Estimated of U, Rn and Po Concentrations in Smokers Blood Samples Collected from Babylon, Iraq

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ABSTRACT

Because of the great pressures on humans, there are resorted to smoking without knowing its effects on health. Such symptoms include adult lung cancer, cardiovascular, respiratory infections, kidney failure, congenital abnormalities and chronic bronchitis. Uranium and radon estimation has carried out in 100 smoker and Non-smoker blood samples from Babylon, Iraq, using solid state nuclear track detector (CR-39). The results have been shown the total uranium concentrations in blood smokers and non-smokers samples to be 1.02 ± 0.26 ppb and 0.86 ± 0.17 ppb respectively. On the other side, the total concentrations of radon in blood smokers and non-smokers samples 4.98 ± 0.79 Bqm⁻³ and 3.59 ± 0.28 Bqm⁻³ respectively. The total concentrations of uranium and radon in blood samples of smokers are greater than non-smokers blood samples. While, the total polonium (POW) and (POS) for smoker and non-smoker samples to be 0.527 KBqm⁻³ - 0.127 KBqm⁻³ and from 0.378 KBqm⁻³ to 0.091 KBqm⁻³ respectively. These studies conclude the smoking causes an increase in the concentration of uranium and radon and polonium in the blood of smokers.

1. Introduction

Radiation has been presented in space and the earth since the beginning of life, the radiation create with for motion of the life, and it can be defined as the energy emission as waves or particles through a space or material medium. There are two sources of radiation in the natural and man-made environment [1]. Radionuclides such as uranium and radon enters the human body by consuming meat, fish, plants, vegetables, cigarette, soil, water and inhalation air external exposure to radionuclides comes from human contact with soil, so it increases the radiation concentration in the blood [2, 3]. Uranium is element radioactive high toxic, it is dissolved, absorbed into the intestine and transported into the blood after entering human body, it is a terrestrial natural, element with three isotopes (²³⁸U, ²³⁵U, ²³⁴U), decrease
emissions of alpha, some emissions of beta and gamma\[4 , 5\]. Radon is noble gas, atomic number of (86) and a density of 73.9 kg.cm\(^{-3}\), colorless tasteless, odorless, and imperceptible. It is heavier than air, it is results from the decay of radionuclides as U\(^{238}\), U\(^{235}\), and Th\(^{232}\). Radon isotopes are (radon) \(^{222}\)Rn, (thoron) \(^{220}\)Rn and (actinon) \(^{219}\)Rn with half-life of 3.82 days, 55.65 s and 3.96 s respectively [6 , 7]. Alpha-particles emit from uranium and radon, it is interfere with the electrons of the external atoms, causing atoms to ionize and destroy the blood cells and diseases, it is very damaging when entering into the human body, if ingested, inhaled, absorbed in lungs or blood. On the other side, their presence in the human bones, blood and other tissues causes many health problems, including cancer, kidney failure, skin, increases in aberrations for chromosomal in living cells and birth defects [2, 3, 8, 9]. The study proved that the average alpha particles by monitoring radionuclides concentrations for non-smokers in blood samples is lower than for smokers [10]. By increasing cigarette smoking in closed areas, radon in the human body increases its concentration in the lungs and small amounts moved from the lungs to the blood and other body organs [11]. Previous research indicated that the increase in smoking causes an increase in the concentration of uranium and radon in the blood of smokers, due to its risk to human health and the studies have confirmed that smoking cigarette has toxic, geotaxis, carcinogenic properties, deadly and effect dangerous to the healthy [12]. The aim of this study was to calculate the concentration of uranium and radon in the blood of smokers and non-smokers and compare with samples collected from Babylon Governorate, Iraq.

2. Materials and methods

One hundred samples blood were collected from smokers and non-smokers working at the national center for occupational safety and health, employees at the municipal department, Hilla contemporary museum and other areas in Babylon governorate. It was taken 5 ml of blood for each volunteer in two groups: 50 samples of smokers and 50 samples of non-smokers, it was placed in an EDTA tube to ensure no blood clotting, and then it was stored in plastic petri dishes and symbolized by numbers. After then put in an electric heating incubator for the purpose of drying at 37 C\(^{\circ}\) for 24 hours [13]. It was crushed by using a hand grinder and sifted to obtain homogeneous powder, (Figure 1.A) and 0.5 gm of powder was placed in PVC tubes with CR-39 detector for 60 days to detection of radon-emitted alpha particles in smoker and non-smoker blood samples (Figure 1.b). CR-39 is abbreviation for plastic polymer detectors, which have a thickness of 500 μm (Tasl Service, UK). To calculate the concentration of uranium, we mix 0.1 gm of starch with 0.5 gm of blood powder after extracting from the storage tubes, then put the mixture in an iron mold and project to a
pressure of 6 tons by piston. The samples made as pellet 1.5 mm thick and 10 mm diameter [14]. Then put the pellet between two CR-39 detectors and it is damaged by adhesive tape and labeled, and then it is paved one by one in a long tape (figure 1.c). Finlay, the samples place the samples inside a neutron source for the purpose of irradiation by source consists of a rod of (Am - Be) surrounded by a paraffin wax, with a thermal flounce equal to \(3.024 \times 10^9\) n.cm\(^{-2}\) (figure 2), exposure for 7 days lead to the uranium atoms in the samples will fission [15]. After that completing the irradiation of blood samples and were kept the CR-39 to prepare for measure the uranium concentration. All the pellet samples are destroyed by burying them under the soil in an area far from the population based on the International Atomic Energy Agency (IAEA). On the other hand, the CR-39 detector was chemically etched at a temperature of 70° C for 6 h in NaOH solution in normality of 6.25 N [16]. Number of tracks measured using etching, washing and dry respectively on every detector by an microscope with 400X with digital microscope camera (model mc500) (figure 3.b) [17].

**Figure 1:** (A) hand grinder (b) PVC tube to storage (c) Blood samples ready for irradiation

**Figure 2:** The irradiation of the samples and CR-39 detectors
3. Calculation

3.1 Calculations of Uranium Concentrations of Blood Samples.

Uranium concentration calculation for blood samples, the track densities of the detectors for those samples were compared with the track densities for the standard samples [18].

$$\frac{C_X}{C_S} = \frac{\rho_X}{\rho_S}$$

Where, $\rho_X$ is the track densities of the study samples (tracks/ mm$^2$), $\rho_S$ is the track densities of the standard samples (tracks/ mm$^2$), $C_S$ and $C_X$ are the uranium concentrations of the Standard and unknown samples respectively.

To calculate the concentration of uranium in human blood uses the equation:

$$\text{CRN} = \frac{\rho}{\text{slope} \times 1}$$

3.2 Calculations of Radon Concentrations.

The concentrations of radon in blood samples were determined by CR-39. The average of tracks for each detector was calculated. The density of the tracks (\(\rho\)) for each detector was calculated according to the following equation:

$$\rho = \frac{N}{A}$$

Where $\rho$ = The track density (track m$^{-2}$)

$N$ = The average number of tracks on the CR-39 detector surface

$A$ = Area of view field (mm$^2$) visible under the microscope
To calculate the radon concentration in samples of human blood following equation: [19]

\[
C_{RN} = \frac{\rho}{K \times T}
\]  

(4)

Where:
- \( C_{RN} \) = radon concentration
- \( T \) = the exposure time (60 d)
- \( K \) = The detector calibration factor equal (0.212 tr. cm\(^{-2}\) Per Bqm\(^{-3}\).d) [13].

To calculate of density of the effectiveness of the concentration of radon in human blood samples by following equation. [20]

\[
C = \frac{CRN \lambda_{Rn} h T}{l}
\]  

(5)

Where:
- \( C \) is density of the effectiveness of the concentration of radon, \( \lambda_{Rn} \) is constant decay of radon (0.1814 d\(^{-1}\)), \( h \) is distance between CR-39 and blood samples in the tube equal 10.5 cm, \( T \) is the exposure time (60 day) and, \( l \) is thickness the sample equal 0.2 cm.

To calculate of radon concentration progeny (Polonium) (\(^{218}\)Po, \(^{214}\)Po) precipitated on the walls tube (POW) and on the face cr-39 Detector (POS) [20]

\[
D_{Po218} = D_{Po214} = \frac{C}{4} r (\frac{r}{r+h}) \cos \theta_c
\]  

(6)

\[
D_{Po218} = D_{Po214} = \frac{C}{4} r (\frac{r}{r+h}) (\cos \theta_c \frac{r}{R_a})
\]  

(7)

Where:
- \( R \) is the radius of exposure tube equal 1.5 cm, \( R_a \) is average alpha particle range in air to radon 222 is 4.15 cm, \( \theta_c \) is average value of critical angle of CR 39 detectors is 35°.

### 4. Results and Discussion

Table 1 shows the blood samples were classified into age groups of smokers and non-smokers collected from Babylon governorate, Iraq. The results showed that the highest and lowest concentration of uranium in the blood samples of smokers and non-smokers is (1.85 ± 0.35 ppb - 0.50 ± 0.12 ppb) and (1.63 ± 0.17 ppb - 0.32 ± 0.09 ppb) respectively. While, the average uranium concentration in the smokers bloods is (1.26 ± 0.25 ppb - 0.58 ± 0.27 ppb) for age groups 50 - 60 year and 10 - 20 years respectively. While, the average uranium concentrations in the non-smokers blood is (1.23 ± 0.25 ppb - 0.47 ± 0.20 ppb) for age groups 50 - 60 year and 10 - 20 years respectively. Add to that, the total uranium concentrations in blood smokers and non-smokers samples 1.02 ± 0.26 ppb and 0.86 ± 0.17...
From the above, we found, the concentrations of uranium in the blood increase cumulatively with increasing age and total concentration of uranium in smokers blood is greater than non-smokers.

Table 2 displays uranium concentrations in smoker and non-smoker blood samples were compared with reports in different regions in the world. The total concentration of uranium in blood for smoking and non-smoking were $1.02 \pm 0.26$ ppb and $0.86 \pm 0.17$ ppb respectively. The comparison revealed, the concentration of uranium in this study for smokers is below than the values recorded in other selected regions of Iraq. While, the uranium concentration of non–smoking were found bigger than the values recorded in India, Mexico and Babylon in Iraq and lower than Serbian. Based on the comparison, the results show, the concentration of uranium in blood within the allowable limits[21].

Table 3 represents a summary radon concentration ($C_{RN}$) in the blood for 100 Smoker and Non-smoker samples collected from Babylon governorate. The results showed that the highest and lowest concentration of radon in the blood of smokers and non- smokers is $(9.53 \pm 0.50 \text{ Bqm}^{-3} - 2.32 \pm 0.70 \text{ Bqm}^{-3})$ and $(6.51 \pm 0.02 \text{ Bqm}^{-3} - 2.10 \pm 0.01 \text{ Bqm}^{-3})$ respectively. Add to that, the average concentration of radon in smokers blood from $(6.86 \pm 0.29 \text{ Bqm}^{-3} - 3.37 \pm 0.43 \text{ Bqm}^{-3})$ for age groups 50 - 60 year and 10 - 20 years respectively. While, the average radon concentrations in the blood of non- smokers were found from $(4.25 \pm 0.27 \text{ Bqm}^{-3} - 2.46 \pm 0.11 \text{ Bqm}^{-3})$ for age groups 50 - 60 year and 10 - 20 years respectively. On the other side, the total concentration of radon in blood smokers and non-smokers samples $4.98 \pm 0.79 \text{ Bqm}^{-3}$ and $3.59 \pm 0.28 \text{ Bqm}^{-3}$ respectively. The results found that the total radon concentration in blood smokers is larger than non-smokers.

Table 4 the concentrations of radon in the blood samples of smokers and non-smokers were compared with reports in different regions in the world. The total uranium concentrations in blood of smoking and non- smoking were $4.98 \pm 0.79$ ppm and $3.59 \pm 0.28$ ppm in the present study. The comparison shows, the radon concentration for smokers are higher than the values recorded in other selected regions of Iraq. Add to that, the concentration of radon for non–smoking were found bigger than the values recorded in Anbar and Karbala of Iraq and lower than Babylon of Iraq. Based on the comparison. All the results were within the permitted ICRP limits and IAEA (200 Bqm$^{-3}$) [13].

Table 5 the total value concentration of radon (C), polonium (POW) and (POS) for smoker and non-smoker equal ($2.832 \text{ KBq}^{-3} - 0.527 \text{ KBqm}^{-3} - 0.127 \text{ KBq}^{-3}$) and ($2.034 \text{ KBq}^{-3} - 0.378 \text{ KBq}^{-3} - 0.091 \text{ KBq}^{-3}$) respectively. Add to that, all concentrations of smoker samples are higher than non-smokers. The Radon concentrations (C) are higher than that of polonium
on the wall and detector. On the other side, results found that the concentration $^{214}$Po and $^{218}$Po is lower, it may be neglected due to the effects of this offspring within error limits of measuring radon concentrations.

**Table 1**: Min ,Max , average and total uranium concentration in blood samples for smokers and non–smokers.

| Age group year | No. of subjects | Uranium concentration (ppb), Min - Max | Average Uranium Concentration(ppb) | Type of samples |
|----------------|----------------|----------------------------------------|-----------------------------------|----------------|
| 10-20          | 2              | $0.50 \pm 0.12 - 0.66 \pm 0.08$        | $0.58\pm 0.27$                    | Smoking samples |
| 20-30          | 11             | $0.72 \pm 0.12 - 1.45 \pm 0.23$        | $1.06 \pm 0.17$                   | Smoking samples |
| 30-40          | 10             | $0.52 \pm 0.12 - 1.33 \pm 0.50$        | $1.09 \pm 0.18$                   | Smoking samples |
| 40-50          | 14             | $0.78 \pm 0.16 - 1.57 \pm 0.7$         | $1.18\pm 0.39$                    | Smoking samples |
| 50-60          | 13             | $0.60 \pm 0.20 - 1.85 \pm 0.35$        | $1.26\pm 0.29$                    | Non - Smoking samples |
| Total ± SD     |                |                                        | $1.02 \pm 0.26$                   | Non - Smoking samples |

| Age group year | No. of subjects | Uranium concentration (ppb), Min - Max | Average Uranium Concentration(ppb) | Type of samples |
|----------------|----------------|----------------------------------------|-----------------------------------|----------------|
| 10-20          | 3              | $0.32 \pm 0.09 - 0.62 \pm 0.02$        | $0.47\pm 0.05$                    | Non - Smoking samples |
| 20-30          | 6              | $0.44 \pm 0.06 - 0.99 \pm 0.33$        | $0.70 \pm 0.15$                   | Non - Smoking samples |
| 30-40          | 6              | $0.6 \pm 0.23 - 1.48 \pm 0.03$         | $0.86\pm 0.19$                    | Non - Smoking samples |
| 40-50          | 19             | $0.81 \pm 0.13 - 1.34 \pm 0.10$        | $1.02\pm 0.22$                    | Non - Smoking samples |
| 50-60          | 16             | $0.78 \pm 0.23 - 1.63 \pm 0.17$        | $1.23 \pm 0.25$                   | Non - Smoking samples |
| Total ± SD     |                |                                        | $0.86 \pm 0.17$                   | Non - Smoking samples |

**Table 2**: A comparison between uranium concentrations in blood samples with other studies

| country          | Uranium concentrations in blood samples (ppb) | References |
|------------------|-----------------------------------------------|------------|
|  | Smoking Max - min | Non- smoking Max - min | |
| Serbian          | -                                             | 60         | [22] |
| India            | -                                             | 0.33 - 0.74 | [23] |
| Mexico           | -                                             | 0.91       | [24] |
| Iraq, selected regions | -                                         | 0.26 - 1.90 | [25] |
| Iraq, selected regions | 1.94 ± 0.04                                    | -         | [26] |
Iraq, Babylon - 0.56 – 1.24 [27]
Iraq - Babylon - 0.32 – 1.47 [28]
Allowable limit - 115* [21]
Iraq, Babylon 0.50 - 1.85 Av. 1.02 ± 0.26 0.32 - 1.63 Av. 0.86 ± 0.17 Present Study

*Units were converted by the author

**Table 3**: Min, Max, average and total concentration of radon in blood for smokers and non-smokers samples gathered from Babylon governorate

| Age group year | No. of subjects | Radon concentration in blood (C_{RN}) Bqm^{-3} | Average (C_{RN}) Bqm^{-3} | Type of samples |
|----------------|-----------------|-----------------------------------------------|---------------------------|-----------------|
| 10-20          | 2               | 2.32 ± 0.70 – 4.41 ± 0.16                      | 3.37 ± 0.43               | Smoking samples |
| 20-30          | 11              | 2.44 ± 1.15 – 9.53 ± 1.16                      | 4.34 ± 0.87               | Smoking samples |
| 30-40          | 10              | 3.37 ± 0.57 – 6.16 ± 0.58                      | 5.15 ± 0.91               | Non-Smoking samples |
| 40-50          | 14              | 3.83 ± 0.32 – 7.79 ±0.32                       | 5.18 ± 0.9                | Non-Smoking samples |
| 50-60          | 13              | 4.07 ± 0.72 – 8.11 ± 0.59                      | 6.86 ± 0.29               | Non-Smoking samples |
| Total ± SD     | 3               | 2.10 ± 0.01 – 2.83 ± 0.20                      | 2.46 ± 0.11               | Non-Smoking samples |
| 10-20          | 3               | 2.20 ± 0.26 – 4.65 ± 0.39                      | 3.67 ± 0.27               | Non-Smoking samples |
| 20-30          | 6               | 3.14 ± 0.27 – 4.41 ± 0.33                      | 3.74 ± 0.45               | Non-Smoking samples |
| 30-40          | 6               | 3.02 ± 0.06 – 5.46 ± 0.27                      | 3.84 ± 0.31               | Non-Smoking samples |
| 40-50          | 19              | 2.67 ± 0.48 – 6.51 ± 0.02                      | 4.25 ± 0.27               | Non-Smoking samples |
| 50-60          | 16              | 3.59 ± 0.28                                    |                           | Non-Smoking samples |

**Table 4**: A comparison between radon concentrations in blood samples with other study

| country          | Radon concentrations in blood samples(Bqm^{-3}) | References |
|------------------|-----------------------------------------------|------------|
|                  | smoking                                      | Non- smoking |         |
| Iraq, Babylon    | -                                            | 4.32 ± 0.39 | [29]     |
| Iraq-Anbar       | -                                            | 0.075 - 0.136 | [30]   |
| Iraq, Karbala    | -                                            | 3.3         | [9]      |
| Allowable limit  | -                                            | 200         | [13]     |

8
Table 5 concentrations of radon progeny (\(^{214}\)Po, \(^{218}\)Po) in the irradiation tube

| Age group year | No. of subjects | Radon con. (C) KBq m\(^{-3}\) Min – Max | Con. of (POW) KBq m\(^{-3}\) Min – Max | AV. POW | Con. of (POS) KBq m\(^{-3}\) Min – Max | AV. POS | Type of sample     |
|----------------|----------------|------------------------------------------|---------------------------------------|---------|---------------------------------------|---------|-------------------|
| 10-20          | 2              | 1.262 - 2.399                            | 0.234 - 0.446                         | 0.341   | 0.056 - 0.107                         | 0.081   | Smoking samples   |
| 20-30          | 11             | 1.327 - 5.186                            | 0.247 - 0.965                         | 0.485   | 0.059 - 0.232                         | 0.117   | Smoking samples   |
| 30-40          | 10             | 1.833 - 3.352                            | 0.341 - 0.623                         | 0.522   | 0.082 - 0.150                         | 0.126   | Non-Smoking samples |
| 40-50          | 14             | 2.084 - 4.239                            | 0.387 - 0.787                         | 0.524   | 0.150 - 0.190                         | 0.126   | Non-Smoking samples |
| 50-60          | 13             | 2.214 - 4.413                            | 0.412 - 0.800                         | 0.597   | 0.099 - 0.193                         | 0.144   | Non-Smoking samples |
| Total ± SD     | 2.832          |                                          | 0.527                                 | 0.127   |                                       |         |                   |
| 10-20          | 3              | 1.142 - 1.540                            | 0.212 - 0.286                         | 0.249   | 0.051 - 0.069                         | 0.060   | Non-Smoking samples |
| 20-30          | 6              | 1.197 - 2.530                            | 0.222 - 0.470                         | 0.330   | 0.053 - 0.113                         | 0.079   | Non-Smoking samples |
| 30-40          | 6              | 1.708 - 2.399                            | 0.318 - 0.446                         | 0.372   | 0.076 - 0.107                         | 0.089   | Non-Smoking samples |
| 40-50          | 19             | 1.643 - 2.971                            | 0.305 - 0.552                         | 0.372   | 0.073 - 0.133                         | 0.089   | Non-Smoking samples |
| 50-60          | 16             | 1.453 - 3.542                            | 0.270 - 0.659                         | 0.430   | 0.065 - 0.159                         | 0.103   | Non-Smoking samples |
| Total ± SD     | 2.034          |                                          | 0.378                                 | 0.091   |                                       |         |                   |

5. Conclusions

In the current study, uranium and radon concentrations were determined in the blood of smokers and non-smokers for the samples collected from Babylon governorate, Iraq. The total uranium concentration in the blood of smokers is higher than that of non-smokers equal 1.02 ± 0.26 ppb and 0.86 ± 0.17 ppb respectively. On the other side, the total concentration of radon in blood of smokers is bigger than that of non-smokers equal 4.98 ± 0.79 Bq m\(^{-3}\) and 3.59 ± 0.28 Bq m\(^{-3}\) respectively. The total radon concentration (C, POW and POS) in the blood of smoker were found higher than that of non-smokers. We conclude the smoking causes an increase in the concentration of uranium and radon and polonium in the blood of smokers. Therefore, we recommend smokers to stop smoking for the purpose of keep their good healthy.
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