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Seasonal variation of indoor radon levels in public hospitals of Iraqi Kurdistan region

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ABSTRACT

Indoor radon levels were measured in four seasons throughout 2013 in public hospitals for Iraqi Kurdistan, using a passive technique CR-39 nuclear track detectors. Thus, the highest and lowest values of rate indoor radon were in winter (105.3 ± 17.20 Bq/m^3) and summer (39.92 ± 8.28 Bq/m^3) season, respectively. This different value depended for ventilation rate, building material and geological formation. According to the estimation risk factor, the radon induced lung cancer risks for public hospitals in selected locations was varied from 2.7 ± 0.08 to 11.16 ± 1.94 per million people. The highest and lowest values of annual effective dose were recorded in winter and summer seasons, respectively.

Introduction

Radon isotopes (^{219}Rn, ^{220}Rn, ^{222}Rn) occur in the environment, being produced in the natural decay chains of (^{235}U, ^{232}Th, ^{238}U), respectively, all decaying by alpha emission [1].The alpha particles emitted from indoor radon and its daughter products are highly effective in damaging the tissue and are considered to be a causative agent for leukemia and cancers of the lung, kidney and prostate in human beings [2].Indoor radon levels are known to vary from work pleas to work pleas which in turn depend on radon source, building characteristics, natural daily cycle other longer temporal and spatial cycles, related to occupancy, geological and meteorological factors, dwelling characteristics and habits of the occupants [3,4].Therefore, in order to determine annual average from the indoor radon levels, measured for a less than a year, seasonal correction factor has to be applied because seasonal correction factor takes into account the average seasonal variations of radon concentration. Even after applying seasonal correction factor, some uncertainty is expected to be introduced when using measurement periods shorter than one year [5,6].In general, residential radon is regulated by an action level of radon concentration between 200 and 300 Bq/m^3 based on ICRP recommendations[7]. In the present study, beside of measure indoor radon concentration in four seasons, we have measure most of important that related to estimate a risks of inhalation of radon gas by the workers inside the hospitals.

Materials and Methods

Iraqi Kurdistan consist of three main governors; Erbil, Duhok and Sulaymaniya. These areas are different from each other geographical location is shown in Figure1. Passive radon dosimeter geometry is a closed-opened chamber into which radon diffuses, and it has been calibrated by Ismail and Jaafar [8]. Plastic chambers of 7 cm length and 6 cm diameter, equipped with CR-39NTDs. The technique used in this survey is based on CR-39NTDs, it has an area of 1.5×1.5 cm^2, which is fixed by double-stick tape at the bottom of the dosimeter shown in Figure 2. On the cover there is a hole covered with a 5-mm thick soft sponge. The design of the chamber ensures that all aerosols and radon decay products are deposited on the soft sponge from the outside and that only radon gas. The design of the chamber ensures that the aerosol particles and radon decay products are deposited on the sponge from outside and only radon, among other gases, diffuses through it to the sensitive volume of the chamber. The dosimeters were distributed inside 8 public hospitals of Iraqi Kurdistan. After each season (90 day) of exposure, exposed detectors etched in 6N NaOH at 70 ◦C for 10 h. The counting of alpha damage tracks was done using an optical microscope with a magnification of 400X was used.

Figure 1: Sketch map of the area under study (Kurdistan Region)

Figure 2: Exposed plastic chamber containing

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Table 1. Concentrations of indoor radon per season for each governorate of Iraqi Kurdistan.

Governorates	Hospitals	Radon concentration (Bq /m^3)			
		Winter	Summer	Autumn	Spring
Erbil	Rizgary	96.50±9.34	34.03±3.32	80.52±5.46	54.04±6.08
	Emergency west	86.45±9.16	30.15±2.83	69.54±4.97	52.3±4.39
	Erbil Teaching	82.13±10.05	31.346±2.77	73.07±4.55	48.02±3.77
	Maternity and Teaching	106.24±10.04	36.9±3.12	85.42±5.60	60.38±6.34
Duhok	Azadi Teaching	113.05±10.72	43.12±2.89	98.80±5.50	65.36±5.07
	Emergency	102.68±8.87	41.78±2.27	80.006±8.94	59.05±4.49
Sulaymaniya	Shahid Dr. Aso	131.73±9.40	52.89±3.52	106.92±4.63	67.56±4.05
	Shorsh General	123.62±7.23	49.2±2.22	110.08±4.86	71.09±4.3

Table 2. Summary of the measurement annual effective dose and lung cancer per year/10^{-6} person

G	Hospital	Effective dose (mSv/y)				Lung cancer/10^{-6} Person			
		Wi	Sp	Su	Au	Wi	Sp	Su	Au
Er	Rizgary	0.43± 0.01	0.24± 0.07	0.18± 0.03	0.35± 0.02	7.74± 1.34	4.32± 1.04	3.24± 0.12	6.3± 1.06
	Emergency west	0.39± 0.08	0.23± 0.03	0.15± 0.06	0.31± 0.01	7.02± 1.26	4.14± 1.02	2.7± 0.08	5.58± 1.02
	Erbil Teaching	0.37± 0.05	0.21± 0.08	0.17± 0.02	0.33± 0.08	6.66± 1.15	3.78± 0.96	3.06± 0.44	5.94± 1.08
	Maternity and Teaching	0.49± 0.06	0.28± 0.09	0.23± 0.07	0.39± 0.03	8.82± 1.84	5.04± 0.86	4.14± 0.14	7.02± 1.04
Du	Azadi Teaching	0.52± 0.09	0.30± 0.05	0.24± 0.05	0.46± 0.04	9.36± 1.92	5.40± 0.54	4.32± 0.42	8.28± 1.12
	Emergency	0.48± 0.02	0.27± 0.01	0.22± 0.08	0.37± 0.05	8.64± 16.47	4.86± 0.48	3.96± 0.28	6.66± 1.14
Su	Shahid Dr. Aso	0.62± 0.04	0.31± 0.06	0.26± 0.09	0.49± 0.06	11.16± 1.94	5.58± 0.65	4.91± 0.16	8.82± 1.18
	Shorsh General	0.59± 0.03	0.33± 0.04	0.27± 0.02	0.53± 0.01	10.62± 1.88	5.94± 0.52	4.86± 0.18	9.54± 1.16

G= Governorates; Er= Erbil; Du= Duhok; Su= Sulaymaniya; Wi= Winter; Sp= Spring; Su= Summer; Au= Autumn

Results and Discussion

The average value of indoor radon concentration in public hospitals for Iraqi Kurdistan in the four seasons summarized in Table 1. Analysing of data shows that the highest and lowest average radon concentration was in the winter season for Shahid Dr. Aso hospital (131.73 ± 9.4 Bq/m^3) and summer season for Emergency west hospital (30.15±2.83Bq/m^3), respectively, as shown in Figure 3. This difference depended for geological formation, type building and ventilation rate. The rate of indoor radon gas inside Iraqi Kurdistan hospitals was less than the accepted level of IAEA level 148 Bq/m^3 [9].

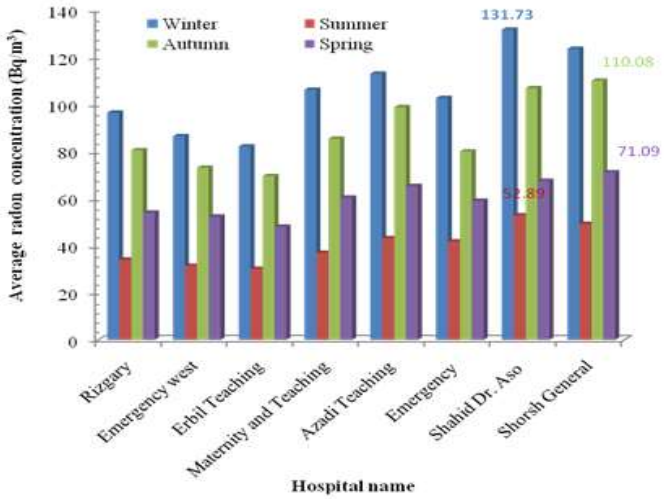

Figure 3: Measurements of average radon concentration inside public hospitals within four seasons

The influence of season variation in the measurement of indoor radon depends rate of air movement. Thus, range of the ratio of the measurements within winter season was 2.457 to 2.867 times of its measurements within summer season, as shown in Figure 4. On the other hand, the second highest ratio of the measurements of indoor radon found within autumn season, its range was 1.914 to 2.366 times than its range within summer season. Lastly, within spring season, the measurements were between 1.277 to 1.734 times than its measurements within summer season. Radon has long been considered as a main reason of lung cancer and it was identified as a natural source due to human lung carcinogen. Thus, annual effective dose and its risk of lung cancer has been evaluated per million person per year (CPPP) within the seasons (winter, spring, summer, and autumn), and the results summarized in Table 2.

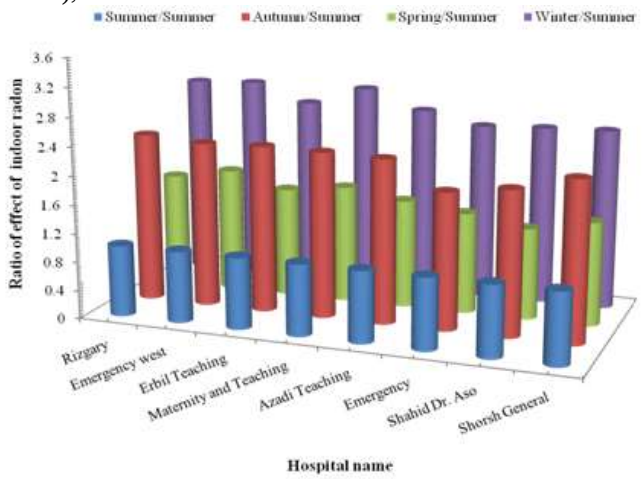

Figure 4: Ratio effects for indoor radon concentration per summer season for each season

According to the estimation risk factor, the radon-induced lung cancer risks for public hospitals in selected locations were variable from 2.7 ± 0.08 to 11.16 ± 1.94 per million people, as mentioned in the above table.

Conclusion

The seasonal exposure dose of indoor radon gas has assessed for the seasons of winter, spring, summer, and autumn using CR-39 nuclear track detectors (NTDs) for the public hospitals of Iraqi Kurdistan. It was found that the high and low concentration of average indoor radon gas was given in winter and summer season, respectively, and this referred to low and high rate of ventilation. Thus, range of the ratio of the measurements within winter season was 2.457 to 2.867 times of its measurements within summer season. Thus, annual effective dose and its risk of lung cancer has been evaluated per million person per year (CPPP) within the four seasons.

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