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(Research Article)

Assessment and evaluation of residents' excess lifetime cancer risk of federal university of Kashere, Gombe State, Nigeria

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Abstract

A Study of indoor and outdoor radiation dose rate level measurements for male and female hostels at the Federal University of Kashere Hostels, Gombe State, Nigeria, has been carried out with the radiation alert smart 4 to ascertain the radiation level. The measured radiation dose rates were used to calculate the excess lifetime cancer risk and assess radiological health risks. The mean annual outdoor and indoor equivalent doses were 0.025 mSv/y. and 0.370 mSv/y. were recorded, with less than 1 mSv/y. maximum recommended limit for the general public. The mean annual outdoor and indoor effective doses were 0.017 mSv/y. and 0.086 mSv/y. respectively with a total of 0.103 mSv/yr. respectively. were computed. Mean outdoor and indoor ELCR values of 0.061×10^{-3} and 0.302×10^{-3} respectively, with a mean total of 0.363×10^{-3} were also computed.

Keywords: ELCR; Effective Dose; Annual Effective Dose; Radiation Dose Rate

1. Introduction

Natural ecosystems are known to have some amount of radiation concentration, due to elevated levels of radiation emissions caused by human activity in these natural areas. Ionizing and non-ionizing radiation continue to be a threat to humans from a variety of sources. There are now many people using productive radiation sources, which has increased human interaction [1, 2]. Terrestrial gamma radiation is produced by the radioactive decay of a few primordial radionuclides from the families of the non-series 40K and radionuclides from the ^{238}U and ^{232}Th series [3]. Heat, sunshine, and radio waves are all forms of radiation that are constantly present around us, but nuclear radiation and X-rays are unique types of ionizing radiation that can be dangerous if not managed. Qureshi et al.'s findings [4] that radiation in our environment comes from cosmogenic, anthropogenic, and primordial sources, with primordial radioactivity being common in the Earth's environment, provide credence to this claim. This corroborates the findings of UNSCEAR [5], which found that each person on earth receives an annual radiation dose of about 2.5 mSv from cosmic sources, the earth's crust, artificial sources, the nuclear industry, and nuclear bomb explosions. However, following radiation exposure, no heritable effects have been reported [6]. Building materials (soil and rock) constitute a significant source of radiation exposure for people and a route for radionuclide migration into the environment. The primary causes of natural radioactivity in soil are 238U, 40K, and 226Ra, which pose both external and internal radiological dangers due to gamma ray emission and inhalation of radon and its offspring [7]. The X-ray-producing bremsstrahlung mechanism is used in the majority of radiological methods. X-rays are thought to be responsible for about 14% of all radiation exposures worldwide, according to estimates from both natural and manmade sources [8]. There may be some ionizing radiation in the area because the pharmacy department employs radioisotopes like various isotopes of iodine. Restrictions on radiation exposure dose may be to blame for the increased cancer risk, which may also explain Basrah's high rate of cancer-related injuries. By monitoring background radiation levels and determining soil gamma dose rates,

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it is crucial to take the high rates of cancer cases into account when calculating excess lifetime cancer risk (ELCR). [9]. There is a novel theory that suggests even small radiation doses from background radiation could nonetheless induce cancer [10] despite the exceedingly low probability of induction. Even at low doses, ionizing radiation can result in cancer and heritable illnesses. Because they are probabilistic and presume that any exposure can have an effect, these effects are referred to as stochastic effects [6]. The presence of rock materials and other building materials coupled with laboratory chemicals may influence the background radiation of the environment [11]. The current study's goal is to establish baseline data for future radiation effect assessments and, if necessary, radiation protection measures by measuring dose rates in order to assess health hazards, if any, and compare equivalent doses.

1.1. Study area

This research work covers male and female hostels of the Federal University of Kashere with the coordinate latitude N 9.9128'' longitude 11.0065 E''. The site is characterized by heaps of rocks, concrete building with tiles and painted walls, most of which are newly built, a population of approximately 7000 staff and students, surrounded by green vegetation, mainly palm trees and other shrubs and weeds, mini-market, refuge dump sites, laboratory chemicals and drugs from laboratories and medical centers, office accommodations and classroom blocks, herds of cattle and their rearers, stationary and motional vehicles, generating plants and science equipment, among others. Public employees, students, and members of the general public can all be found at the study location. Background radiation may be produced by the institution's medical facilities, laboratory workshops, storage facilities for chemicals, reagents, and equipment, as well as by the granite and other rocks, assorted building materials like tile for the roof and ceiling, assorted paints, and research samples brought in from other locations. Given that there had never previously been a radioactive survey conducted at the site, it is prudent to conduct surveys to assess the level of radioactive radiation in comparison to the maximum permissible level to determine whether it requires the attention of regulatory control agencies, to make recommendations based on findings, and to establish a baseline for future impact assessment.

2. Material and Method

The in-situ measurement approach of background radiation measurement was adopted, which enabled the samples to maintain their original environmental characteristics. A radiation survey meter (Radiation Alert Smart 4) with its unit of measurement in microsiverts per hour (μS/h) was used for the detection and measurement of the radiation equivalent dose. The radiation alert Smart 4, the meter, was first calibrated to detect and measure the equivalent dose in μSv/h. The handheld radiation monitor measures alpha, beta, gamma, and X-ray radiation. The zero error of the meter was first verified and recorded alongside the calibration factor of the instrument. At each strategic point within the study area, the meter was placed at a height of 1 m from ground level to avoid any form of contamination and interference on the ground surface [12]. The readings were obtained three times at each location, and the average values were obtained for each of the 80 (eighty) selected study locations within the site. The measurements were taken in micro-Sievert per hour (μSv/hr.) Equivalent dose rate (μSv/h) from the survey meter was converted to the annual equivalent dose rate in mSv/y. by employing the mathematical relationship given by Marilyn and Maguine [13]. Global Positioning System (GPS) meter was also used for the geographical identification of the study locations in terms of latitude and longitude. In the female hostel block, A, block B, block C, and block D, five rooms from each block, in block G from floor 1 to 4 sums of 20 rooms out of 55 rooms, while in the male hostel, block E, five rooms then block F from floor 1 to 4, each floor 5 rooms the sum of 20 rooms and block H both 1st and 2nd floor, five rooms from each floor the sum of 10 rooms. Therefore, 35 rooms for male hostels and 55 rooms for females were measured.

2.1. Radiation indices measurements

Gamma and alpha radiation, as well as other radioactive substances found in terrestrial materials, including potassium-40, thorium-232, radium-226, and cobalt-60, are all sources of exposure for the local population [14]. The combined effects of activity concentration are influenced by these and other elements. Radiation indices were measured and estimated to evaluate a single parameter, including equivalent activity or equivalent dosage, yearly equivalent dose, outdoor and indoor doses, annual effective dose, and excessive lifetime cancer risk. Using the formula provided by Marilyn and Maguine [13], [15], the equivalent dose rate (Sv/h) from the survey meter was converted to the yearly equivalent dose rate (mSv/y) thus:

$$HT_a = \sigma \times \mu \times 24 \times 365 \times 10^{-3} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where $\sigma = \frac{HT}{Q}$ being the absorbed dose

HT is equivalent dose in (meter reading) $\mu Sv/hr$.

HT_a being annual equivalent in mSv/hr.

μ is the occupancy factor, expressing the proportion of the total time which an individual is exposed to radiation UNSCEAR (1998 and 2000) recommend outdoor and indoor occupancy factors of 0.2 and 0.8 respectively.

Q is the quality factor equal to 1

$$HT_{ao} = HT \times 0.2 \times 24 \times 365 \times 10^{-3} (mSvyr^{-1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (2)$$

And

$$HT_{ai} = HT \times 0.8 \times 24 \times 365 \times 10^{-3} (mSvyr^{-1}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where HT_{ao} expresses outdoor annual equivalent dose and HT_{ai} denotes indoor annual equivalent dose.

3. Result

3.1. Equivalent dose

The equivalent dose (HT) measured for the outdoor locations ranged between 0.007 to 0.023 μSv/hr. with mean of 0.014 μSv/hr., while that of indoor locations was between 0.005 to 0.041 μSv/hr., with a mean of 0.018 μSv/hr. The results are presented in Tables 1 and 2.

Table 1 Equivalent Dose Rate (HT_o), Annual Equivalent Dose Rate (HT_{ao}), External Dose (D_o), Annual Effective Dose (E_o), and Excess Lifetime Cancer Risk Rate (ELCR)

Location (Outdoor)	**Latitude**	**Longitude**	**HT_i (μSv/hr)**	**HT_{ai} (mSv/y)**	**D_i (nGy/hr)**	**E_i (mSv/y)**	**ELCR X 10^{-3}**
OR 1	N9^{0}54’48.576”	E11^{0}0’22.433”	0.011	0.0193	0.000011	0.0135	0.0472
OR 2	N9^{0}54’48.576”	E11^{0}0’22.433”	0.010	0.0175	0.000010	0.0123	0.0429
OR 3	N9^{0}54’48.576”	E11^{0}0’22.433”	0.011	0.0193	0.000011	0.0135	0.0472
OR 4	N9^{0}54’48.576”	E11^{0}0’22.433”	0.012	0.0210	0.000012	0.0147	0.0515
OR 5	N9^{0}54’48.576”	E11^{0}0’22.433”	0.011	0.0193	0.000011	0.0135	0.0472
OR 6	N9^{0}54’48.63”	E11^{0}0’22.146”	0.011	0.0193	0.000011	0.0135	0.0472
OR 7	N9^{0}54’48.63”	E11^{0}0’22.146”	0.012	0.0210	0.000012	0.0147	0.0515
OR 8	N9^{0}54’48.63”	E11^{0}0’22.146”	0.012	0.0210	0.000012	0.0147	0.0515
OR 9	N9^{0}54’48.63”	E11^{0}0’22.146”	0.011	0.0193	0.000011	0.0135	0.0472
OR 10	N9^{0}54’48.63”	E11^{0}0’22.146”	0.013	0.0228	0.000013	0.0159	0.0558
OR 11	N9^{0}54’48.36”	E11^{0}0’20.088”	0.011	0.0193	0.000011	0.0135	0.0472
OR 12	N9^{0}54’48.36”	E11^{0}0’20.088”	0.011	0.0193	0.000011	0.0135	0.0472
OR 13	N9^{0}54’48.36”	E11^{0}0’20.088”	0.010	0.0175	0.000010	0.0123	0.0429
OR 14	N9^{0}54’48.36”	E11^{0}0’20.088”	0.012	0.0210	0.000012	0.0147	0.0515
OR 15	N9^{0}54’48.36”	E11^{0}0’20.088”	0.011	0.0193	0.000011	0.0135	0.0472
OR 16	N9^{0}54’45.66”	E11^{0}0’21.222”	0.021	0.0368	0.000021	0.0258	0.0901
OR 17	N9^{0}54’45.66”	E11^{0}0’21.222”	0.022	0.0385	0.000022	0.0270	0.0944

OR 18	N9^{0}54’45.66”	E11^{0}0’21.222”	0.021	0.0368	0.000021	0.0258	0.0901
OR 19	N9^{0}54’45.66”	E11^{0}0’21.222”	0.023	0.0403	0.000023	0.0282	0.0987
OR 20	N9^{0}54’45.66”	E11^{0}0’21.222”	0.021	0.0368	0.000021	0.0258	0.0901
OR 21	N9^{0}54’43.098”	E11^{0}0’21.348”	0.012	0.0210	0.000012	0.0147	0.0515
OR 22	N9^{0}54’43.098”	E11^{0}0’21.348”	0.012	0.0210	0.000012	0.0147	0.0515
OR 23	N9^{0}54’43.098”	E11^{0}0’21.348”	0.011	0.0193	0.000011	0.0135	0.0472
OR 24	N9^{0}54’43.098”	E11^{0}0’21.348”	0.013	0.0228	0.000013	0.0159	0.0558
OR 25	N9^{0}54’43.098”	E11^{0}0’21.348”	0.012	0.0210	0.000012	0.0147	0.0515
OR 26	N9^{0}54’40.188”	E11^{0}0’17.208”	0.019	0.0333	0.000019	0.0233	0.0816
OR 27	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 28	N9^{0}54’40.188”	E11^{0}0’17.208”	0.017	0.0298	0.000017	0.0208	0.0730
OR 29	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 30	N9^{0}54’40.188”	E11^{0}0’17.208”	0.019	0.0333	0.000019	0.0233	0.0816
OR 31	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 32	N9^{0}54’40.188”	E11^{0}0’17.208”	0.017	0.0298	0.000017	0.0208	0.0730
OR 33	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 34	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 35	N9^{0}54’40.188”	E11^{0}0’17.208”	0.019	0.0333	0.000019	0.0233	0.0816
OR 36	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 37	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 38	N9^{0}54’40.188”	E11^{0}0’17.208”	0.017	0.0298	0.000017	0.0208	0.0730
OR 39	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 40	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 41	N9^{0}54’40.188”	E11^{0}0’17.208”	0.017	0.0298	0.000017	0.0208	0.0730
OR 42	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 43	N9^{0}54’40.188”	E11^{0}0’17.208”	0.019	0.0333	0.000019	0.0233	0.0816
OR 44	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 45	N9^{0}54’40.188”	E11^{0}0’17.208”	0.018	0.0315	0.000018	0.0221	0.0773
OR 46	N9^{0}54’46.41”	E11^{0}0’30.192”	0.008	0.0140	0.000008	0.0098	0.0343
OR 47	N9^{0}54’46.41”	E11^{0}0’30.192”	0.009	0.0158	0.000009	0.0110	0.0386
OR 48	N9^{0}54’46.41”	E11^{0}0’30.192”	0.009	0.0158	0.000009	0.0110	0.0386
OR 49	N9^{0}54’46.41”	E11^{0}0’30.192”	0.007	0.0123	0.000007	0.0086	0.0300
OR 50	N9^{0}54’46.41”	E11^{0}0’30.192”	0.008	0.0140	0.000008	0.0098	0.0343
OR 51	N9^{0}54’46.41”	E11^{0}0’30.192”	0.009	0.0158	0.000009	0.0110	0.0386
OR 52	N9^{0}54’46.41”	E11^{0}0’30.192”	0.008	0.0140	0.000008	0.0098	0.0343
OR 53	N9^{0}54’46.41”	E11^{0}0’30.192”	0.008	0.0140	0.000008	0.0098	0.0343

OR 54	N9^{0}54’46.41”	E11^{0}0’30.192”	0.010	0.0175	0.000010	0.0123	0.0429
OR 55	N9^{0}54’46.41”	E11^{0}0’30.192”	0.009	0.0158	0.000009	0.0110	0.0386
OR 56	N9^{0}54’41.118”	E11^{0}0’18.252”	0.017	0.0298	0.000017	0.0208	0.0730
OR 57	N9^{0}54’41.118”	E11^{0}0’18.252”	0.014	0.0245	0.000014	0.0172	0.0601
OR 58	N9^{0}54’41.118”	E11^{0}0’18.252”	0.016	0.0280	0.000016	0.0196	0.0687
OR 59	N9^{0}54’41.118”	E11^{0}0’18.252”	0.015	0.0263	0.000015	0.0184	0.0644
OR 60	N9^{0}54’41.118”	E11^{0}0’18.252”	0.016	0.0280	0.000016	0.0196	0.0687
OR 61	N9^{0}54’41.118”	E11^{0}0’18.252”	0.017	0.0298	0.000017	0.0208	0.0730
OR 62	N9^{0}54’41.118”	E11^{0}0’18.252”	0.016	0.0280	0.000016	0.0196	0.0687
OR 63	N9^{0}54’41.118”	E11^{0}0’18.252”	0.015	0.0263	0.000015	0.0184	0.0644
OR 64	N9^{0}54’41.118”	E11^{0}0’18.252”	0.016	0.0280	0.000016	0.0196	0.0687
OR 65	N9^{0}54’41.118”	E11^{0}0’18.252”	0.018	0.0315	0.000018	0.0221	0.0773
OR 66	N9^{0}54’51.408”	E11^{0}0’39.216”	0.010	0.0175	0.000010	0.0123	0.0429
OR 67	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 68	N9^{0}54’51.408”	E11^{0}0’39.216”	0.011	0.0193	0.000011	0.0135	0.0472
OR 69	N9^{0}54’51.408”	E11^{0}0’39.216”	0.013	0.0228	0.000013	0.0159	0.0558
OR 70	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 71	N9^{0}54’51.408”	E11^{0}0’39.216”	0.011	0.0193	0.000011	0.0135	0.0472
OR 72	N9^{0}54’51.408”	E11^{0}0’39.216”	0.015	0.0263	0.000015	0.0184	0.0644
OR 73	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 74	N9^{0}54’51.408”	E11^{0}0’39.216”	0.013	0.0228	0.000013	0.0159	0.0558
OR 75	N9^{0}54’51.408”	E11^{0}0’39.216”	0.011	0.0193	0.000011	0.0135	0.0472
OR 76	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 77	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 78	N9^{0}54’51.408”	E11^{0}0’39.216”	0.013	0.0228	0.000013	0.0159	0.0558
OR 79	N9^{0}54’51.408”	E11^{0}0’39.216”	0.012	0.0210	0.000012	0.0147	0.0515
OR 80	N9^{0}54’51.408”	E11^{0}0’39.216”	0.014	0.0245	0.000014	0.0172	0.0601
Minimum			0.007	0.0123	0.000007	0.0086	0.0300
Maximum			0.023	0.0403	0.000023	0.0282	0.0987
Mean			0.014	0.0247	1.40000E-05	0.0173	0.0605

Table 2 Equivalent Dose Rate (HT$_i$), Annual Equivalent Dose Rate (HT$_{ai}$), External Dose (D$_i$), Annual Effective Dose (E$_i$), and Excess Lifetime Cancer Risk Rate (ELCR)

Location (Indoor)	**Latitude**	**Longitude**	**HT$_i$ (µSv/hr)**	**HT$_{ai}$ (mSv/y)**	**D$_i$ (nGy/hr)**	**E$_i$ (mSv/y)**	**ELCR X 10^{-3}**
IR 1	N9^{0}54’48.516”	E11^{0}0’22.764”	0.016	0.3364	0.000016	0.0785	0.2747
IR 2	N9^{0}54’48.516”	E11^{0}0’22.764”	0.011	0.2313	0.000011	0.0540	0.1889
IR 3	N9^{0}54’48.516”	E11^{0}0’22.764”	0.009	0.1892	0.000009	0.0442	0.1545
IR 4	N9^{0}54’48.516”	E11^{0}0’22.764”	0.018	0.3784	0.000018	0.0883	0.3091
IR 5	N9^{0}54’48.516”	E11^{0}0’22.764”	0.009	0.1892	0.000009	0.0442	0.1545
IR 6	N9^{0}54’48.504”	E11^{0}0’22.224”	0.039	0.8199	0.000039	0.1913	0.6696
IR 7	N9^{0}54’48.504”	E11^{0}0’22.224”	0.040	0.8410	0.000040	0.1962	0.6868
IR 8	N9^{0}54’48.504”	E11^{0}0’22.224”	0.025	0.5256	0.000025	0.1226	0.4292
IR 9	N9^{0}54’48.504”	E11^{0}0’22.224”	0.041	0.8620	0.000041	0.2011	0.7040
IR 10	N9^{0}54’48.504”	E11^{0}0’22.224”	0.012	0.2523	0.000012	0.0589	0.2060
IR 11	N9^{0}54’50.382”	E11^{0}0’23.22”	0.021	0.4415	0.000021	0.1030	0.3606
IR 12	N9^{0}54’50.382”	E11^{0}0’23.22”	0.019	0.3995	0.000019	0.0932	0.3262
IR 13	N9^{0}54’50.382”	E11^{0}0’23.22”	0.011	0.2313	0.000011	0.0540	0.1889
IR 14	N9^{0}54’50.382”	E11^{0}0’23.22”	0.005	0.1051	0.000005	0.0245	0.0858
IR 15	N9^{0}54’50.382”	E11^{0}0’23.22”	0.007	0.1472	0.000007	0.0343	0.1202
IR 16	N9^{0}54’45.594”	E11^{0}0’21.066”	0.030	0.6307	0.000030	0.1472	0.5151
IR 17	N9^{0}54’45.594”	E11^{0}0’21.066”	0.011	0.2313	0.000011	0.0540	0.1889
IR 18	N9^{0}54’45.594”	E11^{0}0’21.066”	0.028	0.5887	0.000028	0.1374	0.4807
IR 19	N9^{0}54’45.594”	E11^{0}0’21.066”	0.031	0.6517	0.000031	0.1521	0.5323
IR 20	N9^{0}54’45.594”	E11^{0}0’21.066”	0.011	0.2313	0.000011	0.0540	0.1889
IR 21	N9^{0}54’42.912”	E11^{0}0’21.924”	0.011	0.2313	0.000011	0.0540	0.1889
IR 22	N9^{0}54’42.912”	E11^{0}0’21.924”	0.016	0.3364	0.000016	0.0785	0.2747
IR 23	N9^{0}54’42.912”	E11^{0}0’21.924”	0.040	0.8410	0.000040	0.1962	0.6868
IR 24	N9^{0}54’42.912”	E11^{0}0’21.924”	0.013	0.2733	0.000013	0.0638	0.2232
IR 25	N9^{0}54’42.912”	E11^{0}0’21.924”	0.018	0.3784	0.000018	0.0883	0.3091
IR 26	N9^{0}54’39.564”	E11^{0}0’19.092”	0.019	0.3995	0.000019	0.0932	0.3262
IR 27	N9^{0}54’39.564”	E11^{0}0’19.092”	0.016	0.3364	0.000016	0.0785	0.2747
IR 28	N9^{0}54’39.564”	E11^{0}0’19.092”	0.018	0.3784	0.000018	0.0883	0.3091
IR 29	N9^{0}54’39.564”	E11^{0}0’19.092”	0.016	0.3364	0.000016	0.0785	0.2747
IR 30	N9^{0}54’39.564”	E11^{0}0’19.092”	0.018	0.3784	0.000018	0.0883	0.3091
IR 31	N9^{0}54’39.564”	E11^{0}0’19.092”	0.012	0.2523	0.000012	0.0589	0.2060

IR 32	N9^{0}54’39.564”	E11^{0}0’19.092”	0.020	0.4205	0.000020	0.0981	0.3434
IR 33	N9^{0}54’39.564”	E11^{0}0’19.092”	0.016	0.3364	0.000016	0.0785	0.2747
IR 34	N9^{0}54’39.564”	E11^{0}0’19.092”	0.018	0.3784	0.000018	0.0883	0.3091
IR 35	N9^{0}54’39.564”	E11^{0}0’19.092”	0.021	0.4415	0.000021	0.1030	0.3606
IR 36	N9^{0}54’39.564”	E11^{0}0’19.092”	0.016	0.3364	0.000016	0.0785	0.2747
IR 37	N9^{0}54’39.564”	E11^{0}0’19.092”	0.018	0.3784	0.000018	0.0883	0.3091
IR 38	N9^{0}54’39.564”	E11^{0}0’19.092”	0.021	0.4415	0.000021	0.1030	0.3606
IR 39	N9^{0}54’39.564”	E11^{0}0’19.092”	0.017	0.3574	0.000017	0.0834	0.2919
IR 40	N9^{0}54’39.564”	E11^{0}0’19.092”	0.020	0.4205	0.000020	0.0981	0.3434
IR 41	N9^{0}54’39.564”	E11^{0}0’19.092”	0.015	0.3154	0.000015	0.0736	0.2575
IR 42	N9^{0}54’39.564”	E11^{0}0’19.092”	0.015	0.3154	0.000015	0.0736	0.2575
IR 43	N9^{0}54’39.564”	E11^{0}0’19.092”	0.011	0.2313	0.000011	0.0540	0.1889
IR 44	N9^{0}54’39.564”	E11^{0}0’19.092”	0.016	0.3364	0.000016	0.0785	0.2747
IR 45	N9^{0}54’39.564”	E11^{0}0’19.092”	0.030	0.6307	0.000030	0.1472	0.5151
IR 46	N9^{0}54’42.594”	E11^{0}0’19.728”	0.015	0.3154	0.000015	0.0736	0.2575
IR 47	N9^{0}54’42.594”	E11^{0}0’19.728”	0.010	0.2102	0.000010	0.0491	0.1717
IR 48	N9^{0}54’42.594”	E11^{0}0’19.728”	0.010	0.2102	0.000010	0.0491	0.1717
IR 49	N9^{0}54’42.594”	E11^{0}0’19.728”	0.011	0.2313	0.000011	0.0540	0.1889
IR 50	N9^{0}54’42.594”	E11^{0}0’19.728”	0.011	0.2313	0.000011	0.0540	0.1889
IR 51	N9^{0}54’42.594”	E11^{0}0’19.728”	0.018	0.3784	0.000018	0.0883	0.3091
IR 52	N9^{0}54’42.594”	E11^{0}0’19.728”	0.014	0.2943	0.000014	0.0687	0.2404
IR 53	N9^{0}54’42.594”	E11^{0}0’19.728”	0.010	0.2102	0.000010	0.0491	0.1717
IR 54	N9^{0}54’42.594”	E11^{0}0’19.728”	0.008	0.1682	0.000008	0.0392	0.1374
IR 55	N9^{0}54’42.594”	E11^{0}0’19.728”	0.014	0.2943	0.000014	0.0687	0.2404
IR 56	N9^{0}54’42.918”	E11^{0}0’21.618”	0.021	0.4415	0.000021	0.1030	0.3606
IR 57	N9^{0}54’42.918”	E11^{0}0’21.618”	0.019	0.3995	0.000019	0.0932	0.3262
IR 58	N9^{0}54’42.918”	E11^{0}0’21.618”	0.020	0.4205	0.000020	0.0981	0.3434
IR 59	N9^{0}54’42.918”	E11^{0}0’21.618”	0.019	0.3995	0.000019	0.0932	0.3262
IR 60	N9^{0}54’42.918”	E11^{0}0’21.618”	0.016	0.3364	0.000016	0.0785	0.2747
IR 61	N9^{0}54’42.918”	E11^{0}0’21.618”	0.016	0.3364	0.000016	0.0785	0.2747
IR 62	N9^{0}54’42.918”	E11^{0}0’21.618”	0.016	0.3364	0.000016	0.0785	0.2747
IR 63	N9^{0}54’42.918”	E11^{0}0’21.618”	0.019	0.3995	0.000019	0.0932	0.3262
IR 64	N9^{0}54’42.918”	E11^{0}0’21.618”	0.015	0.3154	0.000015	0.0736	0.2575
IR 65	N9^{0}54’42.918”	E11^{0}0’21.618”	0.016	0.3364	0.000016	0.0785	0.2747
IR 66	N9^{0}54’44.514”	E11^{0}0’17.634”	0.016	0.3364	0.000016	0.0785	0.2747
IR 67	N9^{0}54’44.514”	E11^{0}0’17.634”	0.012	0.2523	0.000012	0.0589	0.2060

IR 68	N9^{0}54’44.514”	E11^{0}0’17.634”	0.014	0.2943	0.000014	0.0687	0.2404
IR 69	N9^{0}54’44.514”	E11^{0}0’17.634”	0.021	0.4415	0.000021	0.1030	0.3606
IR 70	N9^{0}54’44.514”	E11^{0}0’17.634”	0.014	0.2943	0.000014	0.0687	0.2404
IR 71	N9^{0}54’44.514”	E11^{0}0’17.634”	0.020	0.4205	0.000020	0.0981	0.3434
IR 72	N9^{0}54’44.514”	E11^{0}0’17.634”	0.016	0.3364	0.000016	0.0785	0.2747
IR 73	N9^{0}54’44.514”	E11^{0}0’17.634”	0.019	0.3995	0.000019	0.0932	0.3262
IR 74	N9^{0}54’44.514”	E11^{0}0’17.634”	0.019	0.3995	0.000019	0.0932	0.3262
IR 75	N9^{0}54’44.514”	E11^{0}0’17.634”	0.017	0.3574	0.000017	0.0834	0.2919
IR 76	N9^{0}54’44.514”	E11^{0}0’17.634”	0.018	0.3784	0.000018	0.0883	0.3091
IR 77	N9^{0}54’44.514”	E11^{0}0’17.634”	0.015	0.3154	0.000015	0.0736	0.2575
IR 78	N9^{0}54’44.514”	E11^{0}0’17.634”	0.019	0.3995	0.000019	0.0932	0.3262
IR 79	N9^{0}54’44.514”	E11^{0}0’17.634”	0.016	0.3364	0.000016	0.0785	0.2747
IR 80	N9^{0}54’44.514”	E11^{0}0’17.634”	0.018	0.3784	0.000018	0.0883	0.3091
Minimum			0.005	0.1051	0.000005	0.0245	0.0858
Maximum			0.041	0.8620	0.000041	0.2011	0.7040
Mean			0.018	0.3700	0.000018	0.0863	0.3021

3.2. Annual equivalent dose

The annual equivalent dose (HT_a) is calculated from the (HT) values for outdoor (HT_{ao}) and indoor (HT_{ai}) using equations (2) and (3) respectively. The result of our calculations is shown in Tables 1 and 2 for outdoor and indoor annual equivalent dose equivalent respectively. HT_{ao} values ranges from 0.025 to 0.040 with a mean value of 0.025 mSv/y., while HT_{ai} values ranges from 0.105 to 0.862 with a mean of 0.370 mSv/y., this is less than 2.4 mSv/y., which is the world average equivalent dose for human as stipulated by UNSCEAR [6]. Our mean value was below the recommended annual stochastic limit of 1mSv/yr. for the general public [16].

3.3. Annual effective dose

In this study, both the annual effective dose for outdoor E_o and the annual effective dose for indoor E_i are considered.

3.3.1. The annual outdoor effective dose E_o

The E_o is calculated by employing the outdoor external dose D_o, occupancy factor, or proportion of the total outdoor time that an individual is exposed to the radiation μ_0 = 0.2 of 8760 hr within a year, and the conversion factor (CF) = 0.7 $(SvGy^{-1})$ for converting the absorbed dose in air to an effective dose.

The equations given by UNSCEAR [6] and Qureshi [4] are as follows:

$$E_o = D_o(nGyhr^{-1}) \times 0.2 \times 8760\ hr\ \times 0.7\ SvGy^{-1} \times 10^{-3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Was used for estimation of annual outdoor effective dose, E_o

Where

$$D_o(nGyhr^{-1}) = \frac{HT_o(\mu Svhr^{-1})}{Q} \times 10^{-3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (5)$$

From our calculation as seen in Table 1 the values (E_o) ranges from 0.009 to 0.029 mSv/y. with a mean value of 0.017 mSv/y. The value is higher than the world's average of 0.07 mSv/y. stipulated by Qureshi [4].

3.3.2. The annual indoor effective dose (E_i)

The E_i is calculated using the indoor external dose (D_i), occupancy factor for indoor μ_i = 0.8 of 8760 hr within a year, and the conversion factor $(CF) = 0.7$ ($SvGy^{-1}$) for converting the absorbed dose in the air to the effective dose. The equations given by Qureshi [4] and UNSCEAR [6] are as follows:

$$E_i = D_i(nGyhr^{-1}) \times 0.8 \times 8760\ hr\ \times 0.7\ SvGy^{-1} \times 10^{-3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

For estimation of annual indoor effective dose was employed for calculation of E_i

Where

$$D_i(nGyhr^{-1}) = \frac{HT_i(\mu Svhr^{-1})}{Q} \times 10^{-3} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Our results, as shown in Table 2, reveal a range of annual indoor effective dose rates of 0.025 to 0.201 with a mean value of 0.086 mSv/y. This value is below the reported global average of 0.41 mSv/y [6].

The total mean annual effective dose ($E_o + E_i$) estimated for the study area is seen to be $(0.017 + 0.086)$ mSv/yr., giving 0.103 mSv/yr., which is 19.8% below the world average estimated by UNSCEAR [6] as 0.52 mSv/y. Conti et al [17] reporting on effective dose defines the effective dose as the risk weighted summation of the equivalent dose in the tissues and organs of the body, expressing it as

$$E = \sum\nolimits_T W_T H_T \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (8)$$

Where W_T is the tissue weighing factor of the organ or tissue T and H_T is the equivalent dose in the organ or tissue T.

The equivalent dose in the organ or tissue (T) is copiously defined as the product of the mean absorbed dose in the organ or tissue and a radiation weighing factor WR. WR value depends on the type of radiation used. [18] and [19] provided a factor of 1 as the radiation weighting factor for gamma rays. This makes $HT = DT$ for gamma rays. DT being the mean absorbed dose in an organ or tissue (T).

Employing the data on radiation weighting factor (WR) given by ICRP-60 [19] and data given on the tissue weighting factor (WR) by ICRU-60 (1991), coupled with the effective dose values determined in this work, the absorbed dose in each organ for the location can be calculated using equation (8).

3.3.3. Excess lifetime cancer risk (ELCR)

The excess lifetime cancer risk (ELCR), which depends on the annual effective dose value, was calculated for outdoor and indoor locations within the study area using the equation expressed by Qureshi et al. [4] and Taskin et al. [20]:

$$ELCR = E \times LE \times RF \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (9)$$

For calculation of $ELCR$ in outdoor location we have

$$ELCR = E_o \times LE \times RF \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (10)$$

And

$$ELCR = E_i \times LE \times RF \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (11)$$

For indoor environment

Where E is annual effective dose generally, E_o and E_i are annual outdoor effective dose and annual indoor effective dose respectively, LE is life expectancy (70), while RF is fatal risk factor in per Sievert and it is pegged at 0.05 per Sievert [19].

The calculated ELCR for the outdoor environment ranges from 0.03×10^{-3} to 0.1×10^{-3} with a mean value of 0.06×10^{-3}.This mean value is consistent with that reported by Agbalagba et al. [21] for Enugu. The range for the indoor environment is 0.1×10^{-3} to $0.7 \times 10^{-3}$with a mean value of 0.3×10^{-3}.

The total ELCR ranges from 0.13×10^{-3} to $0.8 \times 10^{-3}$with a mean total value of 0.36×10^{-3}. The mean total ELCR is lower than the world average of 1.45×10^{-3} by 24.8%. The 3D map in (fig 1) for the excess lifetime cancer risk for indoor exposure shows a high value of ELCR within the north-central region of the study area. In contrast, the 3D map for excess lifetime cancer risk for outdoor exposure within the study area indicated a high value in the northeastern region of the study area.

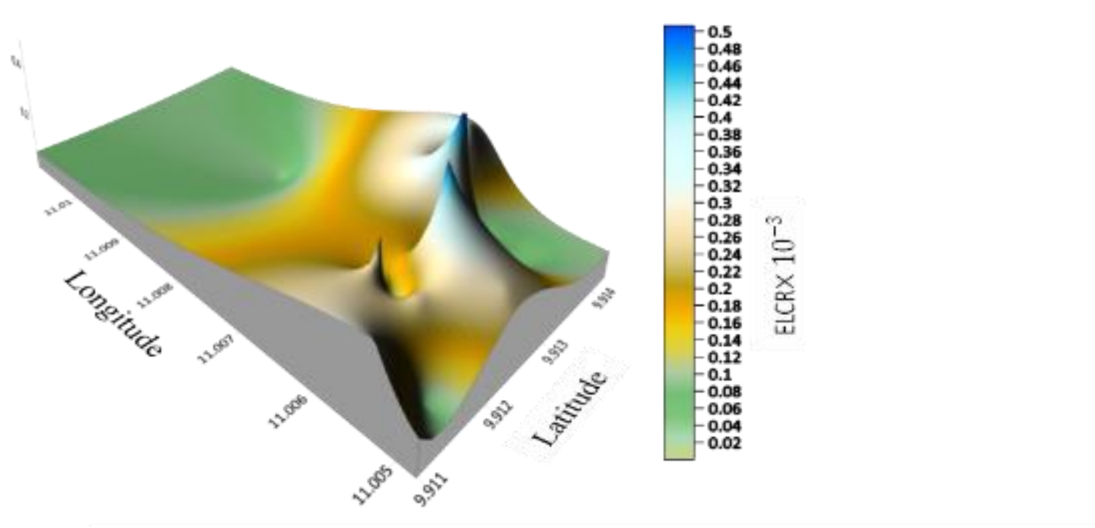

Fig. 1. 3D Map for ELCR in the research locations for both outdoor and

Figure 1 3D Map for ELCR Outdoor and Indoor

4. Discussion

In this study, background radioactivity measurements, activity concentration radiation indices, and estimates of excess lifetime cancer risk were made inside the male and female dorms at the Federal University of Kashere in Nigeria's Gombe State.

Long-term radiation exposure may cause cancer [22]. revealed that the lifetime cancer risk for American men is 44%, compared to the projected 38% lifetime cancer risk for women.

In the current study, the mean excess lifetime cancer risk (ELCR) factor for outdoor exposure is 0.3×10^{-3}. This is below the world's outdoor average of 0.29×10^{-3} . for outdoor. Our calculated mean ELCR value for indoor is 0.06×10^{-3}. This is lower than the world average of 1.16×10^{-3}. for indoor. Our total estimated mean ELCR value for both indoor and outdoor stands was 0.36×10^{-3}. that is 24.8% lower than the world's total ELCR average of 1.45×10^{-3}.

ELCR has been the subject of certain studies at various sites in Nigeria, including [15], [21], [23], and [24]. However, some of their data in their study site are for indoor ELCRs, while others are for outdoor ELCRs, therefore their results do not reflect the whole ELCR for the locations. For instance, [21] provided a typical sum. ELCR of 0.61×10^{-3}. for outdoor for Warri and Ef-furun,. Their report did not show any value for the indoor environment. [23] reported an average total indoor ELCR of 0.143×10^{-3}. for building materials from the Ogun River. Their value, though less than our mean indoor value, does not show outdoor values. [24] report 0.152×10^{-3}. indoor average total ELCR for soil profile for Ogba/Egbema/Ndoni local government area of Rivers State, Nigeria. This value is less than our value, but their report does not reflect the outdoor value.

Nurudeen et al. [12] found that the maximum allowed limit of 0.133 Sv/h for the public was not even close to being reached at any of the locations' indoor dose rate levels. As a result, the radiation exposure rate values in these particular departments may not suggest any potential risk to staff members or the general public. These findings can be used as a guide when determining the indoor background radiation levels in different places.

Sunday et al. [11] It was determined that 2.86×10^{-3} is the excessive lifetime cancer risk factor for the research location. that is more than the global average. This is most likely caused by the rock and other building materials used, as well as the lab chemicals and medications transferred to the new location.

Olanrewaju et. al. [25] determined that all of the health risk factors were safe for all of their tested levels. The findings demonstrated that there was no difference in background radiation levels between the research locations and blacksmithing workshops. The calculated excess lifetime cancer risk showed that the estimated effective dosages of adult organs in all organs are minimal, and the possibility of developing cancer for study region inhabitants who spend their entire lives in those communities is low.

Rafique et al [26] reporting for indoor and outdoor in Jhelum valley in Pakistan gave an average total value of 1.629×10^{-3}. for indoor and 0.543×10^{-3}. for outdoor, making a total of 2.172×10^{-3}.

Whereas Qureshi et al (2014) report an average total of 0.37×10^{-3}. for outdoor and 2.84×10^{-3}. for indoor, with a total of 3.21×10^{-3}. for northern Pakistan.

5. **Conclusion**

In conclusion, the study area's mean equivalent dose for the outdoors is lower than that for the indoors, the indoor annual equivalent dose rate is lower than the average equivalent dose for humans around the world, and the estimated annual effective dose is also lower than the global average.

The study locations for the present work are on the university campus where new buildings, including laboratories, are being built using a variety of building materials, including different rocks, metal rods, paints, metals, cement, and various soil types, including sand, gravel, granite, and others that are brought in for construction. These and other elements may raise background radiation levels and radioactivity, which may have an impact on the effective dosage and equivalent radioactive dose and raise the lifetime risk of developing cancer.

The study area's lifetime cancer risk factor was 0.36×10^{-3}. This is less than the global average. However, this requires continuous monitoring and control.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to disclosed.

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