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INDOOR RADOON MEASURMENT IN HOSPITALS AND HEALTH CENTRE, IN THIQAR GOVERNORATE (IRAQ) BY USING LR115 TYPE II (SSNTD)

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ABSTRACT

Exposure to natural sources of radiation, especially Radon and its short-lived daughter products has become an important issue throughout the world because sustained exposure of humans to indoor radon may cause lung cancer. Therefore, indoor radon concentration levels have been measured inside 57 government hospitals and health centers in Thiqar Governorate south of Iraq by using LR115 type II nuclear track detector. The radon concentration ranges from 39.4 to 157.8 Bq. m^{-3} with an average value of 95.5 Bq. $m^{-3}$and annual effective dose received by the human lunges varies from 0.68 to 2.72 mSv/y with an average value of 1.65 mSv/y. The Results show higher indoor radon levels and radon effective dose especially in hospitals as compared to other locations.

KEYWORDS: Annual Effective Dose, Indoor Radon, LR115 Type II, The Hospitals, PAEC

INTRODUCTION

Radon (^{222}Rn) is a radioactive noble gas emitted by the decay of ^{226}Ra, an element of the ^{238}U decay series. Radon-222 decays into a series of other radioactive elements, ^{214}Po and ^{218}Po are the most significant, as they contribute to the majority of radiation dose when inhaled. Following a number of decay series, ^{218}Po transforms into ^{210}Po and it decays into stable ^{206}Pb. The ^{222}Rn and its decay products are reported as major causes of lung cancer [1]. Assessment of health effects due to exposure to ionizing radiation from natural sources requires knowledge of its distribution in the environment. The estimated global average annual dose of the population receiving natural radiation equals 2.4 mSv [2]. It is well established that the inhalation of radon (^{222}Rn) and mainly its radioactive decay products, contributes more than 50% of the total radiation dose to the world population from natural sources [3].

^{222}Rn is an alpha emitter that decays with a half-life of 3.8 days into a short-lived series of progeny. A certain fraction of radon progeny may attach to aerosol particles. By inhalation, these particles may be deposited in lungs thereby exposing sensitive tissues with alpha radiation. Consequently, it may lead to lung cancer and has been identified to be the second leading cause of lung cancer [4]. In the United States of America, radon alone is reported to be responsible for ~15,000-20,000 lung cancer deaths per year [5]. The risk is reported to be proportional to the radon level down to EPA's action level of 4 pCi l^{-1} and probably below this level [6]. Therefore, the present study, beside of measure indoor radon concentration, we have measure most of important that related to estimate a risks of inhalation of radon gas by the workers inside the hospitals and health centers. Potential alpha energy concentration (PAEC), equilibrium factor between radon and its daughter(F), and the annual effective dose considered important parameters.

METHODS

The method involved exposure of the film to the indoor environment for a known period of time, during which the alpha particles from radon and its daughters would leave tracks on the film. LR-115 type II solid state nuclear detectors (SSNTDs) were employed for measuring the radon concentration The detector films having a size of 1.5 cm x1.5 cm were fixed on glass slides and then these slides were mounted on the walls of different dwellings at a height of about 2m from the ground with there sensitive surface facing the air, in bare mode, taking due care that there was nothing to obstruct the detectors. After the exposure of detectors for 3 months these detectors were removed and etched in 2.5 NaOH for 2 h in a constant temperature bath (60 ± 1Co) and after a thorough washing they were scanned for track density measurements using optical microscope at a magnification of 400x. All α-particles that reach the LR- 115 type II SSNTDs with a residual energy between (1.6 - 4.7) MeV are registered as bright track holes. An unexposed film of the LR-115 was also etched and scanned for the determination of background track density of the film. This background track density was found very small and was subtracted from the observed value of the readings.

The Potential Alpha Energy Concentration (PAEC) was determined using the expression:

$$C_{p(WL)} = \frac{\rho}{k.t}$$

Where ρ is the track density (number of track per cm2) obtained after subtracting the background, k is the sensitivity factor or calibration factor preferably found by a calibration experiment and t is the total time of exposure. Sensitivity factor was found by simulating the environmental condition in the Environmental Assessment Division of Bhabha Atomic Research Center [7].

A sensitivity factor of 625 tracks/cm2 d per WL was used for evaluating the working level (WL) concentration of radon progeny. The radon concentrations in Bq/m3 were calculated by using the relation:

$$C_{Rn(Bq.m^{-3})} = \frac{3700*WL}{F}$$

Where F is the equilibrium factor The value of F was taken to be 0.4 as recommended by [2].

The annual exposure to potential alpha energy Ep (effective dose equivalent) is then related to the average radon concentration CRn by following expression [8].

$$E_{p(WLM.y^{-1})} = \frac{T*n*F*C_{Rn}}{170*3700}$$

T: Is the indoor occupancy time (24h*365=8760)

n: Is the indoor occupancy factor (0.8)

The effective dose received by the bronchial and pulmonary regions of human lungs has been calculated using a conversion factor of 3.88 mSv/WLM and assuming an occupancy factor of 0.8 [9].

RESULTS AND DISCUSSIONS

Table 1 gives a summary of the results of the track densities, indoor radon concentration levels, the annual effective dose rate and the annual dose equivalent rate measured in 57 hospitals and health centers in Thiqar Governorate south of Iraq " Figure 1" for the present study where the observation were taken from April to Jun 2014. The average number of tracks per unit area was taken from the mean of the individual number of tracks per unit area. Table 1 present the measurement made for PAEC values of radon daughters in WL units, radon concentration in Bq m^{-3}, and annual effective dose in mSv/y to the occupant of the hospitals and health centers in Thiqar (Iraq). The PAEC obtained values vary from 4.2 to 17.1 mWL with an average value of 10.32 mWL. The significant radon concentration ranges from 39.4 to 157.8 Bq. m^{-3} with an average value of 95.5 Bq. m^{-3} and annual effective dose received by the human lunges varies from 0.68 to 2.72 mSv/y with an average value of 1.65 mSv/y.

The Results show higher indoor radon levels and radon effective dose especially in hospitals as compared to other locations. This refers to the different building material and ventilation rate.

Table 1: Values of Indoor Radon Concentration in Hospitals and Health Centers in Thiqar

District	Hospitals & Health Centers	P (T. cm^{-2} d-1)	PAEC (mWl)	Radon Activity ($Bq.m^{-3}$)	Annual Exposure ($WLM. y^{-1}$)	Annual Effective Dose ($mSv.y^{-1}$)
Suq Al Shyouk	Suq Al Shyouk*	9.333±0.4	14.9±0.73	138.1±8.5	0.61±0.02	2.38±0.01
	Al Hadi	7.333±0.3	11.7±0.61	108.5±7.1	0.48±0.01	1.87±0.07
	Al Sadiq	5.333±0.2	8.5±0.41	78.9±5.4	0.35±0.01	1.36±0.06
	Al Hwraa	8.142±0.3	13.1±0.67	120.5±7.9	0.53±0.02	2.10±0.11
	Al Zahra	6.666±0.2	10.6±0.59	98.6±6.1	0.44±0.01	1.70±0.08
	Al Fadlia	6.293±0.3	10.1±0.55	93.1±6.2	0.41±0.02	1.60±0.06
	Al Tar	8.666±0.4	13.8±0.68	128.2±7.8	0.57±0.02	2.21±0.12
	Al Noor	6.666±0.3	10.6±0.52	98.6±6.3	0.44±0.01	1.70±0.07
	Al Gadeer	7.333±0.4	11.7±0.73	108.5±6.7	0.48±0.02	1.87±0.05
	Al Emam Ali	5.333±0.3	8.5±0.44	78.9±4.8	0.35±0.01	1.36±0.06
	Al Garma	4.284±0.2	6.8±0.37	63.4±3.9	0.28±0.01	1.10±0.06
Al Rifai	Al Rifai*	10.193±0.4	16.3±0.81	150.8±10.2	0.67±0.02	2.60±0.14
	Al Haqeem	8.384±0.3	13.4±0.76	124.1±7.6	0.55±0.02	2.14±0.13
	Sauid Al Shuhada	6.294±0.2	10.1±0.63	93.1±5.9	0.41±0.02	1.60±0.07
	Qalat Sukkar	7.194±0.3	11.5±0.71	106.5±6.9	0.47±0.02	1.83±0.09
	Al Fajer	9.118±0.4	14.5±0.77	134.9±7.3	0.60±0.03	2.33±0.11
	Al Zahra	3.333±0.1	5.3±0.31	49.3±3.2	0.22±0.01	0.85±0.02
	Al Naser	8.182±0.3	13.1±0.68	121.1±6.9	0.53±0.01	2.10±0.11
	Shalal	2.726±0.1	4.3±0.36	40.3±4.7	0.18±0.01	0.69±0.02
AL Chibayish	AL Chibayish*	6.666±0.3	10.6±0.67	98.6±5.7	0.44±0.02	1.70±0.08
	Al fouhod	4.666±0.2	7.4±0.41	69.1±4.8	0.31±0.01	1.19±0.06
	Al Asadi	6.182±0.4	9.8±0.52	91.5±4.1	0.41±0.01	1.57±0.07
	Al Asqari	5.333±0.2	8.5±0.49	78.9±3.8	0.35±0.02	1.36±0.06
	Al Eslah	4.182±0.2	6.7±0.38	61.9±5.2	0.27±0.01	1.06±0.04
	Al Emaira	2.666±0.1	4.2±0.27	39.4±2.9	0.17±0.01	0.68±0.03
	Al Baqer	2.666±0.1	4.2±0.23	39.4±3.1	0.17±0.01	0.68±0.04
	Al Hammar	4.666±0.3	7.4±0.41	69.1±5.1	0.31±0.02	1.19±0.09
Al Shatrah	Al Shatrah*	10.666±0.5	17.1±0.77	157.8±11.7	0.70±0.03	2.72±0.13
	Aqade	5.333±0.2	8.5±0.39	78.9±4.1	0.35±0.01	1.36±0.08
	Al Aroba	4.172±0.3	6.7±0.25	61.7±3.5	0.27±0.01	1.06±0.05
	Al Qalisa	8.263±0.4	13.2±0.81	122.3±8.9	0.54±0.02	2.11±0.11
	Al Moalimin	9.333±0.3	14.9±0.89	138.1±9.3	0.61±0.03	2.38±0.13
	Al Ftahia	4.666±0.2	7.4±0.42	69.1±4.1	0.31±0.01	1.19±0.09
	Al Gharraf	9.333±0.3	14.9±0.69	138.1±8.2	0.61±0.02	2.38±0.12
	Al Dawaia	4.666±0.2	7.4±0.37	69.1±4.3	0.31±0.01	1.19±0.07
	Said Dikhil	2.726±0.1	4.3±0.22	40.3±3.3	0.18±0.01	0.69±0.03

	Al Qudis	4.666±0.3	7.4±0.31	69.1±3.8	0.31±0.01	1.19±0.06
Al Nasiriya	Al Hussain*	7.982±0.4	12.7±0.68	118.1±9.3	0.52±0.02	2.03±0.11
	Al Razei	6.162±0.3	9.86±0.42	91.2±7.2	0.41±0.02	1.57±0.08
	Am Al Banin	4.152±0.2	6.6±0.37	61.4±4.5	0.27±0.01	1.06±0.05
	Al Sader	5.333±0.2	8.5±0.45	78.9±5.1	0.35±0.01	1.36±0.06
	Al Mahdi	8.666±0.4	13.8±0.79	128.2±9.3	0.57±0.02	2.21±0.12
	Areido	6.182±0.3	9.9±0.41	91.5±7.5	0.41±0.02	1.57±0.07
	Somer	3.333±0.1	5.3±0.32	49.3±3.9	0.22±0.01	0.85±0.05
	Al Habobi*	6.666±0.3	10.6±0.63	98.6±6.5	0.44±0.01	1.70±0.07
	Al bashear	9.333±0.3	14.9±0.71	138.1±8.3	0.61±0.03	2.38±0.11
	Al Bateha	7.333±0.2	11.7±0.69	108.5±8.9	0.48±0.02	1.87±0.07
	Al Krrar	5.333±0.2	8.5±0.57	78.9±4.2	0.35±0.01	1.36±0.06
	Dental Center*	7.333±0.3	11.7±0.66	108.5±8.1	0.48±0.02	1.87±0.06
	Al Rasool	6.666±0.2	10.6±0.61	98.6±7.8	0.44±0.01	1.70±0.08
	Al Mansoria	8.666±0.4	13.8±0.73	128.2±9.1	0.57±0.02	2.21±0.13
	Abed Al Rida	6.183±0.2	9.9±0.42	91.5±7.1	0.41±0.02	1.58±0.07
	Bent Al Huda*	8.666±0.4	13.8±0.78	128.2±10.2	0.57±0.03	2.21±0.11
	Al Ridah	4.152±0.2	6.6±0.37	61.4±4.5	0.27±0.01	1.06±0.05
	Al Nasiriya	8.666±0.5	13.8±0.81	128.2±9.9	0.57±0.02	2.21±0.12
	Al Hasen	9.333±0.6	14.9±0.88	138.1±11.1	0.61±0.03	2.38±0.11
	Al Beqa	7.938±0.3	12.7±0.71	117.4±10.3	0.52±0.02	2.02±0.11

*Hospitals in districts

CONCLUSIONS

The calculated of radon levels in running Hospital and Health Centre having maximum values in hospitals. In present work most of the radiation dose are not higher than the world wide average back ground dose of 2.4 mSv/yr [2] and hence they does not pose any serious threat to the occupants.

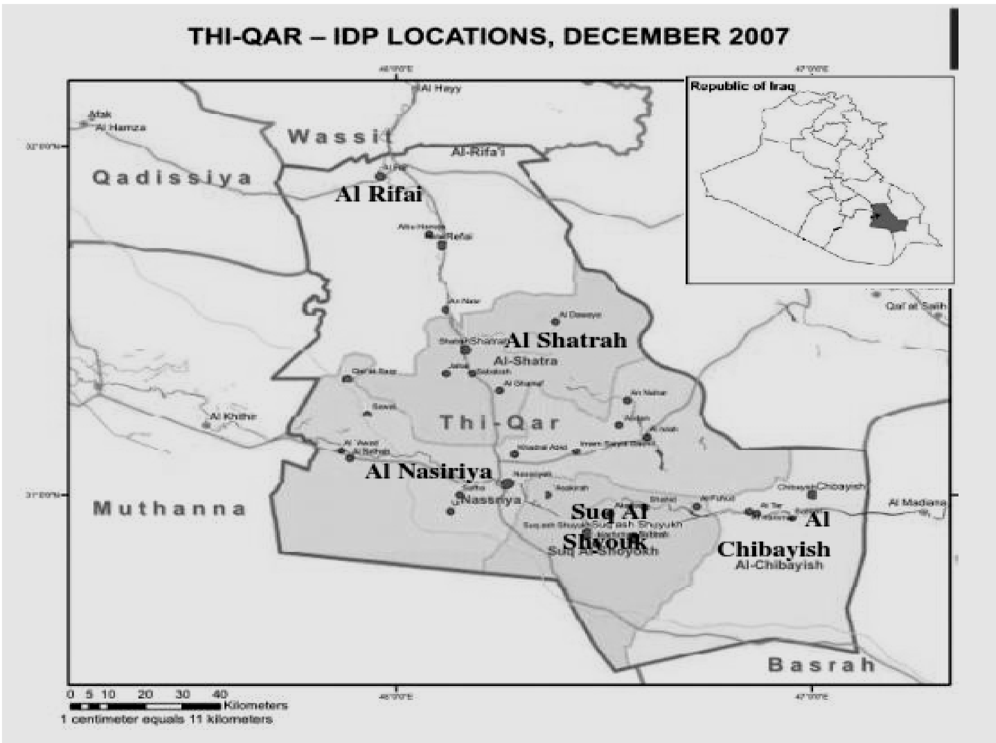

Figure 1: Thiqar Governorate Map

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