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Research Article

Sensitive Organ Doses and Cancer Implication Due to Background Radiation Exposure in Federal University Birnin Kebbi, Kebbi State, Nigeria

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Abstract

Due to its detrimental impact on human health, environmental background ionizing radiation contamination and degradation are a major concern worldwide. Risk to public health is one of Nigeria's top environmental and societal concerns. The public's exposure to the environment was significantly influenced by the natural background radiation emissions from the earth's crust, food, water, and building materials. 82% of the population's background radiation exposure comes from sources that are out of control, including internal, cosmic, and external radiation. The current work aimed to conduct an investigational study of the background radiation exposure to sensitive organs from both indoor and outdoor sources, identify areas with high or low BIR, and evaluate the cancer risk to sensitive organs among residents of Federal University Birnin Kebbi based on absorbed dose rate, annual effective dose equivalent, and excess life cancer risk to sensitive organs. Using a nuclear radiation detector, background radiation exposure indoors and outside was determined. One meter was maintained between the detector and the ground. The Overall average radiation dose rate, annual effective dose rate, and cancer risks of all the locations within FUBK were found to be 0.118µSv/hr, 0.828mSv/yr, and 2.898×10-4. The mean sensitive organ dose was found to be 0.681 mSv/yr, 0.617 mSv/yr, 0.734 mSv/yr, 0.872 mSv/yr, 0.489 mSv/yr, and 0.723mSv/yr for Lung, Ovaries, Bone Marrow, Tests, Kidney, and Whole Body respectively, while the mean cancer risks to each organ were 2.382×10-4, 2.159×10-4, 2.568×10-4, 3.052×10-4, 1.712×10-4, and 2.531×10-4 for Lung, Ovaries, Bone Marrow, Tests, Kidney and Whole Body respectively. The faculty of education has the greatest dose rate, annual effective dose rate, and ELCR, according to the findings that were presented. Because the buildings were recently built and are not occupied by staff or students, no radon emission could escape due to inadequate ventilation, which may be the cause of the rise in radiation exposure. Due to the sensitivity of test organs to radiation than other organs, they have the greatest Dose rate, annual effective dose rate, and ECLR. Based on the results, it can be said that neither University staff nor students need to be concerned about the radiation levels in various FUBK buildings since the average values of annual effective dose and cancer risks were remarkably in line with the acceptable limits of 1.0mSv/yr and 2.93×10-4 except for the test organ cancer risk. Moreover, the management of FUBK is encouraged to thoroughly evaluate the building materials and select one with lower radon emission in collaboration with contractors and the government. The amounts of exposure to radioactive elements in buildings should be determined by taking samples of construction materials such as cement, soil, paint, water, etc. for radioactive elemental analysis.

Keywords: organs; cancer; radiation exposure; federal university birnin kebbi

Introduction

Natural radiation, often known as background radiation, is the radiation that results from the natural surroundings of humans and is divided into three types: primordial, cosmogenic, and anthropogenic. Primordial sources can be discovered in the earth's crust and the surrounding environment. Cosmogenic sources are formed when cosmic rays interact with atmospheric elements and deposit materials on both wet and dry depositions. As a result of their ubiquitous presence, anthropogenic sources are characterized as background sources (Abubakar et al., 2017). According to estimates, 82–85% of a person's ionizing radiation exposure comes from natural sources, and depending on factors like geology, altitude, the type of building material used, and food, a person's average annual dose is between 1-3 mSv (Samaila et al., 2020 and Samaila et al., 2022**).** The interaction of radiation with matter can result in a biological risk that could later manifest clinical signs. Radiation Safety is concerned about cellular impacts that could harm chromosomes and their constituent parts, such as genes and DNA. When radiation interacts with the body, it causes small, subcellular impacts that may cause cellular reactions to change and, over time, result in macro-observable health effects on particular organs or tissues. Tissue radiation may induce cellular damage, which could subsequently result in damage to the organ and the organism. A living organism's response to a fixed dose can be altered by several variables. There are two ways that molecular impacts, such as changes in DNA, might result from radiation exposure. First of all, radiation and DNA can interact directly, leading to bonded pairs or single or double-strand DNA breakage. Secondly, radiations can interact directly with nearby molecules inside or outside of the cell, like water, to create free radicals and active oxygen species. When these reactive chemicals interact with DNA and/or other cell components including membranes, mitochondria, lipids, proteins, etc., they can have a variety of negative effects on the health of cells and tissue tissues (Samaila et al., 2022).

The impact of radiation is further influenced by biological elements such as species, age, sex, the percentage of exposed tissues, various radio sensitivities, and repair processes. The more subtle DNA modifications might also manifest later on as mutations and/or cancers if the cells are sufficiently healed and their function is restored (Rilwan et al., 2022). This study aims to assess the level of indoor and outdoor background ionizing radiation at the Federal University Birnin Kebbi, reveal the various factors that lead to the variation in radiation effects in the university, and highlight the dangers of man's ongoing exposure to radiation through different radiation emitters. Several studies have been conducted in different parts of Nigeria to ascertain levels of environmental ionizing radiation and its potential health effects on the public.

Material and Method

The medological flow chart depict various steps involved in this research

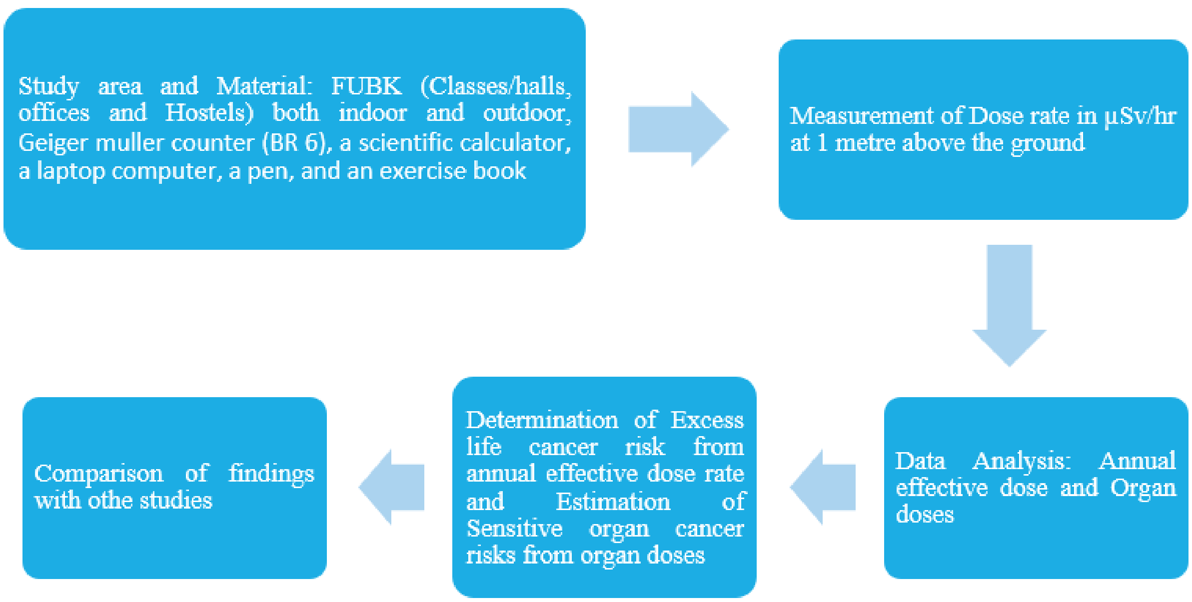

Figure 1: Methodological flow chart

Materials

The Geiger muller counter (BR 6), a scientific calculator, a laptop computer, a pen, and an exercise book were the tools utilized to carry out this investigation. The following methodological chart was adopted in this research.

Study Area

The study was carried out at the federal university Birnin Kebbi (Permanent site). It is located along Kalgo Bunza Road 4 km drive from Kalgo local government area in Kebbi state. The university lies on latitude 12°N and longitude 4°E as it maintains two campuses such as take-off and permanent sites. The take-off campus maintains the school of postgraduate studies, the female hostel as well as the school of remedial studies while the permanent site is the major campus capacity building at Unguwar Jeji village 4km away from Kalgo. Table (1) below shows the location of the sample point, code, and the coordinates of the location where indoor and outdoor radiation measurement was carried out.

S/N	LOCATION	CODE	Indoor coordinate	Outdoor coordinate
1	Faculty of Science Offices	FSO	N12°19'53.58324" E4°9'3.07368''	N12°19'53.3224" E4°9'306936"
2	Faculty of Science Laboratories	FSL	N12°19'49.21104" E4°9'5.75176''	N12°19'47.08308" E4°9'5.37948''
3	Faculty of Science Halls	FSH	N12°19'11.42688" E4°8' 56.31792''	N12°19'52.44528"

4	Faculty of Environmental Offices	FEO	N12˚200'29976." E4˚9'4.35204"	N12˚19'56'.0678" E4˚9'2.24856"
5	Faculty of Environment Lecture Halls	FEL	N12˚19'57'.21096" E4˚9'4.5486"	N12˚19'57.47988" E4˚9'8.0802"
6	Faculty of Arts	FAS	N12˚19'47.7264" E4˚9'15.29352"	N12˚19'47.94384" E4˚9'15.96808"
7	Faculty of Arts Lectures Halls	FAL	N12˚19'44.46948" E4˚9'21.65472''	N12˚19'4676592" E4˚9'13.33188''
8	Faculty of Management Science	FMS	N12˚19''46.93584" E4˚9'28.50528"	N12˚19''46.45701" E4˚9'28.21036"
9	Faculty of Management Science Lecture Halls	FML	N12˚19''47.93547" E4˚9'25.50652"	N12˚19''46.8454" E4˚9'28.50018"
10	Faculty of Education	FED	N12˚19'42.0276" E4˚9'9.42624"	N12˚19'42.1518" E4˚9'9.0216"
11	Senate Building	SEB	N12˚19'55.60572" E4˚9'18.63352"	N12˚19'55.82728" E4˚9'11.2763108"
12	School Library	SLB	N12˚19''59.60613" E4˚9'10.33124"	N12˚19''59.33553" E4˚9'10.7173"
13	School Clinic	SCL	N12˚19'44.35104" E4˚9'5.80716"	N12˚19'42.86352" E4˚9'5.66388"
14	Students Centre	STC	N12˚19'55.85484" E4˚9'18.69084"	N12˚19'56.62956" E4˚9'18.74772"
15	ICT/Data Centre	ICT	N12˚19'49.2834" E4˚9'11.43396"	N12˚19'49.25939" E4˚9'11.30016"
16	Male Hostel Block A	BLA	N12˚19''4793583" E4˚9'28.1568"	N12˚19''48.5245" E4˚9'24.1422"
17	Male Hostel Block B	BLB	N12˚19'20'7.33552" E4˚9'5.15154"	N12˚19'20'7.50142" E4˚9'5.47455"
18	Old VC Complex	OVC	N12˚19'59.61612" E4˚9'9.37188"	N12˚19'58.57716" E4˚9'12.6612"
19	Entrepreneurship Complex	ENT	N12˚20'5.5118" E4˚8'50.56008"	N12˚19'53.71644" E4˚9'15.44184"
20	Arc studio classes	AST	N12˚19'57.47988" E4˚9'8.0802"	N12˚19'56.75772" E4˚9'6.01776"

Table 1: location of the sample point with code and the coordinates

Method of Measurement

Using a radiation monitor with an integrated Geiger Muller tube operating in the Dose Rate mode, the selected Areas spanning FUBK were used as the source of the background ionizing radiation that was detected in this investigation. Ionization results from the electrical current pulse that is produced each time radiation travels through the Geiger-Muller tube. Although each pulse is electronically sensed and registered as a count, the proper method was chosen because Sv/h is the most precise and direct technique to evaluate the background dosage rate. A meter above the ground was maintained for the Geiger-Muller counter (BR 6). After the monitor was turned on, a deep audible sound that indicated the statistical accuracy of the readings on its liquid crystal display (LCD) was heard, and measurements were then taken. At the federal university Birnin Kebbi, a total of 278 sample points from 20 sites (indoors and outdoors) were marked for radiation measurement. The sample points were uniformly chosen to cover the study region. The Inspector Alert Meter was the tool in use. This detector is a reasonably cheap meter that is widely used to conduct assessments of extremely low radiation fields. It can track changes in dosage rate. It has an industrial quality that encourages long-lasting protection. To reflect human measurements in micro-sievert per hour taken at the abdominal level, the meter was held one meter above the ground. For each of the camps that were visited, readings were obtained three times in µSv/hr, following which the average reading was determined. In FUBK, the analysis process lasted for 2 weeks.

Data Analysis

The occupancy factor is the proportion of the total time during which an individual is exposed to a radiation field (Samaila *et al.*, 2020). UNSCEAR recommended indoor and outdoor occupancy factors of 0.8 and 0.2 respectively. Eight thousand seven hundred and sixty hours per year (8760hr/yr) were used. The nuclear radiation meter that has reading in count rate per minute (CPM) can be converted to Roentgen per hour (R/H), mathematically as

$$1\ cpm = 0.5 \times 104\ R/h$$

$$1\ cpm = 0.044\ mSv/yr$$
(1)

In this study, the radiation detector has a reading calibrated into **µSv/hr**

Annual effective dose (Indoor & outdoor)

The Effective Dose refers to the radiation dose parameter which takes into account the absorbed Dose received by each irradiated organ and the organs' relative sensitivity according to ICRP (Samson, 2015). It is a protection level Dosimetry quantity that could be used as an approximate measure of stochastic effect. Thus, for the public exposed to natural ionizing radiation, the annual effective dose for both indoors and outdoors can be expressed as

IAEDR (mSv/yr) = Y (µSv/hr) × 8760 (hr/yr) × 0.8 ÷ 1000 (2)

OAEDR (mSv/yr) = Z (µSv/hr) × 8760 (hr/yr) × 0.2 ÷ 1000 (3)

Where; Y and Z are the indoor and outdoor meter readings while IAEDR and OEDR are the indoor and outdoor annual effective dose rates respectively (Samaila *et al.*, 2020).

Organ annual effective dose

This is the amount of radiation received by an individual organ of the body such as the lung, ovaries, tests, liver, kidney, etc. Many research papers used in this study did not take into account the organ doses. The organ radiation doses due to the inhalation exposure pathway were computed from the annual effective data extracted using equation (4), to ascertain the amount of natural background radiation received by each organ over one year.

$$D_{organs}(mSvy^{-1}) = AEDR_{for\ ind\&outd}(mSvy^{-1}) \times CF \quad (4)$$

Where CF is the coefficient of reduction for individual organs in the body which includes 0.64, 0.58, 0.69, 0.82, 0.46, and 0.68 for Lung, Ovaries, Bone Marrow, Tests, Kidney, and Whole Body respectively

Cancer and organ cancer risks

This is concerned with the likelihood of developing cancer throughout a lifetime for a particular degree of exposure. It is expressed as a number representing the number of cancers expected in a specific number of people after exposure to a carcinogen at a particular dose. It's worth mentioning that an increase in the ELCR leads to a corresponding increase in the risk of developing breast, prostate, or even blood cancer. Excess lifetime cancer risk (ELCR) is determined using the equation.

$$ELCR = AED \times DL \times RF \quad (5)$$

Where AEDE is the Annual Equivalent Dose Equivalent, DL is the average duration of life (estimated to 70 years) and RF is the Risk Factor (Sv^{-1}), i.e., fatal cancer risk per Sievert. For stochastic effects, ICRP uses RF as 0.05 for the public 0.05. The cancer risks of individual organs were assessed using equation (6). The excess lifetime cancer risk is used in radiation protection assessment to predict the probability of an individual developing cancer over his lifetime due to low radiation dose exposure if it will occur at all (Samaila *et al.*, 2020)

$$Cancer\ Risk_{organs} = D_{organs}(mSvy^{-1}) \times DL \times RF \quad (6)$$

In the works of literature, many researchers paid no attention to organ cancer risk which is a vital aspect in determining the health implications of natural background radiation in a region or place. The organ dose calculated earlier was used to assess individual organ cancer risk.

Result and Discussions

Background ionizing radiations were measured at multiple locations within the study area as presented in Table 2-5. Dose rate level was obtained from the field, after which equations (1) – (5) were used to evaluate the Annual Effective Dose Rate (AEDR), and Excess Lifetime Cancer Risk (ELCR) for both indoor and outdoor. The organ effective dose and organ cancer risks were evaluated using equation (4) & (6). The raw data for dose rate, Annual effective dose, and excess life cancer risks for both indoor and outdoors were tabulated in Table 2 below:

S/N	CODE	IDR (µSv/hr)	ODR (µSv/hr)	IAED (mSv/y)	OAED (mSv/y)	IELCR $\times10^{-4}$	OELCR $\times10^{-4}$
1.0	FSO	0.121	0.108	0.851	0.188	2.977	0.659
2.0	FSL	0.130	0.111	0.908	0.194	3.177	0.680
3.0	FSH	0.141	0.113	0.989	0.199	3.461	0.695
4.0	FEO	0.126	0.106	0.884	0.186	3.094	0.652
5.0	FEL	0.126	0.108	0.883	0.189	3.091	0.662
6.0	FAS	0.127	0.110	0.891	0.193	3.119	0.675
7.0	FAL	0.124	0.112	0.869	0.196	3.041	0.687
8.0	FMS	0.125	0.107	0.873	0.188	3.055	0.658
9.0	FML	0.125	0.106	0.876	0.186	3.066	0.652
10.0	FED	0.147	0.114	1.030	0.199	3.604	0.698
11.0	SEB	0.128	0.113	0.898	0.197	3.144	0.691
12.0	SLB	0.128	0.108	0.898	0.190	3.144	0.663
13.0	SCL	0.121	0.105	0.846	0.184	2.961	0.644
14.0	STC	0.128	0.109	0.895	0.191	3.134	0.667
15.0	ICT	0.128	0.103	0.934	0.181	3.270	0.634
16.0	BLA	0.128	0.108	0.897	0.190	3.140	0.665
17.0	BLB	0.132	0.108	0.928	0.189	3.247	0.662
18.0	OVC	0.118	0.106	0.828	0.186	2.897	0.651
19.0	ENT	0.134	0.100	0.936	0.175	3.277	0.613
20.0	AST	0.126	0.109	0.881	0.190	3.083	0.665
MEAN		0.128	0.108	0.900	0.190	3.149	0.664

Table 2: Effective dose rate (µSv/hr) and annual effective dose (mSv/y)

Table 2 presents the summary of the raw data obtained for the effective dose rate and annual effective dose rate at different points in Federal University Birnin Kebbi. Based on the data presented, FUBK has the mean indoor dose rate of 0.128μSv/hr with faculty of education (FED) buildings having the highest value of 0.147 μSv/hr followed by faculty of science lecture halls (FSH) with 0.141 μSv/hr then Old VC complex having the lowest value of 0.118 μSv/hr. Meanwhile, FUBK has the mean outdoor dose rate of 0.108 μSv/hr with FED having the highest value of 0.114μSv/hr followed by FSH and **Senate Building (SEB)** with 0.113μSv/hr then Entrepreneurship Centre (ENT) having the lowest value of 0.100 μSv/hr. On exposure annual effective dose rate, FUBK has the mean indoor & outdoor annual effective dose rate of 0.900 μSv/hr & 0.190 μSv/hr with FED having the highest value of 1.030 μSv/hr & 0.199 μSv/hr followed by FSH 0.989 μSv/hr & 0.199 μSv/hr, then faculty of science offices (FSO) and ENT having the lowest value of 0.851& 0.175 μSv/hr for indoor and outdoor. The mean value of excess life cancer risk in FUBK was found to be 3.149×$\mathbf{10^{-4}}$ and 0.664×$\mathbf{10^{-4}}$ for indoor and outdoor with FED having the highest of 3.604×$\mathbf{10^{-4}}$ **&** 0.698×$\mathbf{10^{-4}}$ (indoor & outdoor), followed by FSH with 3.461×10^{-4} & 0.695×10^{-4} (indoor & outdoor), then OVC having the lowest value of 2.897×10^{-4} indoor followed by ENT with outdoor value of 0.613×10^{-4}

S/N	CODE	Location	Dose rate (μSv/hr)	AED (mSv/y)	ELCR (×10^{-4})
1.0	FSO	Faculty of Science Offices	0.114	0.802	2.806
2.0	FSL	Faculty of Science Laboratories	0.120	0.842	2.948
3.0	FSH	Faculty of Science Lectures Halls	0.127	0.891	3.120
4.0	FEO	Faculty of Environmental Offices	0.116	0.814	2.850
5.0	FEL	Faculty of Environment Lecture Halls	0.117	0.820	2.870
6.0	FAS	Faculty of Arts	0.119	0.831	2.908
7.0	FAL	Faculty of Arts Lectures Halls	0.118	0.827	2.894
8.0	FMS	Faculty of Management Science	0.116	0.812	2.842
9.0	FML	Faculty of Management Science Halls	0.116	0.811	2.838
10.0	FED	Faculty of Education	0.130	0.913	3.197
11.0	SEB	Senate Building	0.120	0.844	2.953
12.0	SLB	School Library	0.118	0.828	2.897
13.0	SCL	School Clinic	0.113	0.791	2.768
14.0	STC	Students Centre	0.118	0.829	2.900
15.0	ICT	ICT/Data Centre	0.116	0.809	2.833
16.0	BLA	Male Hostel Block A	0.118	0.828	2.899
17.0	BLB	Male Hostel Block B	0.120	0.842	2.948
18.0	OVC	Old VC Complex	0.112	0.786	2.751
19.0	ENT	Entrepreneurship Complex	0.117	0.819	2.865
20.0	AST	Arc studio classes	0.117	0.821	2.872
MEAN			0.118	0.828	2.898
Nigerian Nuclear Regulatory Agency (NNRA) limit				**1.0**	2.903

Table 3: Overall results of FUBK

Table 3 presents the summary of the overall results obtained for the effective dose rate annual effective dose rate and excess life cancer risks at different points in Federal University Birnin Kebbi. Based on the results presented, the mean dose rate was found to be 0.118 μSv/h with FED having the highest value of 0.130 μSv/h followed by FSH with 0.127 μSv/h then OVC having the lowest dose rate value of 0.112 μSv/h. Similarly, for AED and ECLR, the mean values were 0.828 mSv/hr and 2.898×10^{-4} with FED having the highest value of 0.913mSv/yr and 3.197×10^{-4}, followed by FSH with 0.891mSv/yr and 3.120×10^{-4} then OVC having the lowest AED and ECLCR with 0.786mSv/yr and 2.751×10^{-4}

S/N	CODE	Lung	Ovaries	Bone Marrow	Tests	Kidney	Whole Body
1.0	FSO	0.332	0.301	0.358	0.426	0.239	0.353
2.0	FSL	0.705	0.639	0.760	0.904	0.507	0.749
3.0	FSH	0.760	0.689	0.819	0.974	0.546	0.807
4.0	FEO	0.685	0.621	0.738	0.877	0.492	0.728

5.0	FEL	0.686	0.622	0.740	0.879	0.493	0.729
6.0	FAS	0.694	0.629	0.748	0.889	0.499	0.737
7.0	FAL	0.682	0.618	0.735	0.873	0.490	0.724
8.0	FMS	0.679	0.615	0.732	0.870	0.488	0.721
9.0	FML	0.680	0.616	0.733	0.871	0.489	0.722
10.0	FED	0.787	0.713	0.848	1.008	0.565	0.836
11.0	SEB	0.701	0.635	0.756	0.898	0.504	0.745
12.0	SLB	0.696	0.631	0.751	0.892	0.500	0.740
13.0	SCL	0.659	0.597	0.711	0.844	0.474	0.700
14.0	STC	0.695	0.630	0.749	0.891	0.500	0.739
15.0	ICT	0.714	0.647	0.770	0.915	0.513	0.758
16.0	BLA	0.696	0.630	0.750	0.891	0.500	0.739
17.0	BLB	0.715	0.648	0.771	0.916	0.514	0.760
18.0	OVC	0.649	0.588	0.700	0.831	0.466	0.689
19.0	ENT	0.711	0.645	0.767	0.911	0.511	0.756
20.0	AST	0.685	0.621	0.739	0.878	0.493	0.728
Mean		0.681	0.617	0.734	0.872	0.489	0.723
NNRA value		1.0 mSv/year					

Table 4: Organs effective dose rate (mSv/y)

Table 4 presents the summary of the evaluated results for organ dose values for the lungs, ovaries, bone marrow, testes, kidney, liver, and whole body due to radiation exposure in different locations. Based on the findings presented, FUBK has the mean effective dose to lungs of 0.681 mSv/y with FED having the highest value of 0.787 mSv/y followed by FSH with 0.760 mSv/y, then FSO having the lowest value of 0.332 mSv/y.

The mean effective ovaries, Bone Marrow, Tests, Kidney, and Whole-Body doses were 0.617 mSv/y, 0.734 mSv/y, 0.872 mSv/y, 0.489 mSv/y and 0.723 mSv/y with FED having the highest values of 0.713 mSv/y, 0.848 mSv/y, 1.008 mSv/y, 0.565 mSv/y, and 0.836 mSv/y for ovaries, Bone Marrow, Tests, Kidney, and Whole-Body then FSO having the lowest value of 0.301mSv/y, 0.358 mSv/y, 0.426 mSv/y, 0.239 mSv/y and 0.353 mSv/y

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S/N	CODE	Lung	Ovary	Bone marrow	Tests	Kidney	Whole body
1.0	FSO	1.164	1.055	1.255	1.491	0.836	1.236
2.0	FSL	2.468	2.237	2.661	3.163	1.774	2.623
3.0	FSH	2.660	2.410	2.868	3.408	1.912	2.826
4.0	FEO	2.397	2.172	2.584	3.071	1.723	2.547
5.0	FEL	2.402	2.177	2.589	3.077	1.726	2.552
6.0	FAS	2.428	2.200	2.617	3.110	1.745	2.579
7.0	FAL	2.386	2.162	2.572	3.057	1.715	2.535
8.0	FMS	2.376	2.153	2.562	3.044	1.708	2.524
9.0	FML	2.380	2.157	2.566	3.049	1.710	2.529
10.0	FED	2.753	2.495	2.968	3.527	1.979	2.925
11.0	SEB	2.454	2.224	2.646	3.144	1.764	2.608
12.0	SLB	2.436	2.208	2.627	3.122	1.751	2.589
13.0	SCL	2.307	2.090	2.487	2.956	1.658	2.451
14.0	STC	2.433	2.205	2.623	3.117	1.749	2.585
15.0	ICT	2.498	2.264	2.694	3.201	1.796	2.655
16.0	BLA	2.435	2.206	2.625	3.119	1.750	2.587

17.0	BLB	2.502	2.268	2.698	3.206	1.798	2.658
18.0	OVC	2.271	2.058	2.448	2.910	1.632	2.413
19.0	ENT	2.490	2.256	2.684	3.190	1.789	2.645
20.0	AST	2.399	2.174	2.586	3.073	1.724	2.549
Mean		2.382	2.159	2.568	3.052	1.712	2.531
Acceptable limit		$\mathbf{2.9\times10^{-4}}$					

Table 5: Organs Cancer Risks

Based on the findings presented in Table 5, FUBK has the mean excess life cancer risks of 2.382×10^{-4}, 2.159×10^{-4}, 2.568×10^{-4}, 3.052×10^{-4}, 1.712×10^{-4} and 2.531×10^{-4} for Lung, Ovary, Bone marrow, Tests, Kidney, and Whole-body respectively with Faculty of education having the highest value for tests 3.527×10^{-4}, 2.968×10^{-4} for Bone marrow, 2.925×10^{-4} for whole body, 2.753×10^{-4} for lungs, 2.495×10^{-4} for ovary, and 1.979×10^{-4} for kidney and followed by Faculty of Science Lectures Halls, $3.408\times10^{-4}$for tests, 2.868×10^{-4} Bone marrow, 2.826×10^{-4} whole body, 2.660×10^{-4} for lung and 2.410×10^{-4} for ovary, and 1.912×10^{-4} for kidney, then the lowest value were found to be 1.164×10^{-4}, 1.055×10^{-4}, 1.255×10^{-4}, 1.491×10^{-4}, 0.836×10^{-4} and 1.236×10^{-4} for Lung, Ovary, Bone marrow, Tests, Kidney and Whole body respective

Studies	IDR µSv/hr	ODR µSv/hr	IAED [msv/y]	OAED [msv/y]	Overall Dose rate µSv/hr	Overall AED msv/y	ELCR $\times10^{-4}$
This study	0.128	0.108	0.900	0.190	0.118	0.828	2.898
Felix *et al.*, 2015	0.256	0.249	1.54	0.44	0.25	0.99	1.54
Bello et al., 2021	0.13	0.10	0.91	0.18	0.12	0.545	0.63
Akintunde *et al.*, 2021	0.25	0.22	-	-	0.24	2.40	8.40
James *et al.*, 2020	0.11	0.07	0.56	0.09	0.10	0.325	1.945
Mahmoud *et al.*, 2020	0.14	0.15	-	-	0.15	-	-
Hamed & Mohammad, 2021	0.11	0.14	-	-	0.13	-	-
Eke & Emelue, 2020	0.14	0.14	-	-	0.14	-	-
Esi et al., 2019	0.015	0.014	1.135	0.635	0.013	-	1.729
Oladele *et al.*, 2018	0.21	0.24	-	-	0.23	1.56	5.46
Jafaria *et al.*, 2017	0.11	0.08	-	-	0.10	-	-
Ononugbo *et al.*, 2015	0.24	0.002	0.08	0.016	0.12		0.055
Emumejaye & Daniel *et al.*, 2018	-	0.22	-	-	0.22	1.09	0.95
Rilwan *et al.*, 2022	-	0.04	-	-	0.04	0.17	0.14

Source: Samaila et al., 2023

Table 6: Comparison with other studies

Based on the findings presented in Table 6, the findings of ELCR are in line with the world average threshold value of $\mathbf{2.9\times10^{-4}}$, similarly for the overall annual effective dose, the findings are below 1.0 mSv/yr set by NNRA.

S/N	**Studies**	**Lung**	**Ovary**	**Bone marrow**	**Tests**	**Kidney**	**Liver**	**Whole body**
1	**This study**	2.382	2.159	2.568	3.052	1.712	-	2.531
2	Hyacienth *et al.*, 2022	1.810	1.636	1.946	2.313	1.298	1.298	1.918
3	Felix *et al.*, 2015	3.449	3.126	3.719	4.419	2.479	2.479	3.665
4	Omogunloye *et al.*, 2022	0.185	0.168	0.200	0.238	0.134	0.1336	0.198
5	Galadima et al.,2022	0.062	0.056	0.067	0.079	0.059	0.044	0.065
6	Bello *et al.*, 2021	2.038	1.847	2.198	2.612	1.465	1.465	2.166
7	Rilwan *et al.*, 2022	0.381	0.345	0.410	0.488	0.274	0.274	0.405

Source: *Samaila et al., 2023*

Table 7: Comparison of Organ cancer risks with other findings

Based on the results presented in Table 7 above, test organs received the highest amount of radiation due to their sensitivity to radiation which led to higher cancer probability with an average value of **3.052**, followed by Bone marrow with **2.568.**

Discussion

The overall Effective dose rate finding of this study has revealed that the mean effective dose rate for FUBK was 0.118 µSv/hr, which is lower than the literature findings as shown in Table 6 (Felix *et al.,* 2015; Akintunde *et al.*, 2021; Oladele *et al.,* 2018; and Emumejaye & Daniel *et al.,* 2018), but is in line with the findings of (Bello et al., 2021; Eke & Emelue, 2020; James *et al.,* 2020; Hamed & Mohammad, 2021; Esi et al., 2019; Jafaria *et al.*, 2017; Ononugbo *et al.,* 2015 and Rilwan *et al.,* 2022; Mahmoud *et al.,* 2020;). Similarly, the overall annual effective dose rate result was found to be 0.828 mSv/yr, which is higher than 0.45 mSv/yr as recommended by UNSCEAR, but lower than the findings of (Felix *et al.,* 2015; Akintunde *et al.,* 2021; Oladele *et al.,* 2018 and Emumejaye & Daniel *et al.,* 2018) and may not cause radiological hazard to the students and staff unless on excessive exposure, while other literature findings as indicated in the table 6 above were remarkably lower than the findings of this research.

In comparison of excess lifetime cancer risk, the findings of this study have revealed that the mean excess lifetime cancer risk (ELCR) for FUBK was found to be 2.898$\times\mathbf{10^{-4}}$ **which is higher than the findings of (**Felix *et al.,* 2015; Bello et al., 2021; James *et al.,* 2020; Esi et al., 2019; Ononugbo et al., 2015; Emumejaye & Daniel et al., 2018 and Rilwan et al., 2022), but lower than the findings of (Oladele *et al.,* 2018 and Akintunde *et al.,* 2021). The finding of ELCR in this study is **in line with** the world average value of 2$\mathbf{.9\times10^{-4}}$ **as shown in Table 6.** Since the overall findings are in line with a threshold value, there is no cause for radiological risk in FUBK.

The results of this study show that the mean organ dose values for the lungs, ovaries, bone marrow, testes, kidney, and whole body for FUBK are 0.681, 0.617, 0.734, 0.872, 0.489, and 0.723 mSv/year, respectively (table 4). This is less than the value recommended for sensitive organs by the NNRA limits of 1.0 mSv annually, further emphasizing that the radiation levels do not pose a direct health risk to residents of FUBK. The results of Rilwan et al. (2022) do not align with the present study. The researchers used an Inspector Alert Nuclear Radiation Monitor to conduct research in Keffi and Karu, Nasarawa State. The mean organ doses for the lungs, ovaries, bone marrow, testes, kidney, liver, and entire body were 0.00247, 0.00224, 0.00266, 0.00316, 0.00239, 0.00177, and 0.00262 mSv/yr**. For the organ cancer risk, the results were found to be** $\mathbf{2.382\times10^{-4}}$**,** $\mathbf{2.159\times10^{-4}}$**,** $\mathbf{2.568\times10^{-4}}$, 3.052×10^{-4}, 1.712×10^{-4}, and 2.531×10-4. The findings indicated that the test organ receives the highest radiation dose compared to other organs in the body. The findings were in line with the world average value of 2.9×10-4, except for the test organ, which is sensitive and prone to radiation.

Conclusion

This tends to show how living in classrooms, staff offices, and residence halls at FUBK exposes members of staff and students to radiation exposure and its effects on human organs. From Micro Sivert per Hour (µSv/hr) to Annual Effective Dose Rate in Milli Sivert per Year (mSv/yr), from Annual Effective Dose Rate to Excess Lifetime Cancer Risk in Milli Sivert per Year (mSv/yr), and lastly, from Annual Effective Dose Rate to Organs in Milli Sivert per Year (mSv/yr). Based on the presented findings, it can be concluded that background radiation in the various FUBK buildings is not a health concern unless it is accumulated over an extended period by students and staff, at which point exposure may cause cancer in those individuals after roughly seventy years. As a result, it is advised that the government, contractors, and school administration, among others, carefully choose building materials with extremely low concentrations of radioactive and radon materials, as radon and its offspring account for the majority of the natural background radiation emission. To easily regulate radiation impacts through indoor and outdoor exposure, it is also advised that samples of water, soil, paints, and cement be taken for elemental analysis to determine the existence of radioactive elements before being utilized in building construction in FUBK.

Ethical Approval

The ethical approval was obtained from the FUBK research committee through the Physics with Electronics department committed on research.

Conflict of Interest

NO conflict of interest

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