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Measurement of radon gas concentrations in blood of cancer patients using solid state nuclear track detectors (CR-39)

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***Abstract*---**Introduction: Alpha particle emitters are extremely destructive and detrimental to the human body, If inhaled or consumed, swallowed, or absorbed into the lungs or bloodstream. 222Rn is one of alpha-particle emitter. Material and Methods: we studying the concentrations of radon gas (222Rn) in blood samples of 10 cancer patients and 6 control measured using CR-39 detector. The samples were collected from Babylon oncology center. Results: The highest concentration of radon for cancer was 267.22 Bq/m3, while for control was5.98 Bq/m3. The lowest concentration of radon for patient was 16.55 Bq/m3, while for control group was 2.77 Bq/m3. Conclusion: These study concluded the level of radon concentration increased of cancer patient compare with control group, also these study concluded the level of radon in center of Babylon city higher than of rural of Babylon.

***Keywords*---**radon, cancer, CR-39, blood, alpha-particles.

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Introduction

In human surroundings, radon is the most common radioactive pollutant. ^{222}Rn and its short-lived progeny are estimated to account for around half of the total effective dose received by humans from all sources of ionizing radiation. Because of their great attenuation power, the a releasing radioactive compounds are hazardous to normal human tissues. a Chemical and radioactive toxicity impacts of particles cause damage to numerous organs [1]. The acute exposure of human to the high dose of ionizing radiation causes biological effects include: anemia, gastrointestinal troubles, damage of bone marrow and brain, also infertility in women and other diseases and it has caused some cancers such as leukemia [2]. Alpha particles existence in human blood is causes mutations in DNA, it can lead to increase the aberrations for chromosomal in cells [3]. When alpha particle enter the human blood interacted with the external atoms electrons, if they had enough energy a process occurs the ionization of atoms, and therefore they causes damage the blood cells and thus the occurrence of certain diseases which was mentioned above [4]. It's worth noting that radionuclides reach the human body via three different routes. The first is inhalation, which is thought to be the most prevalent method of radioisotope consumption. Ingestion, which includes drinking water, eating food, and smoking cigarettes, is the second method. The third is dermal radionuclide contact, which can enter the circulatory system through open wounds [5].

Materials and Method

The blood samples of cancer patients and healthy individuals was collected from Babylon oncology center and various regions of the governorate, respectively. The samples had been taking are 16 samples, we divided these samples into two groups (10 patients and 6 control). 4ml of blood were collected by syringe and the sample was put in EDTA tube, samples information is written on each tube. After that, transferred to a plastic cup, in an emission chamber, the samples were placed for 28 days to achieve radium and radon equilibrium. To measure radon concentration we use CR-39 detector (Bristol BS119PJ, UK) with a thickness of 1 mm and 2.5×2.5 cm^2 was inserted in samples. As illustrated in (Figure 1), CR-39 were glued to the top end of a cup with a diameter of 3.5 cm and a length of 5 cm, and used to store samples for 10 weeks.

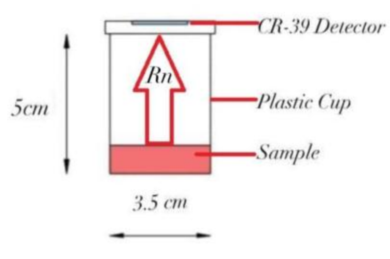

Figure 1. Estimation of Radon Gas Using a CR-39 Detector

When the exposure time is up 10 weeks (70 days) , at 85°C for 3 hours, a sodium hydroxide (NaOH) solution was used to etch the CR-39 detector. [6]. In the water bath, the solution normalcy was 6.25 N. After that, the detectors were cleaned with distilled water. The TASLIMAGE system was used to calculate the track density (track/cm^2) as showed in Figure 2. The background correction was done by subtracting the recorded track density from the background.

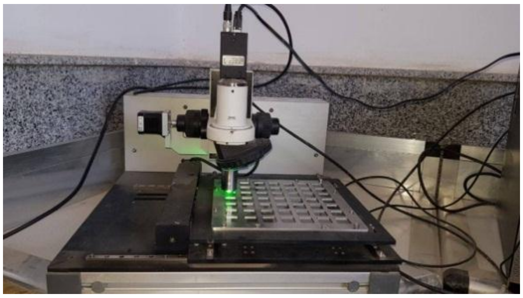

Figure 2.TASLIMAGE System

Calculation

The track detector technology CR-39 was used to determine radon concentrations in blood by recording the tracks of alpha particles on the detector's surface according to the following connection [7]. The equation was used to obtain the track density (track / cm^2).

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

The density in the blood samples represented traces of particles produced by radon during exposure. Equation was used to compute the concentration of alpha particles $\boldsymbol{C_{Rn}^{a}}$ in human blood (Bq/m^3). [8]

$$C_{Rn}^{a}\left(\frac{Bq}{m^3}\right) = \frac{\rho}{K\ t}$$

Where **ρ** represent track density on exposed detector (Tr/cm^2), **t** represent exposure time of the blood sample (70 d), and K represent calibration factor (diffusion constant). ***K*** was measured using the relationship below , using the parameters of the plastic cup [9].

$$K = 0.25\, r\left(2cos\theta_c - \frac{r}{r_a}\right)$$

Where **r** represent the radius of the tube (**r**= 1.75cm), **θc** represent critical angle of the CR-39 detectors ($\boldsymbol{\theta_c}$ = 35^o) [9], and $\mathbf{r_a}$ represents the range of alpha particle in air ($\mathbf{r_a}$ = 4.15 cm) [10], Thus diffusion constant k = 0.049(Tr.cm^{-2}/Bq·m^{-3}·d).

Result and Discussion

Table (1) shown the radon concentrations of cancer patients and control group, the higher concentration of patient cancer was 267.22 Bq/m^3 for male patient and Age 22 and live in center of city , while the higher concentration of radon for control group was 5.98 Bq/m^3 for male smple and age 23 and live in center . The lowest radon concentration of cancer patient was 16.55 Bq/m^3 for female patient with age 24 and lived in Rural, while the lowest concentration of control group was 2.77 Bq/m^3 for female sample with age 25 and live in rural. This could be attributed to dietary variances; also, the removal of radiation from the body is dependent on the person's gender and age, as well as the chemical forms of radioactive materials [12].

Table 1
Information and Radon level for sample

SC.	Age	Gender	Location	C_{Rn} (Bq/m^3)
P1	22	Male	Center	267.22
P2	37	Male	Rural	35.72
P3	30	Male	Center	146.54
P4	40	Male	Center	231.03
P5	42	Male	Rural	73.73
P6	24	Female	Rural	16.55
P7	29	Female	Rural	56.52
P8	32	Female	Center	89.02
P9	40	Female	Center	113.55
P10	39	Female	Rural	97.31
Average				112.719
C1	23	Male	Center	5.98
C2	35	Male	Rural	3.35
C3	41	Male	Rural	3.91
C4	25	Female	Rural	2.77
C5	34	Female	Center	4.73
C6	40	Female	Center	5.02
Average				4.293

P ; Patient, C; Control

Figure (3) show the compare of radon concentration between center of city and rural, The average of Radon in patients that live in city center was 169.472 Bq/m^3, while for Patient that live in rural was 55.966 Bq/m^3 . The average of Radon in Control person that live in city center was 5.243 Bq/m^3, while for control person that live in rural was 3.343 Bq/m^3 .difference between City center and rural in radon concentration, The increase in radon in the city center compared to that in the rural may be attributed to overpopulation and pollution resulting from car exhaust and could be owing to the employment of depleted uranium weapons in this region during Gulf Wars (1991 and 2003) [13].

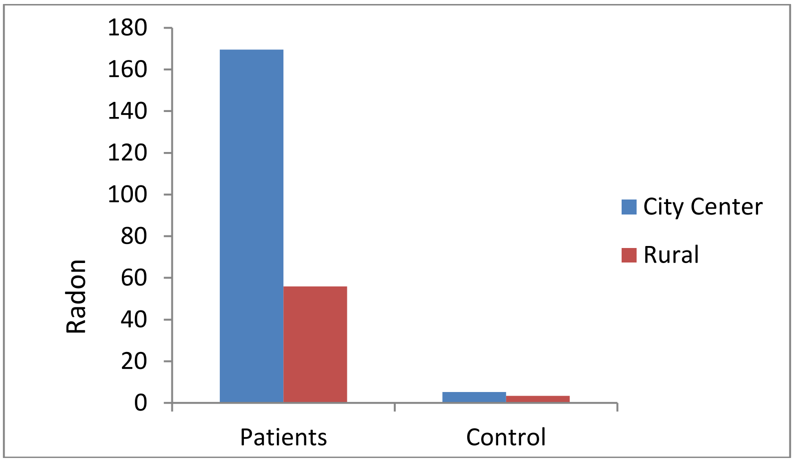

Figure 3. Average of Radon Concentration in Blood Samples According Location.

Because of their labor in diverse exposure regains in the environment, males are more exposed to radiation than females, as illustrated in figure 4, the radon concentrations emitted by males were higher than those emitted by females.

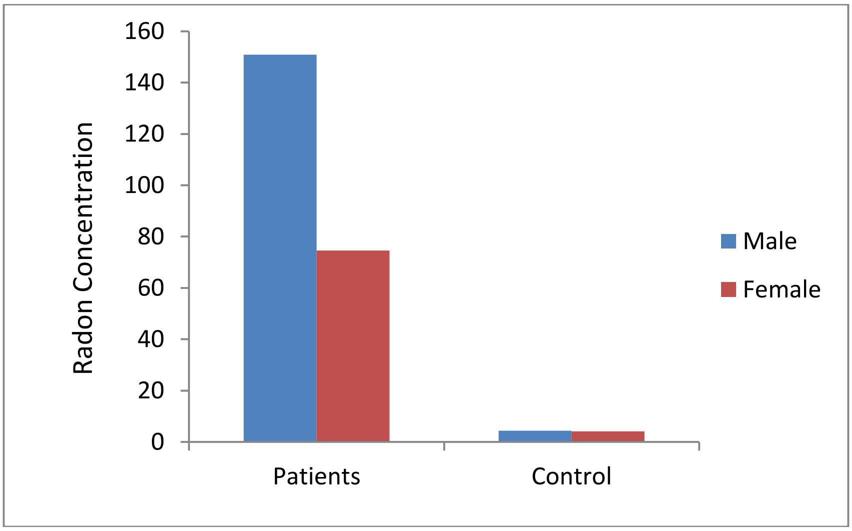

Figure 4. Average of Radon Concentrations in Blood Samples According Gender

Conclusion

These study concluded the level of radon concentration increased of cancer patient compare with control group, also these study concluded the level of radon of male higher than of female. In terms of radon concentration in blood samples, however, the findings shows that the proportion of city center is larger than rural.

References

1. Kendall, G. M., & Smith, T. J. (2002). Doses to organs and tissues from radon and its decay products. *Journal of Radiological Protection*, *22*(4), 389.
2. Muhammad, B. G., Jaafar, M. S., Abdul Rahman, A., & Ingawa, F. A. (2012). Determination of radioactive elements and heavy metals in sediments and soil from domestic water sources in northern peninsular Malaysia. *Environmental monitoring and assessment*, *184*(8), 5043-5049.
3. Meo, S. A. (2004). Hematological findings in male x-ray technicians. *Saudi medical journal*, *25*(7), 852-856.
4. Ismail, A. H., Hamad, M. A., & Harki, E. M. (2012). Radiation exposure of leukemia blood samples and its impacts on the density of RBC, WBC, and PLT: In vitro.
5. Akram, A., Khattak, N. U., Qureshi, A. A., Qureshi, I. E., & Iqbal, A. (2003). Application of neutron induced fission technique in the determination of uranium in drinking water. *Nucleus (Islamabad)*, *40*(1-4), 1-6.
6. Naji, T. F., & Hassoon, S. O. (2021, September). Measuring of Radon Gas Concentrations in serum samples of Lung cancer patients in Babylon governorate, Iraq. In *Journal of Physics: Conference Series* (Vol. 1999, No. 1, p. 012054). IOP Publishing.
7. Karim M S, Mohammed A H and Abbas A A 2010. Measurement of Uranium Concentrations in Human Blood in Some the Regions of Baghdad Governorate Experime ntal Part The present study of uranium concentration in human blood from different. Ibn Al-Hait. Jour. For Pure And Appl. Scie. 23 , 25.
8. Aswood M Sh, Jaafar M S and Bauk S 2014 Measuring Radon Concentration Levels in Fertilizers Using CR-39 Detector. Adva. Mate. Res. 925, 610-614.
9. Barillon, R., Klein, D., Chambaudet, A., & Devillard, C. (1993). Comparison of effectiveness of three radon detectors (LR115, CR39 and silicon diode pin) placed in a cylindrical device-theory and experimental techniques. *Nuclear Tracks and Radiation Measurements*, *22*(1-4), 281-282.
10. Fleischer, R. L., & Mogro-Campero, A. (1978). Mapping of integrated radon emanation for detection of long-distance migration of gases within the Earth: Techniques and principles. *Journal of Geophysical Research: Solid Earth*, *83*(B7), 3539-3549.
11. Ismail, A. H., & Jaafar, M. S. (2009). Experimental measurements on CR-39 response for radon gas and estimating the optimum dimensions of dosimeters for detection of radon. In *Proceedings of the 3rd Asian Physics Symposium, Bandung, Indonesia* (pp. 22-23).
12. Henriksen, T., Maillie, D. H. Francis, (2003). Radiation and health. ISBN 0-415-27162-2.
13. Al-Hamzawi, A. A., Jaafar, M. S., Tawfiq, N. F., (2014). Uranium concentration in blood samples of Southern Iraqi leukemia patients using CR-39 track detector. Radioanalytical and Nuclear Chemistry, Vol. 299(3), P. 1267-1272.