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Letter to the Editor

Indoor Radon Levels in Selected Houses in Isfahan, Central Iran

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Dear Editor in Chief

The highest concentration of radon (^{222}Rn) and thoron (^{220}Rn) in indoor environment is a major health hazard for man (1) as a result many researchers (2–4) are interested to estimate indoor radon concentration in many countries. In this study, a survey of radon and its daughters has been done to provide data on the hourly, daily and seasonal average indoor radon in Isfahan city dwellings and to estimate the effective dose to the general public.

The overall average radon concentration in the surveyed area was 73.32 Bqm^{-3}. All of the season was having a concentration of radon less than the action level (200Bqm^{-3}) as recommended by the International Commission on Radiation Protection (ICRP) (5) and the activity level of 400 Bqm^{-3} given by the Turkish Atomic Energy Commission. The annual effective dose (ERn, mSv) due to the indoor radon and its progeny was calculated as $E_R = C_R \,.\, F.8762.5\ hy^{-1}.O.D.10^{-6}$ (6), where C_R is the indoor radon concentration (Bqm^{-3}), F the equilibrium equivalent concentration factor which is 0.4 for inhabitants, O the indoor occupancy factor which is 0.8 showing that 80% of time is spent indoors and D the dose conversion factor which equal 9 nSv h^{-1} per Bqm^{-3}(4). The radon content of air in the lungs has been calculated by assuming the air volume in the lungs to be 3.2×10^{-3} m^3 for the 'Reference Man' and assuming further that the short-lived decay products will stay in the lungs, the dose rate due to alpha radiation was determined as $\dot{D}_{lung}(nGyh^{-1}) = 0.04C_R(Bqm^{-3})$. The effective dose equivalent rate was calculated by taking a quality factor of 20 for alpha-radiation and applying a weighting factor of 0.12 and 0.88 for the lungs other tissues, respectively, by $\dot{H}_{eff}(nSvh^{-1}) = 0.18\ C_R(Bqm^{-3})$. Equilibrium-equivalent radon concentration (EECRn) using the following equation was used to more express the indoor radon concentration, $EEC_{Rn}=FC_R$, where F is the equilibrium factor (= 0.45) and C_R is the measured indoor radon activity. The equivalent dose received by bronchial pulmonary regions of human lungs has been calculated using a conversion factor 1.0×10^{-5} mSv/Bq h m^3 (7). An average value of the equilibrium-equivalent radon concentration (EEC_{Rn}) and the annual effective dose were calculated for each season and hours. All the results were listed in Table 1 and it shows also a variation of dose relationship from indoor radon measurements from dwellings in Isfahan area. Radon has been classified as a known human carcinogen and after cigarette smoking is a second reason which cause of lung cancer (8). The number of lung cancer deaths which may be attributed to the indoor radon exposure, were determined by $N_{r,a} = (ERR_{r,a} x N_a)/(1 + ERR_{r,a})$, where Nr,a is the number of deaths due to indoor radon expo-

sure at age a, ERRr,a is the excess relative risk for age a and radon exposure r, Na is the total number of lung cancer deaths at age a. In this study, the excess relative risk function uses of BEIR VI age concentration model (9) which at low dose rates the excess relative risk of attaining age a is $ERR_{r,a} = \beta(w_{5-14} + 0.78_{w15-24} + 0.51_{w25+})$, where β is the exposure-response function ranging from 6.0 ×10-3 for ages less than or equal to 55y and 5.4 × 10-4 for ages greater than 75y. The value of the β in this research was considered to be 6.0 × 10-3. The values of w5–14, w15 – 24 and, w25+ are the cumulative exposure incurred 5–14 y, 15–24 y and at least 25 y before the attained age, respectively. Fifty seven lung cancer deaths were reported in the year 2012 in Isfahan city.

Table 1: Variation of dose relationship from indoor radon measurements for dwellings in Isfahan

	6AM	12AM	6PM	12PM
		$\dot{D}_{lung}(nGyh^{-1})$		
Spring	3.59	3.72	3.72	4.17
Summer	0.93	1.12	1.12	1.33
Autumn	3.09	3.13	3.13	3.4
Winter	4.03	3.92	3.92	4.25
		$\dot{H}_{eff}(nSvh^{-1})$		
Spring	16.15	16.75	16.75	18.76
Summer	4.2	5.05	5.05	6.02
Autumn	13.91	14.09	14.09	15.31
Winter	18.14	17.63	17.63	19.16
		EEC_{Rn}		
Spring	40.37	41.88	41.88	46.89
Summer	10.51	12.63	12.63	15.04
Autumn	34.78	35.24	35.24	38.29
Winter	45.35	44.08	44.08	47.9

Using this reported value of lung cancer death and 73.32 Bqm-3 (which is 0.45 WLM) as the geometric mean value of indoor radon concentration in the whole Isfahan city, the number of lung cancer deaths may be attributed to indoor radon exposure at age 60 yr was estimated to be about 4. Then according to this model, about 8% of lung cancer deaths in the Isfahan city are related to the indoor radon exposure.

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