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Research paper

Measurement of radon concentration in Iraqi construction workers and painter's blood samples using CR-39 passive detectors

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Abstract

Radon concentration was estimated in 44 blood samples collected from Iraqi construction workers and painters using CR-39 passive detectors. Twenty-nine of them are non-smokers and the rest are heavy smokers. The result showed that the radon concentrations in the blood samples for construction workers were ranged between 9.201 and 126.763 Bq.m-3 with an average value of 45.987 Bq.m-3. Whilst, the radon concentrations in the blood samples for painters were ranged between 2.385 and 90.983 Bq.m-3 with an average value of 43.664 Bq.m-3. The uranium concentrations in the blood samples for construction workers and painters were ranged between (0.282-3.883) ppb with average value of 1.409 ppb, and between (0.073-2.787) ppb with average value of 1.338 ppb, respectively. The results also showed that the uranium concentration increase with age. On the other side, the average concentrations of uranium in the blood samples for smoker workers is higher than that for non-smoker workers, which conclude that smoking can cause an increase of uranium in the smoker's blood. All the results revealed that the uranium concentration in the study blood samples were lower than the global permitted value reported by UNSCEAR (1993) and WHO (2001).

Keywords: *Blood; CR-39; Radon; Uranium.*

1. Introduction

The effect of radioactive materials on lymphocytes cells and platelets is rapid. The alteration of b1ood composition in the human body can cause Anemia, Fatigue, and Susceptibi1ity to infection, b1eeding or leukemia [1]. People can be exposed to ionizing radiation from natural and man-made sources of ionizing radiation exterior the body. Uptake of radioactive materials can occur through inhalation, ingestion, and skin contact. When radioactive materials enter the human body will go into the blood which in turn carries them throughout the body. Most of it leaves in the urine in a few days, but a little stay in the kidney and bones. Uranium is regarded as one of the very important primordial radioisotopes in the earth crust. It is everywhere around us, exists in rocks, soils, water, air, plants, animals, and in all human beings.

Typically, the human body contains around 90 µg of uranium from regular admission of food, water and air, which is distributed as around 66% in skeleton, 16% in the liver, 8% in the kidneys and 10% in different tissues of the body. Al-Gailani [2], has assessed the average yearly admission of uranium by adults from ingestion and inhalation was around 460 µg.

Many constructing items, such as granite, brick, marble and other materials, have naturally-occurring uranium, thorium and their radioactive decay products. The quantity of radioactivity in constructing materials depends on the sort of constructing item, however the amount of released radiation from those substances is usually very low [3].

In the present work, the estimation of the normal radioactivity and evaluation of hazard of Iraqi construction workers and painters' exposure from ordinarily utilized building materials was considered. The information on the measure of radioisotopes content in their blood and the radiological risks evaluated by the radiological indices related with them will, consequently, fill in as the essential guidelines for the utilization of these materials.

2. Material and method

An amount of 10 milliliters of venous blood of 22 construction workers and 22 painters who were supposed to be exposed to pollutants were taken into sterile blood tubes containing EDTA anticoagulant. Then, the blood samples were transferred under refrigerated conditions to the laboratory within an hour of sampling. At the lab, the samples were centrifuged at 3000 rpm for 10 minutes. Subsequently, 5 mL of the filtered blood plasma samples were put in sterilized 10 mL plastic tubes. A piece of 1.5 cm^2 CR-39 plastic detector was immersed in each plasma sample and left for 2 months. Alpha particles emitted from radon gas, which is one of the uranium-238 progenies, can be recorded by CR-39 detectors [4], [5]. After the exposure period, the detectors were removed from the plasma and washed several

times with plain water and distilled water. Later the CR-39 pieces were treated in caustic soda for chemical etching conditions 6.25 N at 70 °C for 4 h for CR-39 detectors. After the chemical etching, the counting of alpha particle tracks was carried out by examining CR-39 detectors using optical microscope (power 400×).
The radon concentration of dust samples was then measured using the following relationship (1): [6], [7]:

$$C_{Rn}\ (Bq.m^{-3}) = \frac{\text{track density}(Tr.cm^{-2})}{\text{Calibration factor}\times\text{Exposure time(days)}} = \frac{1}{k}\left(\frac{\rho}{T}\right) \quad (1)$$

k was theoretically calculated by the following formula [8]:

$$k = \frac{R}{4}\left[2\cos\theta_c(CR-39\ \text{critical angle}) - \frac{R(\text{radius of the container})}{R_\alpha(\text{range of }\alpha-\text{particle})}\right] \quad (2)$$

Where, $\theta_c = 35^o$ and $R_\alpha = 4.15$ cm.
The calculation of the effective radium content (C_{Ra} ($Bq.kg^{-1}$)) was achieved by taking into consideration the mass (M_s) of the sample, the surface area (A_s) of the sample placed in the sealed cup and the distance (h) between the sample surface and the detector surface, using equation (3) [9-11]:

$$C_{Ra}(Bq.kg^{-1}) = \frac{\rho}{kT}\left(\frac{hA_s}{M_s}\right) = C_{Rn}\left(\frac{hA_s}{M_s}\right) \quad (3)$$

Equation (4) was used to estimate uranium concentrations [12]:

$$U_C(ppb) = \frac{W_U}{W_S} \quad (4)$$

Where, W_U is the weight of uranium in the sample and $W_S = 25$ gm (weight of the sample).

3. Results and discussion

In this research, 44 blood samples taken from 22 construction workers and 22 painters. Uranium concentration (ppb) in the blood samples were measured using solid state plastic detector CR-39 and presented in Table 1. Its average value were 1.338 and 1.409 ppb for painters and constructor workers respectively. The highest uranium concentrations were 2.787 ppb for a smoker painter age 57 year old and 3.883 ppb for a smoker construction worker age 33 year old. Certainly, artificial activities and constructions can be a possible source or increased levels of exposing to radon and progeny. Various researches and reports demonstrate the high radon concentration in working places [13]. Uranium concentrations in all study blood samples were below the permissible limit (3 ppb) given by UNSCEAR [14] and WHO [15].
Figures 1 and 2 show the average uranium concentrations in the construction workers and painters blood samples as a function of the age group, respectively. The results reveal that the average uranium concentrations increase as the age of the workers increases which elucidates a considerable accumulation of uranium with age; this results are comparable with the predictions of ICRP uranium model [16] under circumstances of continuous amount of intake of uranium.
Table 2 shows the average uranium concentrations for the investigated blood samples for smokers and non-smokers workers. The results show that the average uranium concentration for smokers is higher than that for the non-smoker workers. This indicates the possibility of getting higher uranium levels in smokers rather than non-smokers people because the uranium content in tobacco gets in the human body out of smoking, which in turn it carried to all organs of the body through bloodstream. Many researches show that uranium concentration and other radioactive elements are higher in many biological samples of smokers rather than in non-smokers such as teeth, blood, hair and urine [17], [18].

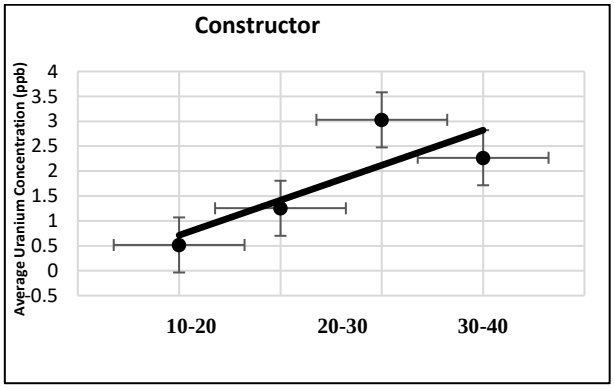

Fig. 1: Average Uranium Concentration in the Constructor's Blood Samples as a Function of Age Group.

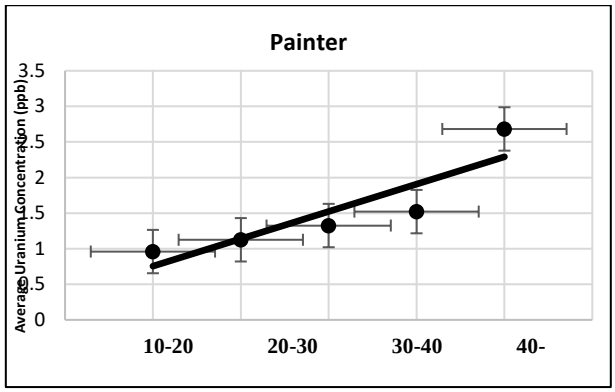

Fig. 2: Average Uranium Concentration in the Painter's Blood Samples as a Function of Age Group.

Table 1: Uranium Concentration in Blood (Ppb) Samples Taken from 22 Painters and 22 Constructing Workers

Painters			Constructors		
Age (yr)	C_{Rn} Bq/m^3	U concentration C(ppb)	Age (yr)	C_{Rn} Bq/m^3	U concentration C(ppb)
25	67.130	2.056	32	84.168	2.578
28	62.019	1.900	31	75.649	2.317
37	51.796	1.587	18	21.127	0.647
42	89.280	2.735	16	12.608	0.386
33	53.500	1.639	27	63.722	1.952
19	31.350	0.960	33	60.315	1.848
22	5.793	0.177	38	63.722	1.952
27	31.350	0.960	41	80.761	2.474
55	84.168	2.578	26	22.831	0.699
57	90.983	2.787	33	126.763	3.883
42	46.684	1.430	22	24.535	0.752
26	41.573	1.273	25	63.722	1.952
45	75.649	2.317	43	79.057	2.422
31	51.796	1.587	17	29.646	0.908
21	58.611	1.795	23	33.054	1.013
27	24.535	0.752	29	44.981	1.378
47	34.758	1.065	25	67.130	2.056
31	16.016	0.491	41	10.904	0.334
27	12.608	0.386	18	14.312	0.438
22	2.385	0.073	15	9.201	0.282
21	19.423	0.595	25	10.904	0.334
45	9.201	0.282	28	12.608	0.386
Average	43.664	1.338	Average	45.9872	1.409
Min	2.385	0.073	Min	9.201	0.282
Max	90.983	2.787	Max	126.7631	3.883

Table 2: Average Uranium Concentration (Ppb) for the Blood Samples of Smokers and Non-Smokers Workers

Age group (yrs.)	painter		Constructor	
	S	NS	S	NS
10-20	----	0.960	0.673	0.438
20-30	1.447	0.823	1.404	1.102
30-40	1.039	1.613	3.883	2.174
40-50	1.300	1.743	2.088	2.448
50-60	2.787	2.578	-----	-----
Average	1.643	1.540	2.012	1.541

4. Conclusion

The results of the 44 investigated human blood samples taken from painting and construction workers indicate that the average uranium concentrations were 1.338 ppb and 1.409 ppb, respectively. The results reveal that the average uranium concentrations increase as the age of the workers increases which elucidates a considerable accumulation of uranium with age. The results also show that the average uranium concentration in blood samples of smokers was higher than that for non-smoker workers, which can get in blood stream through smoking. The uranium concentration values were lower than the permissible world value reported by WHO and UNSCEAR.

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