± 0.03
Control	;7	1.280 ± 0.07
T-Test	---	0.144 NS
P-value	---	0.285
NS: Non-Significant.		

3.2. Parameters related to uranium concentration

3.2.1. Work duration

The results of average uranium concentration in this study for each group were ranged from 1.275 to 1.598 corresponding to the group (A) and group (C), respectively, Figure (5).

The statistical analysis shows significant differences between group (A) and group (B), group (A) and group (C), but no significant differences between group (B) and group (C) Table (4).

The results show the uranium concentration increase with increase work duration.

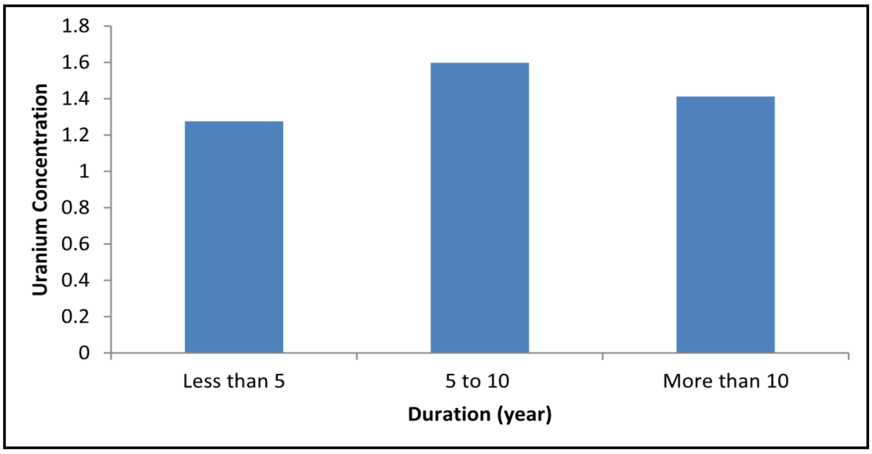

Figure 5: The uranium concentration and duration of worker.

Table 4: Effect of duration of worker (exposed) in uranium concentration.

Duration (year)	No.	Mean ± SE
Less than 5	18	1.275 ± 0.026 b
5-10	5	1.412 ± 0.036 ab
More than 10	5	1.598 ± 0.034 a
LSD Test	---	0.203 *
*** (P<0.05).**		

3.2.2. Smoking Habits

Figure (6) illustrates the uranium concentration as effect of smoking habit. From this Figure, it can be noticed that the uranium concentration recorded in urine for smokers was 1.378 µg/L while for non-smokers workers was 1.311 µg/L.

The results of statistical analysis showed that no significant differences in uranium concentration between smoker and non-smoker workers Table (5).

The results show the values of uranium concentration of smoker peoples is very close to the values of non-smokers people and this result not significantly. The results disagreed with who found that smoker peoples were exposed to uranium levels higher than those non-smoker peoples.

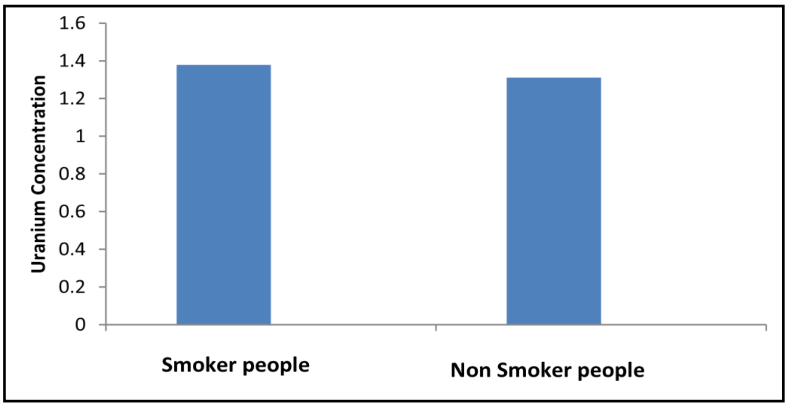

Figure 6: The uranium concentration and Smoking habits.

Table 5: Effect of smoking of worker (exposed) in uranium concentration.

Smoking	No.	Mean ± SE
Yes	19	1.378 ± 0.033
No	9	1.311 ± 0.062
T-Test	---	0.1884 NS
NS: Non-Significant.		

3.2.3. Age Group

The age groups results show the highest mean value of uranium concentration in the present study was recorded in group (C) with 1.602 µg/L while the lowest value with 1.249 µg/L was found in group (A) Figure (7).

The statistical analysis shows significant differences between group (A) and group (B), group (A) and group (C), but no significant differences between group (B) and group (C) Table (6).

The result of correlation coefficients between age and uranium concentration is positive R (0.65) due the uranium concentration increase when increase age.

The results show the uranium concentration in the samples of urine increase when increase age. The model of ICRP U can anticipated such a rise under conditions of continuously intake level. Besides, such an increase with age is expected for a many of causes. For example, nutritional intake, especially during childhood, was correspond to with age. In addition to under conditions of continuous intake, the load of the uranium body (skeletal load) will rise as a function of time of exposure and the proportion of uranium excreted due to bone turnover rising in line with load of body[14].

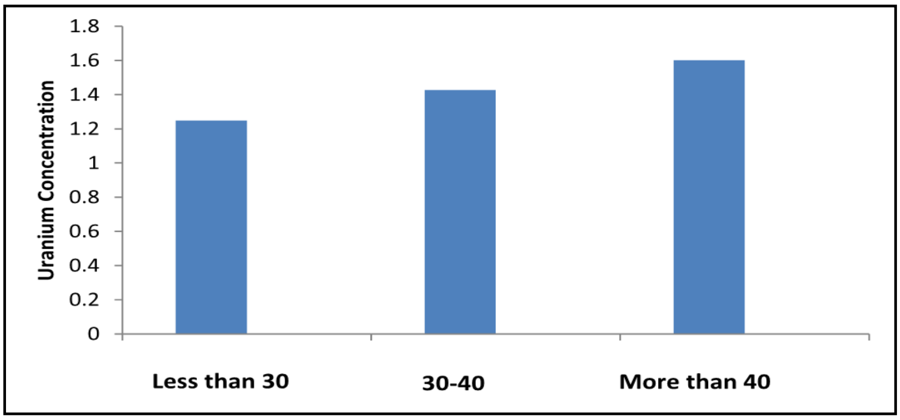

Figure 7: The uranium concentration and Age.

Table 6: Effect of age groups of worker (exposed) in uranium concentration.

Age Group (year)	No.	Mean ± SE
Less than 30	14	1.249 ± 0.025 b
30-40	9	1.427 ± 0.027 ab
More than 40	5	1.602 ± 0.049 a
LSD test	---	0.294 *
*** (P<0.05).**		

IV. Conclusion

The results of uranium concentration in urine observed the worker samples were close to the control groups samples. These results were not significant because the materials have not effective radioactive source.The results value of worker samples and control group samples showed higher than other studies due to the Iraqi environment were effected and contaminated with radiation during three great destructive wars which saw the use of radioactive weapons against the population and environment in Iraq from 1980 until today. The results of uranium concentration in the urine samples showed increase with increase working years number and age, but the results of uranium concentration of smoker peoples due smoker habit is very close to non-smoker people.

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