Determination of Radon Concentrations in AL-NAJAF Governorate by Using Nuclear Track Detector CR-39

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Abstract

Appeared different cases of cancer in certain districts in Al-Najaf governorate and it had assumed several hypotheses. Including the existence of radon in the air inside homes, where the radon gas is the largest and the most important variables contributing to the exposure to natural radiation in the world. Radon cup technique was used, which is a cylindrical chamber 5 cm in diameter and height of 7 cm inside the detector impact in solid state nuclear track detector CR-39 and these detectors was etched with 6.25 N from sodium hydroxide at a temperature of 70^{o} C in a time of 12 hours. Values of radon concentrations ranged between 74.2804 ± 42.6048 Bq/m^3 to 478.1301 ± 53.325 Bq/m^3, also found that the rate of radon concentration in Al-Najaf governorate, up to 183.682 Bq/m^3 with standard deviation of up to 104.231 Bq/m^3. High cancer rates in some neighborhoods in Al-Najaf governorate can be attributed to high concentrations of radon gas in these areas.

Keywords: Radon, Cancer, SSNTD, Radiation Exposure.

Introduction

Radon (^{222}Rn) is a naturally occurring colorless, odorless, tasteless radioactive gas that is formed from the normal radioactive decay of uranium. Uranium is present in small amounts in most rocks and soil. It slowly decays to other products such as radium, which decays to radon. Some of the radon moves to the soil surface and enters the air, while some remains below the soil surface enters the groundwater (water that flows and collects underground). Uranium has been around since the earth was formed and has a very long half-life (4.5 billion years), which is the amount of time required for one-half of uranium to decays. Uranium, radium and thus radon, will continue to exist indefinitely at about the same levels as they do now [1].

Radon also undergoes radioactive decay and has a radioactive half-life of about 3.8 days. Unlike radon, the daughters are metal and easily attach to dust and other particles in the air. The dividing of daughters continues until a stable, nonradioactive daughter is formed. During the decay process, alpha, beta, and gamma radiations are released. Alpha particles can travel only a short distance and cannot penetrate the skin, since radon is a gas and it's daughters are often attached to dust, human are exposed to them primarily by breathing them in. They are present in nearly all air. However background levels of radon in outdoor air are generally quite low, about 0.003 to 2.6 picocuries of radon per liter of air. In indoor locations, such as homes, schools, or office buildings, levels of radon and daughters are generally higher than outdoor levels; are generally about 1.5 pCi/l of air [2].

Cracks in the foundation or basement of homes may allow increased amounts of radon to moves into homes, and may be also exposed to radon and daughters by drinking water obtained from home that contain radon . However, most radon in water is rapidly released into the air and can be breathed in , some radon and most of daughters remain in the lungs and undergo radioactive decay, and the radiation released during this process passes into lung tissue and the sensitive basal epithelial cells in it, which is the cause of lung damage and leads to cancer. Some of radon which that swallows with drinking water passes through the walls of stomach and intestine. After radon enters the blood stream most (greater than 90%) of the radon goes to the lung where breathed most of it out. This occurs very shortly after it is taken in. Any remaining radon undergoes decay. Radon that does not go to the lungs goes to other organs and fat where it may remain and undergo decay [3].

Radon concentration hypothesis is the fundamental basis for the prediction of risk from radiation exposure, and forms the basis for radiation protection practices, when track etched detector were used a significant risk cancer was found for radon concentration at and above the action level for mitigation of houses currently used in many European countries (200-400) Bq/m^3 [8]. There is substantial variation in the mean concentration of radon in Al-Najaf governorate in Iraq homes measured; such findings call into question the assumption that indoor air radon measurements offer a precise estimate of cumulative radon exposures in homes, most biologically meaningful exposure period for cancer etiology [8] From many cases of cancer risk which was studied previously, we were depend on detectors that measured current radon levels in indoor air for more than 90 days to estimate many years of cumulative radon exposure and found convincing association between cancer risk and residential radon.

Experimental Sampling:

In this study, radon dosimeter techniques were used and long period indoor air radon measurements, the measurements were made with the solid state nuclear track detector (SSNTD) technique. Detectors were placed in the living room wherever possible, in the bedrooms and kitchens. All houses used for this survey were built around (greater than 20 years); they were built from bricks, cement and blocks, their heights do not exceed 7 m. The measurements were taken during the summer and winter (one year), when bad cooling and heating environments were used. The cup technique was employed in this work; a schematic diagram was shown in Fig.(1). Each cup container was 7 cm height and 5 cm in diameter and contains (1×1) cm square of CR-39 nuclear track detector fixed with double sided adhesive tape to the bottom of the cup with its sensitive side upward. The design of the chamber ensures that the aerosol particles and radon decay products are deposited from outside. The CR-39 detectors were capable of detecting alpha particles of all energies emitted from radon and its daughters. Some of alpha particles reach the detector and leave tracks, and the number of tracks is proportional to the average radon concentration. The exposed detectors were collected after approximately five months of exposure and then chemical etching simultaneously at a constant time 12 hour and NaOH for 6.25 N at temperature 70^{o}C. An optical microscope with magnification of 10×40 was used to count the number of tracks in each detector.

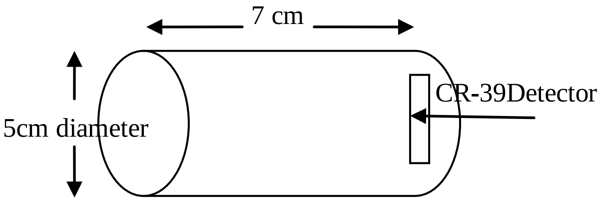

Fig.(1) Represent the Cup technique used in study subject with CR-39 SSNTD.

Radon Concentration Measurement:

For dosimetric purpose, it important to measure the average radon concentration over a time that should be long enough relative to the typical time scale of radon fluctuations caused by environmental conditions. The signal measured by etched track detectors is integrated track density, ρ (track/m^3) recorded on the detector, (K) the average value of the calibration factor of ^{222}Rn in [(Bq .day) per number of tracks] and (T) exposure time (day) has been applied to determine ^{222}Rn concentration (C_{Rn}) in (Bq/m^3) using the following equation (4), [5]:

$$C_{Rn} = K\left(\frac{\rho}{T}\right) \quad \ldots\ldots\ldots\ldots (1)$$

The calibration process for the dosimeters were exposed for 40 days of Radium ^{226}Ra (Radon source) of activity concentration 0.33 x 10^4 (Bq) it gives 27.45 x10^{-2} ±3.35x10^{-3} [(Bq . day) per number of tracks] calibration factor as shown in the following equation [6].

$$K = \left(\frac{C_{Ra}T_{Ra}}{\rho_{Ra}}\right) \quad \ldots\ldots\ldots\ldots (2)$$

where: (C_{Ra}) is the standard radon concentration (Bq/m^3) , (ρ_{Ra}) the track density (number of $Track/m^3$), (T_{Ra}) the exposure time (day) used for the calibration process by Radium ^{226}Ra (Radon source) .

Results and Discussion

The results from this study indicate that the difference between the minimum and maximum Radon concentrations in each region is very high. This large variation in the Radon values inside these regions is due mainly to the difference in the ventilation methods used, different types of locations building (bedroom, living room) and (elevated floor of building basement). The types of building materials such as concrete and stone are also influence the Radon concentration, also poor ventilation rate plays an important role of radon concentration [10].

The decay products of radon-222 gas are rarely in equilibrium with the parent [7]. The radon concentrations obtained at different regions in Al-Najaf governorate, about 42 regions in it, the mean radon concentrations ranged from (74.2804±42.6048) Bq/m^3 to (478.1301±53.325) Bq/m^3 as shown in Table (1)**.** The graphs in Figs. (2-a), (2-b), (2-c) in this study regions shows that the maximum, mean and minimum radon concentrations has been ranged in the sample numbers to exceed the 200 Bq/m^3, as shown in the samples (2, 3, 4, 5, 10, 12, 21 ,27, 28, 29, 30, 31, 33, 34, 44) , also note the increased rate of average radon concentrations in the samples (12, 29, 33, 34) to exceed 400 Bq/m^3.The study monitored the lowest concentration of radon in Al-Najaf governorate 25.608 Bq/m^3, and the maximum reading 640.352 Bq/m^3 the mean of radon concentration in Al-Najaf governorate was found to be 183.682 Bq/m^3 and standard deviation (S.D) of up to 104.231 Bq/m^3.

Conclusion

The high cancer rates in some areas of Najaf governorate, can be caused by high concentration of radon gas in these regions, especially since we used the homes of people in most parts of the study with a high incidence of various types of cancer, according to figures from the Ministry of Health in this city, these injuries frequently in women, children and elderly people who have been increased their presence in their homes, note that the statistics recorded by the Department of Health in Al-Najaf governorate shows that the incidence in females was higher than the incidence in males as they hit the injury in women 56% of the total injuries, as well as the incidence in males for the reconstruction of which less than 15 years and more than 60 years of 76 % of total injuries for males [9].

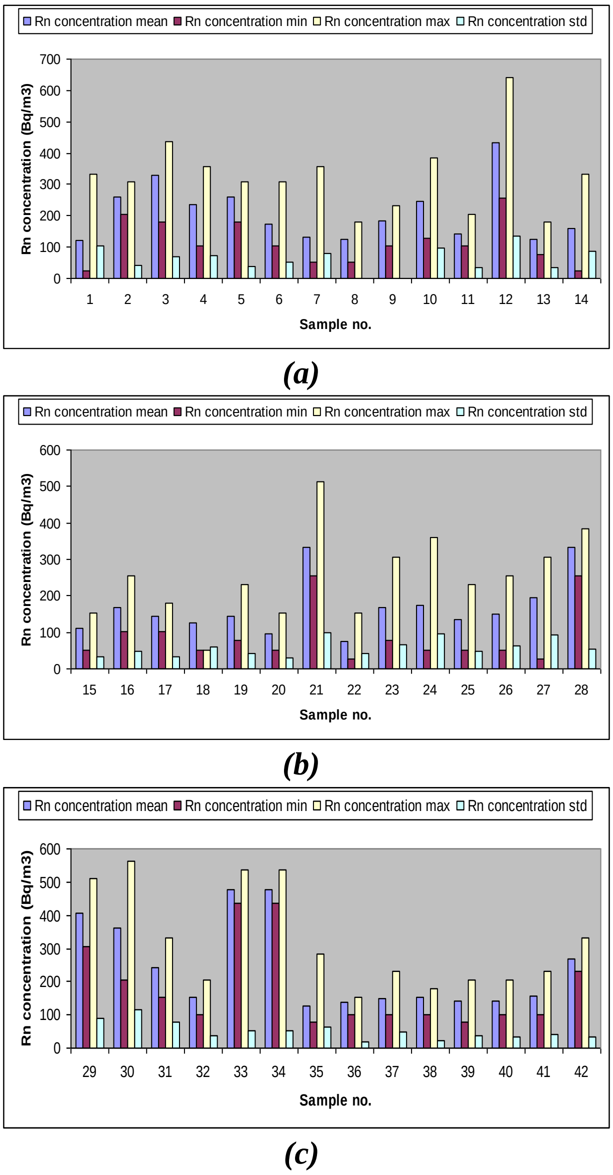

Fig. (2): The mean, minimum, maximum of Radon concentration in samples (a):1 to 14, (b) : 15 to 28, (c): 29 to 42.

Table (1)
Radon concentration at many locations in Al-Najaf governorate.

Sample no.	*Detector Code*	*Average Track density x10^5 (track/m^3)*	*Rn. Concentration. Mean (Bq/m^3)*	*S.D (Bq/m^3)*
1	S-18	0.7190±0.6157	122.5836	104.9730
2	NA-08	1.5174±0.2499	258.7035	42.6021
3	S-17	1.9229±0.4117	327.8553	70.1990
4	NA-14	1.3821±0.4296	235.6472	73.2474
5	NA-07	1.5190± 0.2183	258.9829	37.2158
6	S-20	1.0107±0.3086	172.3135	52.6076
7	S-1	0.7762± 0.4656	132.3426	79.3842
8	NA-21	0.7261±0.2628	123.8035	0.2628
9	NA-22	1.0731±0.2663	182.9578	0.2663
10	S-11	1.4356±0.5627	244.7597	95.9342
11	NA-23	0.8346±0.2003	142.3024	34.1537
12	NA-10	2.5325±0.8017	431.7785	136.6861
13	NA-27	0.7375±0.2066	125.7415	35.2226
14	NA-05	0.9361±0.9361	159.5943	88.2063
15	S-15	0.6472±0.1879	110.3373	32.0343
16	S-16	0.9890± 0.2826	168.6271	48.1768
17	S-19	0.8370±0.1929	142.7059	32.8849
18	NA-24	0.7887±0.3574	126.1404	60.9324
19	S-7	0.8468±0.2538	144.3721	43.2755
20	S-13	0.5675±0.1806	96.7640	30.7846
21	S-10	1.9530±0.5753	332.9805	98.0951
22	S-14	0.4357±0.2499	74.2804	42.6048
23	S-3	0.9915± 0.3827	169.0511	65.2493
24	S-18-01	1.0194±0.5657	173.8082	96.4540
25	S-18-02	0.7887±0.2877	134.4741	49.0476
26	S-18-03	0.8732±0.3729	148.8832	63.5855
27	S-18-04	1.1393±0.5453	194.2414	92.9720
28	NA-08-01	1.9530±0.3187	332.9839	54.3382
29	S-17-01	2.3737±0.5354	404.7017	91.2784
30	NA-14-01	2.1283± 0.6813	362.8657	116.1593
31	S-11-01	1.4272±0.4671	243.3331	79.6333
32	NA-23-01	0.9014±0.2125	153.6859	36.2257
33	NA-10-01	2.8043±0.3128	478.1301	53.3250
34	NA-27-01	2.8043± 0.3128	478.1301	53.3250
35	NA-05-01	0.7511± 0.3766	128.0688	64.2159
36	S-15-01	0.8075±0.1118	137.6756	19.0572
37	S-16-01	0.8799±0.2932	150.0275	49.9960
38	S-19-01	0.9014±0.1301	153.6840	22.1826
39	NA-24-01	0.8370±0.2271	142.7108	38.7260
40	S-7-01	0.8263± 0.1967	140.8795	33.5398
41	S-13-01	0.9229±0.2364	157.3443	40.3066
42	S-10-01	1.5774±0.2071	268.9446	35.3053

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الخلاصة

قد ظهرت حالات مختلفة من الإصابة بالسرطان في بعض المناطق من محافظة النجف وقد تعهدت بها العديد من الفرضيات. بما في ذلك وجود غاز الرادون في الهواء الموجود داخل المنازل, حيث يعتبر عاز الرادون من أوسع واهم المتغيرات المساهمة في التعرض للإشعاع الطبيعي في العالم. كما استخدمت تقنية كوب الرادون وهو عبارة عن حجرة اسطوانية بقطر 5سم وارتفاع 7سم بداخلها كاشف الأثر النووي من المادة الصلدة CR-39 , وتم قشط مادة الكاشف بمادة هيدروكسيد الصوديوم وبعياريه 6.25 N وبدرجة حرارة $70^{o}C$ وبزمن 12 ساعة.

تراوحت قيم تركيز الرادون مابين 74.2804 ± 42.6048 Bq/m^3 الى 478.1301 ± 53.325 Bq/m^3, حيث وجد إن معدل تركيز الرادون في محافظة النجف بحدود 183.682 Bq/m^3 وبانحراف معياري 104.231 Bq/m^3. كما إن ارتفاع معدلات الإصابة بالسرطان في بعض الأحياء من محافظة النجف يمكن أن يعزى إلى ارتفاع تبركيز غاز الرادون في هذه المناطق.