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Appreciation Excess Lifetime Cancer Riskin Qadissiya Governorate of Iraq

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Abstract

In this study, 20 sites were modeled for the purpose samplesof studying the activity concentrations of naturally occurring ^{40}K, ^{238}U, and ^{232}Th radionuclides andits effect on the population of the selected areas within the study area.Theprobability cancer risk is the main objectiveof the studyabsorbed gamma dose rate (D_R), annual effective dose, gamma annual gonadal dose (AGDE). The activity concentration ^{238}U, ^{232}Th and ^{40}K radionuclides are within the ranges 0.19±0.07Bqkg^{-1} to 30.52±0.91Bqkg^{-1}, 0.34±0.03 Bqkg^{-1} to 32.45±0.83Bqkg^{-1}, and 374±3.69 Bqkg^{-1} to 211±2.77Bq/kg respectively in the area of study,The correlations between both the probability of cancer with ^{238}U equalto (0.3724) it means that the relationship of Uranium to cancer is weak but with ^{232}Th and ^{40}K, annual effective dose in air, γ-radiation index, radiation greater than this positive correlation in study area. Correlation between annual gonadal dose and absorbed gamma dose rate RA(nGyh^{-1}) outdoorAGDE and ADRA (nGyh^{-1})intdoor, indicating that most areas of study pose a clear risk to individuals in these areas.

Keywords: Excess lifetime cancer risk; Radioactivity; Annual gonadal dose

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Introduction

The importance of soil, in general, is the fact that it represents the importance and main center of the various organisms, microorganisms, plants, and many animals, and the soil is the first and main component in the production of food essential for human life wherever it exists. Any negative impact or pollution affects the soil directly all the living things that are connected to them and to the human who lives on them [1]. Radiation pollution is pollution with global impact. Since ancient times, humans have been subjected to natural radiation from cosmic rays, and other radioactive materials found in the earth's crust since its origin if they are composed of radioactive neutrons. The particles of alpha, beta and gamma will be dissolved to the human body through food [2].

Natural radionuclides foundinair, soil, water and building materials are the main source of radiation background nature three important isotopes are uranium, thorium and potassium, Uranium heavy and radiant metal dissolves by emitting alpha particles (α) with a constant dissolution of 1.5x10^{-10} each year and with a radioactive activity of 12.4x10^{3} Bq/kg and its density at 25℃ (19.05 g/cm^{3}) Characteristics: silver white, Toxic, melting point (1132 C). Uranium is found in various amounts in nature in rocks, soil, water, air, plants, animals, human body and elsewhere. The concentration of uranium depends on the soil type and then on the type of rock forming the soil [3].

Uranium was originally found in two groups of rocks that have long existed in addition to groundwater and fractures in the soil. The first group is granite rocks and contains about 4 gm/ton. In this group, the liquid magma comes from the underground with uranium. In this case, we get rich raw materials with a high percentage of uranium (5%). The second group is deposits accumulated on the mountainous masses. In general, uranium is found as a byproduct in some other materials, such as phosphates and gold ores, as in South Africa, and sometimes uranium is accompanied by coal ores [4]. The highest concentration of uranium is in acidic volcanic rocks, but its concentration in igneous rocks depends on the abundance of silicates. The rocks that contain silicates have high concentrations of uranium. It accounts for about 99.27% of the total natural uranium, about 0.72%, about 0.0055%, and uranium isotopes of half-life, the half-life of uranium is around 4.5 billion years, uranium about 700 million years, uranium, (About 250,000 years). It is believed that much of the heat of the Earth's surface is produced by uranium radiation There have been several important exploratory studies that examined the radiation background in the soil for the three natural radionuclides that emit gamma doses measuriment soil radiation contentis important in appreciation the risks resulting from it, such as anemia, leukaemia, cancer, hepatic skin andmental retardation affects children whose mothers have been exposed to this radiation during pregnancy [5]. Approximately 4.7 annual effective doses received by persons as recognized UNSCEAR 2016 other human health damage caused by exposure to uranium is the genetic effects of reproductive cell damage, which leads to genetic mutation[6].

Materials and methods

Study area

The governorate of Diwaniyah is locatedin the center-south of

the, between the province s of Muthanna and Najaf the surface area of (8.507) km^2, between 31° 51′ 0″ N latitude and of longitude 45° 3′ 0″ E (Figure 1). The soil of the province is a movable soil formed by the sediments transported by the Euphrates River during the floods that covered the area in the previous eras characterized by a lack of organic matter, high salinity and high levels of ground water in it The soil is classified as riverbeds, river bed soil, sand dunes covers the eastern and eastern parts of the governorate, including Afak district, and bottom sediments which are a shallow area buried in the sands forming the northwestern part of the governorate. Another natural feature is the western plateau, which covers a small area about 132 km^2 of the province and forms the southwestern part of the Shinafiyah area [7].

Sample preparation

Twenty sites were selected from the Diwaniyah governorate for the purpose of studying their radioactivity locations at a depth of 15 cm, about 1.00 kg were neatly packed in well-labelled polyethylene bags properly sealed and transported to the radiation laboratorythat were sifted and removed the impurities and then dried samples and stored for 30 days before counting to allow secular equilibrium to be attained between ^{222}Rn and its parent ^{226}Ra in uranium chain before measurement using a gamma spectrometry system.

Samples Analysis

Usined γ-ray spectrometer Iodide Sodium activated by Thallium NaI (TI) of (3"×3") crystal dimension, supplied by (Alpha Spectra, Inc 12I12/3), coupled with a multi-channel analyzer (MCA) ORTEC-Digi Base with range of 4096 channel joined with ADC (Analog to Digital Convertor) unit, through interface, the spectral data was converted directly to the PC of the laboratory introduced using (Maestro-32) software. Measurements were made tocheck the background level ofradioactivity in the laboratory the γ-ray photo peaks corresponding to 11747 kev of ^{40}K, 203kev for ^{238}U and 62kev of ^{232}Th. The calibration of the detector enables us to find the linear relationship between the pulse coming out of the detector and the gamma energy falling on the crystallization of the detector. The relationship between the channel number in the multichannel analyzer and the spectral line energy of the studied isotopes. The MCDconsists mainly of memory with storage locations equal to the number of MCD channels where the pulses are stored in these channels according to the energy of each pulse.

Evaluted of radiation hazards parameters

Estimating the risk factor for cancer due to exposure to radiation

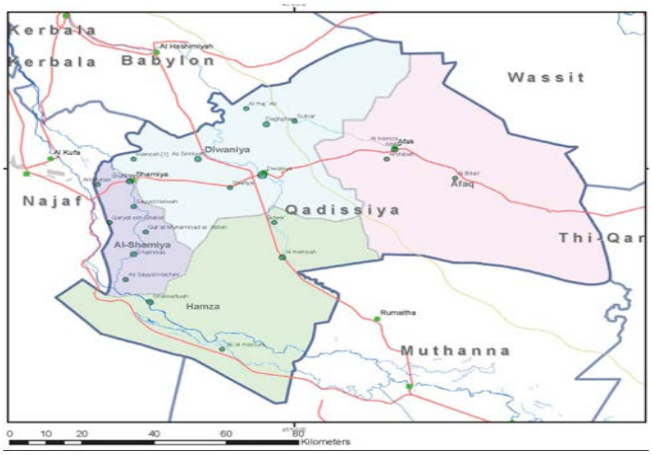

Figure 1: Map showing the study area.

was an important issue that was appreciated by several international organizations such as International Commission on Radiological Protection (ICRP1995) [8], and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1977, 1988, 1994, and 2000) [6]. The absorbed dose in the air is ADRA and measured at a distance of one meter from the surface of the ground containing the naturally occurring radionuclide depending on the concentrations of natural radionuclides in the soil, calculated byequation [9]:

$$A = C_{net} / (\varepsilon . I\gamma m . t) \pm \sqrt{(C_{net})} / (\varepsilon . I\gamma m . t) \quad (1)$$

C_{net} the net count, ε efficiency of detector, t: time for spectrum, m:weigh of the samples in kg. Iγ the transition probability of the emitted gamma ray. The outdoor absorbed dose rate also evaluted by[10]:

$$ADRA(nGyh^{-1}) = 0.642A + 0.604A + 0.0417A < 80nGyh^{-1} \quad (2)$$

The annual effective dose rate defined by equstion [11]:

$$AEDE = (0.49A_U + 0.76\ A_{Ih} + 0.048\ A_K) \times 8.76 \times 10^{-3} \quad (3)$$

Assuming that human about 20 of his time out calculated formulas as [12]:

$$AEDE\ (outdoor)\ (\mu Sv/yr) = AEDR(nGy/h) \times 8760h \times 0.7Sv/Gy \times 0.2 \times 10^{-3} \quad (4)$$

$$AEDE\ (indoor)\ (\mu Sv/yr) = AEDR\ (nGy/h) \times 8760h \times 0.7Sv/Gy \times 0.8 \times 10^{-3} \quad (5)$$

When 8760 time conversion factorm, dose conversion factor is 0.7SvGy^{-1}, but occupancy coefficient 0.2 the represents that human spends about 20 of his time outdoor and indoor 0.8. The excess life time cancer risk (ELCR) for outdoor exposure, which represented the risk of developing cancer of time as a result of radiation exposure from natural radionuclides in the air can be calculated from equation [13]:

$$ELCR = AEDE \times DL \times RF \times 10^{-3} \quad (6)$$

DL:is the average duration of life (estimated to 66 years), and Risk Factor by samble RF (Sv^{-1}) this meanfatal cancer risk per SievertICRP uses RF as(0.05) for public [8]. The gamma Index (Iγ) was estimated using equation [14]:

$$I\gamma = A_U/150(Bqkg^{-1}) + A_{Ih}/100(Bqkg^{-1}) + A_K/1500(Bqkg^{-1}) \quad (7)$$

Annual Gonadal Equivalent Dose (AGED) The effects of three radionuclides on bone marrow and bone marrow cells were assessed using the dose equivalent calculation:

$$AGED(Sv/yr) = 3.09A_U + 4.18A_{Ih} + 0.314A_k \quad (8)$$

Results and Discussion

Measured activities for three isotopes (^{238}U, ^{232}Th and^{40}K) with radium equvelent radiation doselocation points are calculated by equation 1 and equation 2 respectively displayed in the table (Table 1). The activity concentration ^{238}U, ^{232}Th and ^{40}K radionuclides are within the ranges 0.19±0.07 Bqkg^{-1}to 30.52±0.91Bqkg^{-1}, 0.34±0.03 Bqkg^{-1}to 32.45±0.83 Bqkg^{-1}, and 374±3.69 Bqkg^{-1} to 211±2.77 Bqkg^{-1}, ^{238}U, ^{232}Th and ^{40}K respectively in the area of study, The correlations between both the probability of cancer and the activity of uranium radiation were 0.3724 it shows that the relationship of uranium to cancer is weak in the study area (Figure 2). The corresponding radium equivalent activity are 96.83 Bqkg^{-1} to 12.95 Bqkg^{-1}. These values were compared to thestandard mean activityconcentrations of 32, 45 and 420 Bqkg^{-1} for ^{238}U, ^{232}Th and ^{40}K respectively according to worldwide [6]. The measurement of theabsorbed dose rate ADRA(nGyh^{-1}) (indoor and outdoor) by equation 2 and equation 3; the acquired values for this radiological range from ADRA (indoor) 85.10112 (nGyh^{-1}) to 14.30801(nGyh^{-1}). The

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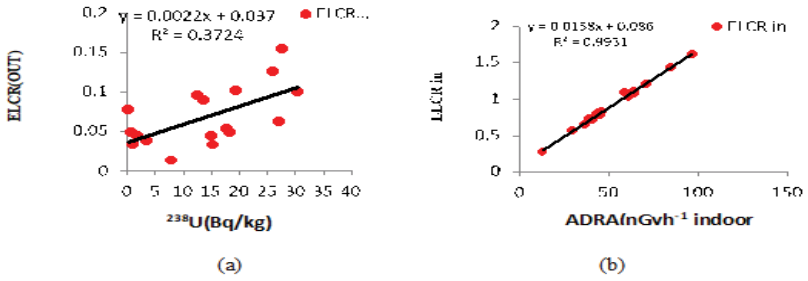

Figure 2: Correlation between (a) activity of ^{238}U and ELCR (out), (b) absorbrd dose with ELCR.

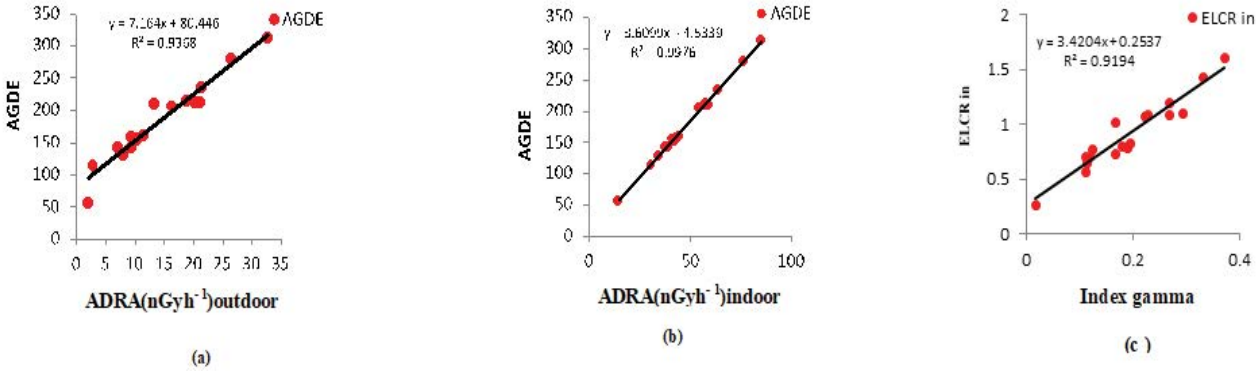

Figure 3: Correlation between (a) AGDE & ADRA (nGyh^{-1}) outdoor (b) AGDE & ADRA (nGyh^{-1}) indoor and, (c) Index gamma & ELCR in.

Table 1: Activity concentrations of naturally occurring radionuclides and random equivalent.

Sample ID	$A_{U(Bq/kg)}$	$A_{Th(Bq/kg)}$	$A_{k(Bq/kg)}$	$Ra_{eq(Bq/kg)}$
D1	7.84±0.46	0.96±0.02	300±3.30	29.56
D2	15.41±0.64	0.40±0.09	299±3.29	39.02
D3	0.68±0.13	15.77±0.58	283±3.20	45.03
D4	1.87±0.22	13.43±53	261±3.08	41.20
D5	13.75±0.61	20.10±0.65	279±3.19	64.04
D6	0.19±0.07	25.33±0.73	320±3.41	61.08
D7	30.52±0.91	12.21±0.51	211±2.77	64.26
D8	15.05±0.64	4.32±0.30	298±3.29	44.27
D9	26.00±0.84	23.76±0.71	319±3.40	84.59
D10	17.83±0.69	5.63±0.34	262±3.09	46.14
D11	18.38±0.13	3.62±0.27	261±3.08	43.67
D12	27.15±0.85	2.20±0.21	374±3.69	59.12
D13	27.61±0.86	32.45±0.83	296±3.28	96.83
D14	12.52±0.58	22.93±0.70	246±2.99	64.27
D15	1.06±0.17	10.48±0.47	307±3.34	39.72
D16	3.48±0.30	10.22±0.46	243±2.97	36.88
D17	19.52±0.72	20.16±0.65	289±3.24	70.66
D18	4.139±0.02	0.34±0.03	228±2.88	12.95
D19	13.15±0.59	1.82±0.19	261±3.08	35.93

measured dose rates are found to be higher than the world average dose rate of 55 (nGyh^{-1}). The correlation between the absorbed dose and the probability of cancerwas 0.99 this indicates the probability relationship with the absorbed dose from all isotopes under study (Figure2).

The annual effective dose in air calculated by of the formula mentioned above outdoor and indoor calculated from equation 4, equation 5 and equation 6 respectively and tabulated in the table (Table 2). annual effective dose (outdoor) worth between the highest 0.040264 mSvy^{-1} and the lowest 0.00248 mSvy^{-1}, but indoor worth between 0.417472 mSvy- to 0.070189 mSvy- these values are clearly

Table 2: The results of all estimated radiological parameters in this study.

Sample ID	ADRA(nGyh^{-1})	ADRA(nGyh^{-1})	AEDR (mSvy^{-1})	AEDR (mSvy^{-1})
D1	2.801649	30.45603	0.003436	0.149405
D2	6.981395	38.85638	0.008562	0.190614
D3	10.40391	40.90932	0.012759	0.200685
D4	9.429511	37.66119	0.011564	0.184751
D5	18.8772	57.42676	0.023151	0.281713
D6	16.31484	53.99542	0.020009	0.26488
D7	21.13783	58.63864	0.025923	0.287658
D8	9.340072	42.83639	0.011455	0.210138
D9	26.56858	75.9493	0.032584	0.372577
D10	11.38886	43.9115	0.013967	0.215412
D11	10.33549	42.0578	0.012675	0.206319
D12	13.25246	57.72022	0.016253	0.283152
D13	32.83076	85.10112	0.040264	0.417472
D14	20.15557	56.69329	0.024719	0.278115
D15	7.178228	37.41185	0.008803	0.183528
D16	8.070192	34.20547	0.009897	0.167798
D17	21.43561	63.60797	0.026289	0.312035
D18	2.02451	14.30801	0.00248	0.070189
D19	6.902223	35.32586	0.008465	0.173295

higher than the globally outdoors annual effective dose average of 0.007 mSvy^{-1} [6]. The results of the estimated γ-radiation hazards index also called representative index or gamma index is displayed in Table 2. This radiological parameter determines the level of γ-radiation associated with the measured activityconcentrations of the primordialnuclides. The value of Iγ must be (Iγ≤1) in order to retain the radiation leve lin consequential. The calculated values from equation7, however the range of the estimated gamma index is from 0.370988 Bqkg^{-1} to0.110937 Bqkg^{-1} (Table 3) in the study area with location D13 having the highest value 0.370988 and also a strong relationship in terms high positive correlation of 0.976 was observed between the levels of estimated γ-radiation index and ELCR in the figure.

Table 3: Estimated radiological parameters.

Sample ID	Iγ	ELCR out	ELCR in	ELCR total	AGDE
D1	0.110937	0.013228	0.57521	0.588438	113.2086
D2	0.166516	0.032964	0.733863	0.766827	142.0542
D3	0.124301	0.049123	0.772636	0.82176	155.8018
D4	0.118699	0.044523	0.71129	0.755813	142.924
D5	0.227467	0.089131	1.084594	1.173725	213.2535
D6	0.165698	0.077033	1.019788	1.096821	205.8101
D7	0.294618	0.099805	1.107482	1.207287	210.8972
D8	0.179277	0.0441	0.809032	0.853132	157.3217
D9	0.331573	0.125447	1.434421	1.559868	278.751
D10	0.195353	0.053774	0.829337	0.883111	160.2001
D11	0.190849	0.0488	0.794327	0.843128	152.9312
D12	0.267335	0.062573	1.090136	1.15271	209.1366
D13	0.370988	0.155015	1.607267	1.762282	312.8247
D14	0.223244	0.095167	1.070741	1.165909	210.89
D15	0.111472	0.033893	0.706581	0.740474	142.4103
D16	0.113411	0.038105	0.646024	0.684128	129.102

In the study area with location D13 having the highest value 0.370988 and also a strong relationship in terms high positive correlation of 0.976 was observed between the levels of estimated γ-radiation index and ELCRin (Figure 3). This further confirms that lengthen exposure to the high level of γ-radiation in this area will pose lifetime cancer. Inter relationships between both the probability of cancerand AGED Annual Gonadal Equivalent Dose (AGED) the effects of three radionuclides on bone marrow and bone marrow cells calculated from equation(8) and the resultes tabulated in the table, we observed that the values were as high 312.8247 Bq/kg as possible at the siteand less in sit 113.2086 Bq/kg (Table 3).

Conclusion

The activity concentration of the naturally occurring radionuclides of ^{238}U, ^{232}Th and ^{40}K in the soil samples were determined by Gamma spectrometry and the correlations between probability of cancer and the activity of uranium radiation were 0.3724, which shows the relationship of uranium to cancer is weak in the study area but correlation between ELCR activity of ^{232}Th and ^{40}K radiation greater than this value. The correlation between the probability of cancer and the internal and external absorbed dose was high in the study area. Excess lifetime cancer risks factor was directly determined using the annual effective dose radiation, which is entirely reliant on the confined radiation dose rate in the area of study. Correlation ADRA (nGyh^{-1}) of both outdoor and indoor with Annual Gonadal Equivalent Dose is very high within the study area.

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