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A Survey of Environmental Radioactivity Levels in Science Laboratories of Abuja Campus University of Port- Harcourt, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author CPO designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author MI managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

An *in-situ* measurement of the background radiation level was carried out at the science laboratories, Ofrima, Abuja campus of University of Port Harcourt, Nigeria. This study was carried out to evaluate the radiological health impact of radiation exposure of staff and students that uses such laboratories. Two portable radiation meters (digilert-200 and Radalert-100) survey meters was used to measure the background radiation levels of the laboratories (indoor and outdoor). The indoor and outdoor exposure rates measured was converted to absorbed dose in nano Grays per hour. The average annual effective dose equivalent of the three major laboratories (Physics, pharmacy and environmental microbiology) estimated are 0.165 ±0.002, 1.109± 0.010 and 0.56 ± 0.02 $mSvy^{-1}$ respectively and their corresponding absorbed dose rates are 119.92, 111.69 and 115.10 $nGyh^{-1}$ respectively. The excess lifetime cancer risks of the three laboratories are 0.512 × 10^{-3}, 1.25 × 10^{-3} and 2.03 ×10^{-3}. From the results, the indoor average annual effective dose equivalents were lower than their permissible safe limit of 1.0 $mSvy^{-1}$ except for pharmaceutical

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laboratory which recorded slightly mean higher value of 1.109 $mSvy^{-1}$. The indoor absorbed doses and excess lifetime cancer risk determined were higher than their permissible values. The outdoor exposure rate of 14.14 μRh^{-1} was recorded and absorbed dose rate of 117.24 $nGyh^{-1}$ was estimated. The average outdoor annual effective dose obtained is 0.150 $mSvy^{-1}$ and excess lifetime cancer risk of 0.525×10^{-3} was obtained. Indoor radiation levels and their associated risk parameters are higher than the outdoor counterpart which is an indication of the radiation emission from chemicals and equipment in the laboratories. The results of this study shows that there is no immediate radiological health risk to workers and students. The study will serve as radiation baseline data for those studied laboratories for future studies.

Keywords: Effective dose; excess life time cancer risk; laboratories; effective dose; cancer.

1. INTRODUCTION

The steady rise in the use of isotopes and nuclear technology for various purposes in human life, both agro-industrial-military, medical, may increase the chances of radioactive contamination (normal uses or after accidents). That increases the exposure of ionizing radiation (external or internal) which raise awareness in increasing the need to know how to assess that exposure. Control of imported foodstuffs to ensure that are not contaminated with radioactive materials is very important at this stage.

Studies on radiation levels and radionuclide distribution in the environment provide vital radiological baseline information. Such information is essential in understanding human exposure from natural and man-made sources of radiation and necessary in establishing rules and regulations relating to radiation protection [1]. Measurements of radioactivity in environment and in foodstuffs are extremely important for controlling radiation levels to which mankind is direct or indirectly exposed. Another important fact is that, importation of contaminated food from any region that suffered a nuclear accident can be indirectly affect people health around the world [2].

Man in his natural environment is exposed to varying amount of radiation without his knowledge. The ambient radiation encompasses both natural and artificial radioactivity in his environment [3]. Radon gas in man's environment contributes high amount of potential lethal dose to man which causes the majority of deaths resulting from lung cancer [4]. The vast global interest in the study of naturally occurring radiation and environmental radioactivity had been essentially based on using the results from such studies for the assessment of public radiation exposure rates and the performance of epidemiological studies, as well as reference radiometric data relevant in studying the possible changes in environmental radioactivity due to nuclear, industrial and other human technology-related activities [5].

Internal exposures arise from the intake of radionuclides by inhalation and ingestion. Radiation doses that are inhaled result from the presence of dust particles containing radionuclides of the ^{238}U and ^{232}Th decay chains in air. The dominant component of inhalation exposure is the short lived decay by-products of radon. Natural sources of radiation includes extra-terrestrial cosmic radiation consisting of 87% proton, 12% α –particles and 1% heavier nuclei [6] and terrestrial radiation from primordial elements in the earth. Building materials in use today contain various concentration of naturally occurring radionuclides which decay to yield radon as one of their progenies [7]. These building materials contribute to indoor ambient radiation levels. Exposure to ionizing radiation pose some health risks such as cancer induction, radiation cataract genesis, and indirect chromosomal transformation.

Owing to the health risks associated with the exposure to indoor radiation, many governmental and international bodies such as the International Commission on Radiological Protection (ICRP), the World Health Organization (WHO), [8,9] have adopted strong measures aimed at minimizing such exposures. The practice being to keep one's exposure to ionizing radiation as low as reasonably possible (known as ALARA principle) [10]. Radiation doses depend on the intensity and energy of radiation, exposure time, the area exposed and the depth of energy deposition. Quantities such as the absorbed dose, the effective dose and the equivalent dose have been introduced to specify the dose received and the biological effectiveness of that dose [11].

Many researches has been done on environmental radioactivity levels [5,7,12,13]. This present paper was designed to add to and enhance the existing information on the survey of environmental radioactivity level in Nigeria with particular interest in Science laboratory Abuja campus, University of Port Harcourt in Niger Delta Region. Presently, there is no data existing on the survey of environmental radioactivity level in Abuja Campus, University of Port Harcourt. The knowledge of radiation level in the laboratory environment is imperative; this study is therefore expected to yield data that will provide information that may be used to assess the health effects on the population in the study area. The objectives of the present study are to: (i) determine the level of radioactivity in all the Laboratories in the Abuja Campus, Ofirima (ii) evaluate radiological health parameters for different science laboratories in the University; and (iii) Determine the radiological health status of the Laboratory workers, students, lecturers and others members of the public.

2. MATERIALS AND METHODS

2.1 Study Area

The study area comprises the major laboratories in faculty of science, University of Port Harcourt as shown in Fig. 1 and Table 1 shows the various laboratories studied.

2.2 Experimental Procedure

An in-situ measurement of indoor and outdoor radiation levels were measured in various science laboratories using well calibrated Radalert-100 and Digilert-200 nuclear radiation meters (S.E. International INC. Summer Town, USA). The detector is halogen- quenched GM tube with thin mica end window of density 1.5 - 2.0 mg cm^{-2} and diameter of 0.360 inch and side wall of 0.012 inch thick. The radiation meters detects alpha down to 2.5Mev with 80% detection efficiency, beta at 50 Kev with 35% detection efficiency and can also detect beta at 150 Kev with 75% detection efficiency. Digilert 200 and Radalert 100 is capable of detecting gamma and X-rays down to 10 Kev through the window, 40 Kev minimum through the case within the temperature range of -10°c to 50°c. The radiation meters were set to measure the exposure rate in milli-Roetgen per hour which has operating range of 0.001 (μRh^{-1}) to 200 mRh^{-1}. A geographical position system (GPS) was used to take the precise positions were readings were taken outdoor. At each laboratory, the survey meter was held about 0.1 m away from laboratory instruments/ equipment/chemicals/reagents and 1m height from the ground. Since radioactivity measurement or process is statistical, about 50 readings were taken on each laboratory, average and error of the readings were obtained.

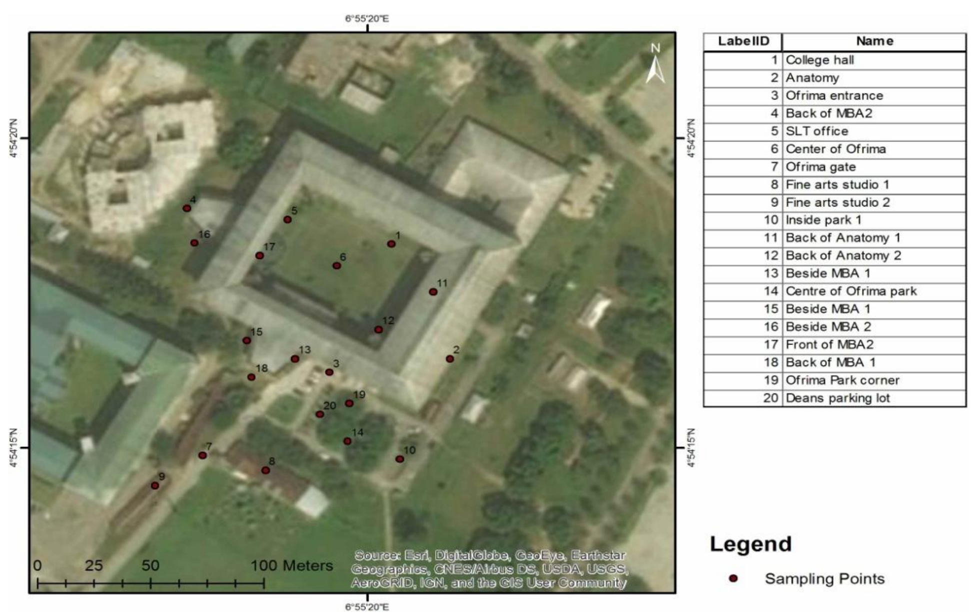

Fig. 1. Study Area showing the various sampling points and laboratories studied.

Table 1. Laboratories studied

S/N	Laboratories	Sample code
1	Physics Laboratory I	SA1
2	Physics Laboratory II	SB2
3	Physics Laboratory III	SC3
4	Physics store	SD4
5	Physics Electronics	SE5
6	Physics (Optics) Laboratory	SF6
7	Pharmacognosy & phytotherapy (Pharmacy Laboratory)	PHL
8	Organic-inorganic Pharmaceuticals &Med. Chemistry Lab	OPMC
9	Pharmaceutical microbiology	PHM
10	Microbiology Research Laboratory	MRL
11	PSB major Laboratory	PSB
12	MCB Major Laboratory	MCB
13	Biosystematics/Plant Taxonomy Research Laboratory	BRL
14	Environmental Microbiology Research Laboratory	EMRL
15	Food/Industrial MCB laboratory	FIML

Measurements were repeated six times at each site on different days within the 1 months to take care of any fluctuation in the environmental radioactivity. Readings were taken between the hours of 1300 and 1600 h, since the radiation meter has the maximum response to environmental radiation within these hours as recommend by NCRP [14].

Six readings were taken in triplicate whereby average value for each was recorded. The mean exposure rates were calculated along with their standard deviations. The absorbed dose rate (nGy/h) was obtained from the exposure dose rate in (μR/h) using the conversion factor [15]:

$$1 \mu Rh^{-1} = 8.7\ nGyh^{-1} = \frac{\mathbf{8.7 \times 10^{-3}}}{\frac{\mathbf{1}}{\mathbf{8760\ y}}}\ \mu Gyy^{-1} = 76.212\ \mu Gyy^{-1} \qquad (2)$$

To estimate the whole body equivalent dose rate over a period of 1 year, we use the National Council on Radiation Protection and Measurement [14,16] recommendation:

$$1\ mRh^{-1} = \frac{0.96 \times 24 \times 365}{100}\ mSvy^{-1} \qquad (3)$$

Absorbed gamma dose rates were used to calculate the annual effective dose equivalent (AEDE) received by laboratory attendants and other staff using the laboratory. For calculating AEDE we used dose conversion factor of 0.7Sv/Gy and the occupancy factor for indoor and outdoor was 0.75 and 0.25 respectively. The annual effective dose is determined using the following equations [15,5].

$$\text{AEDE (indoor/outdoor)} = \frac{\partial \times \mu \times 24 \times 365}{1000} = \partial\ (nGyh^{-1}) \times 1.2264 \times 10\text{-}3\ Sv/Gy \qquad (4)$$

Where AEDE = annual effective dose equivalent, ∂ = absorbed dose in Gyh^{-1}, μ = occupancy factor.

The estimated values of AEDE was used to calculate the excess lifetime cancer risk for the five communities using the equation:

$$\text{ELCR} = \text{AEDE } (mSvy^{-1}) \times \text{average Duration of life (DL) in years} \times \text{Risk factor } (RF\ Sv^{-1}) \qquad (5)$$

Where AEDE, DL and RF are the annual effective dose equivalent, duration of life (70 years) and the risk factor (Sv^{-1}), the fatal cancer risk per Sievert. For low dose background radiation which are considered to produce stochastic effects, ICRP 60 uses value of 0.05 Sv^{-1} for the public exposure [17].

3. RESULTS AND DISCUSSION

The indoor and outdoor ambient radiation exposure rate of 3 major laboratories in the University of Port Harcourt was measured using two radiation meters (Radalert-100 and Digilert-200) and are presented in Tables 2, 3 and 4. Table 2 shows the indoor ambient radiation levels in physics laboratories and its radiological parameters. The average exposure rate ranges from 7.00 to 20.00 μRh^{-1} with mean value of 13.51 μRh^{-1}. The highest exposure rate was recorded at the store due to some radioactive materials and equipment in the store. The lowest value of 7.00 μRh^{-1} was recorded in the dark room. The equivalent dose rate ranges from 0.59 to 1.68 $mSvy^{-1}$ with mean value of 1.16 $mSvy^{-1}$. The absorbed dose ranges from 60.9 to 174.0 $nGyh^{-1}$ with mean value of 119.92 $nGyh^{-1}$ while the annual effective dose equivalent AEDE ranges from 0.289 to 0.827 $mSvh^{-1}$ with mean value of 0.165 $mSvy^{-1}$. This is lower than the permissible value of 1.0 $mSvy^{-1}$ as prescribed by International Commission on Radiation protection as shown in Fig. 2. The excess lifetime cancer risk estimated from the annual effective dose equivalent ranges from 1.013× 10^{-3} to 2.89× 10^{-3} with mean value of 0.52 × 10^{-3}. Table 3 gives the indoor ambient radiation level of pharmacy laboratories and their radiological parameters. Exposure rate ranges from 6.00 to 23.00μRh^{-1} with mean value of 12.86 μRh^{-1}. Equivalent dose rate ranges from 0.51 to 1.93 $mSvy^{-1}$ with mean value of 1.083 $mSvy^{-1}$. The absorbed dose ranges from 52.2 to 200.1 $nGyh^{-1}$ with mean value of 111.69 $nGyh^{-1}$ while the annual effective dose equivalent ranges from 0.25 to 0.95 $mSvy^{-1}$ with mean value of 1.11 $mSvy^{-1}$. The mean value of annual effective dose equivalent is slightly higher than the permissible limit of 1.0 $mSvy^{-1}$. The excess lifetime cancer risk estimated ranges from 0.87 × 10^{-3} to 3.33 × 10^{-3}. The minimum value of 6.00μRh^{-1} and maximum value of

Table 2. Indoor ambient Radiation level at physics laboratories and their radiological parameters

S/N	Sample area	location	Average exposure rate (μRh^{-1})	Equivalent dose rate ($mSvy^{-1}$)	D ($nGyh^{-1}$)	AEDE ($mSvy^{-1}$)	ELCR $\times 10^{-3}$
1	SA1	Entrance	16.00	1.35	139.2	0.662	2.315
2	SA2	Center	14.00	1.18	121.8	0.579	2.026
3	SA3	1st corner	9.00	0.76	78.3	0.372	1.302
4	SA4	2nd corner	19.00	1.60	165.3	0.786	2.749
5	SA5	3rd corner	16.00	1.35	139.2	0.662	2.315
6	SA6	4th corner	10.00	0.84	87.0	0.414	1.447
7	SA7	Preparatory room	17.00	1.43	147.9	0.703	2.46
8	SB1	Entrance	17.00	1.43	147.9	0.703	2.46
9	SB2	Center	18.00	1.51	156.6	0.744	2.605
10	SB3	1st corner	11.00	0.93	95.7	0.455	1.592
11	SB4	2nd corner	17.00	1.43	147.9	0.703	2.46
12	SB5	3rd corner	14.00	1.18	121.8	0.579	2.026
13	SB6	4th corner	15.00	1.26	130.5	0.620	2.171
14	SB7	Preparatory room	10.00	0.84	87.0	0.414	1.447
15	SC1	Entrance	18.0	1.51	156.6	0.744	2.605
16	SC2	Center	16.0	1.35	139.2	0.662	2.315
17	SC3	1st corner	13.0	1.09	113.1	0.538	1.881
18	SC4	2nd corner	15.00	1.26	130.5	0.620	2.171
19	SC5	3rd corner	9.00	0.76	78.3	0.372	1.302
20	SC6	Preparatory room	13.00	1.09	113.1	0.538	1.881
21	SD1	Entrance	16.00	1.35	139.2	0.662	2.315
22	SD2	Center	14.00	1.18	121.8	0.579	2.026
23	SD3	1st corner	16.00	1.35	139.2	0.662	2.315
24	SD4	2nd corner	20.00	1.68	174.0	0.827	2.894
25	SD5	3rd corner	18.00	1.51	156.6	0.744	2.605
26	SE1	Entrance	15.00	1.26	130.5	0.620	2.171
27	SE2	Center	14.00	1.18	121.8	0.579	2.026
28	SE3	1st corner	18.00	1.51	156.6	0.744	2.605
29	SE4	2nd corner	14.00	1.18	121.8	0.579	2.026
30	SF1	Entrance	12.00	1.01	104.4	0.496	1.736
31	SF2	Dark room	7.00	0.59	60.9	0.289	1.013
32	SF3	Center	16.00	1.35	139.2	0.662	2.315
33	SF4	1st corner	16.00	1.35	139.2	0.662	2.315
34	SF5	2nd corner	14.00	1.18	121.8	0.578	2.026
35	SF6	Preparation room	13.00	1.09	113.1	0.538	1.881
		Mean	**13.51**	**1.16**	**119.92**	**0.165**	**0.516**

23.00 μRh^{-1} exposure rate was recorded at biosystematics/plant taxonomy research laboratory (BRL5) and MCB major laboratory (MCB4) respectively. Fig. 3 shows the comparison of annual effective dose equivalent calculated from the absorbed dose in pharmacy

Table 3. Indoor ambient radiation level in pharmacy laboratories and their radiological parameters

S/N	Sample Code	location	Average Exposure rate (μRh^{-1})	Equivalent dose rate (mSvy^{-1})	D (nGyh^{-1})	AEDE (mSvy^{-1})	ELCR ×10^{-3}
1	PHL1	Entrance	10.00	0.84	87.0	0.414	1.447
2	PHL2	Center	9.00	0.76	78.3	0.372	1.302
3	PHL3	1st corner	15.00	1.26	130.5	0.620	2.171
4	PHL4	2nd corner	11.00	0.93	95.7	0.455	1.592
5	PHL5	3rd corner	11.00	0.93	95.7	0.455	1.592
6	PHL6	Preparatory room	19.00	1.60	165.3	0.786	2.749
7	OPMC1	Entrance	9.00	0.76	78.3	0.372	1.302
8	OPMC2	1st corner	14.00	1.18	121.8	0.579	2.026
9	OPMC3	2nd corner	12.00	1.01	104.4	0.496	1.736
10	OPMC4	3rd corner	14.00	1.18	121.8	0.579	2.026
11	PHM1	Center	16.00	1.35	139.2	0.662	2.315
12	PHM2	Preparatory room	12.00	1.01	104.4	0.496	1.736
13	PHM3	Store	9.00	0.76	78.3	0.372	1.302
14	MRL1	Preparatory room	10.00	0.84	87.0	0.414	1.447
15	MRL2	1st corner	8.00	0.67	69.6	0.331	1.158
16	MRL3	2nd corner	10.00	0.84	87.0	0.414	1.447
17	MRL4	3rd corner	12.00	1.01	104.4	0.496	1.736
18	MRL5	4th Corner	11.00	0.93	95.7	0.455	1.592
19	PSB1	Preparatory room	15.00	1.26	130.5	0.620	2.171
20	PSB2	1st corner	16.00	1.35	139.2	0.662	2.315
21	PSB3	2nd corner	19.00	1.60	165.3	0.786	2.749
22	PSB4	3rd corner	13.00	1.09	113.1	0.538	1.881
23	PSB5	4th Corner	14.00	1.18	121.8	0.579	2.026
24	MCB1	Fume cupboard	16.00	1.35	139.2	0.662	2.315
25	MCB2	Preparatory room	19.00	1.60	165.3	0.786	2.749
26	MCB3	1st corner	12.00	1.01	104.4	0.496	1.736
27	MCB4	2nd corner	23.00	1.93	200.1	0.951	3.328
28	MCB5	3rd corner	20.00	1.68	174.0	0.827	2.894
29	MCB6	4th Corner	12.00	1.01	104.4	0.496	1.736
30	BRL1	Entrance	18.00	1.51	156.6	0.744	2.605
31	BRL2	1st corner	19.00	1.60	165.3	0.786	2.749
32	BRL3	2nd corner	16.00	1.35	139.2	0.662	2.315
33	BRL4	3rd corner	13.00	1.09	113.1	0.538	1.881
34	BRL5	4th Corner	6.00	0.51	52.2	0.248	0.868
		MEAN	**12.86**	**1.083**	**111.69**	**1.109**	**1.25**
		Environmental microbiology laboratory					
35	EMRL1	Entrance	11.00	0.93	95.7	0.455	1.592
36	EMRL2	1st corner	15.00	1.26	130.5	0.620	2.171
37	EMRL3	2nd corner	10.00	0.84	87.0	0.414	1.447
38	EMRL4	3rd corner	13.00	1.09	113.1	0.538	1.881
39	EMRL5	4th Corner	14.00	1.18	121.8	0.578	2.026
40	FIML1	Entrance	10.00	0.84	87.0	0.414	1.447
41	FIML2	1st corner	16.00	1.35	139.2	0.662	2.315
42	FIML3	2nd corner	26.00	2.19	226.2	1.075	3.762
43	FIML4	3rd corner	17.00	1.43	147.9	0.703	2.460
44	FIML5	4th Corner	8.00	0.67	69.60	0.331	1.158
		MEAN	**14.0**	**1.18**	**115.10**	**0.526**	**2.026**

laboratories with the ICRP permissible limit. The figure clearly show that the values of all the sampling points.

Table 3 also presents the radiation levels measured at the environmental microbiology laboratory. The exposure rate ranges from 8.00 to 26.00 μRh^{-1} with mean value of 14.0 μRh^{-1}. The equivalent dose rate ranges from 0.67 to 2.19 mSvy^{-1} with mean value of 1.18 mSvy^{-1}. Absorbed dose rate ranges from 69.60 to 226.2 nGyh^{-1} with mean value of 115.10 nGyh^{-1} while the annual effective dose ranges from 0.331 to 1.075 mSvy^{-1} with mean value of 0.526 mSvy^{-1}. The excess lifetime cancer risk ranges from 1.16 × 10^{-3} to 3.76 × 10^{-3} with mean value of 2.03 × 10^{-3}. The minimum and maximum radiation levels in all the sampled laboratories show that the indoor ambient radiation are not evenly distributed in all sampled points. This may be due to different point sources of radiation within the laboratories and different concentrations of radon gas due to different room conditions of the laboratories. The building materials in the laboratories may contain traces of uranium and thorium which emits radiation as they decay to stable nuclei [18].

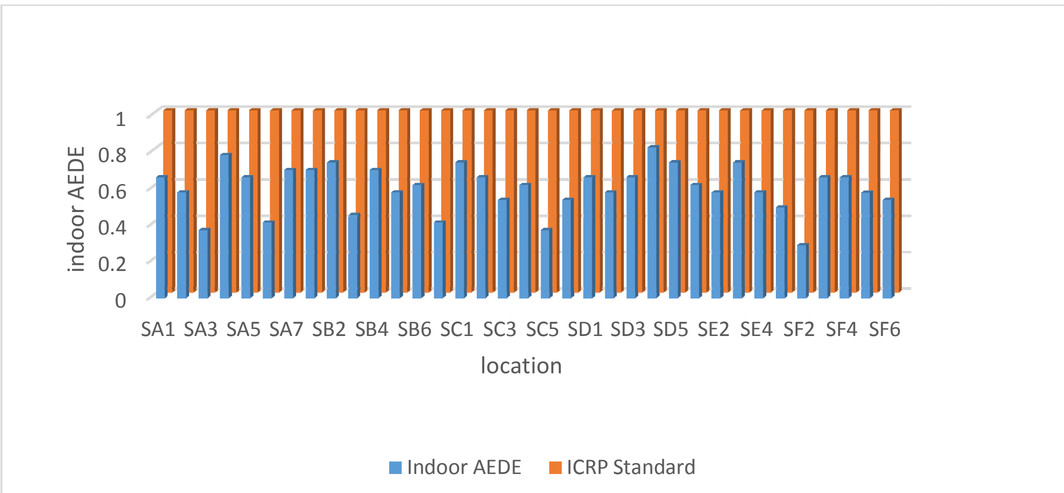

Fig. 2. Comparison of indoor annual effective dose equivalent of physics laboratories with ICRP standard

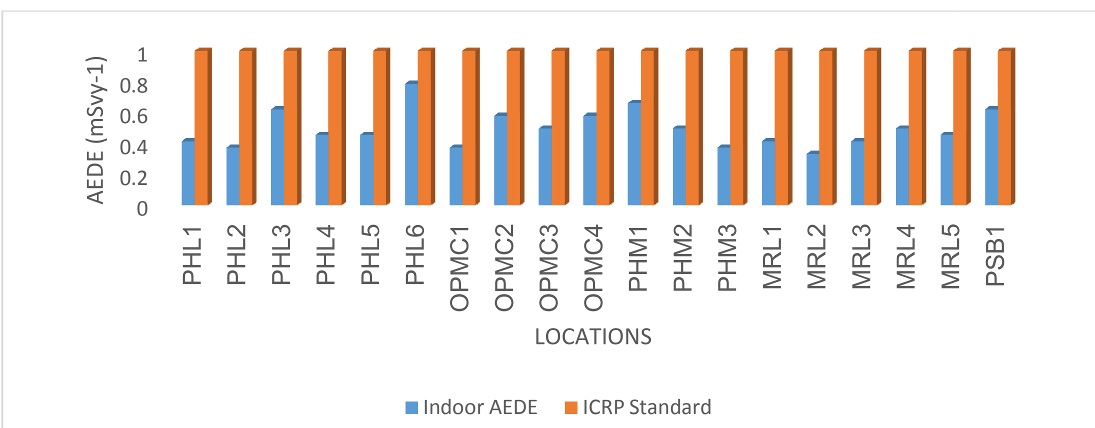

Fig 3. Comparison of indoor annual effective dose equivalent in pharmacy laboratories with ICRP standard

Table 4. Outdoor ambient radiation levels around science laboratories ofrima and their radiological parameters

S/N	Location	GPS	Exposure (μRh^{-1})	Equivalent dose ($mSvy^{-1}$)	Absorbed dose ($nGyh^{-1}$)	AEDE ($mSvy^{-1}$)	ELCR $\times 10^{-3}$
1	College hall	N454.283 E655.329	16.0	1.35	139.20	0.171	0.599
2	Anatomy	N454.274 E655.353	8.00	0.67	69.60	0.085	0.298
3	Ofrima entrance	N454.289 E655.329	15.5	1.30	134.90	0.165	0.578
4	Back of MBA2	N454.302 E655.323	19.0	1.60	165.30	0.203	0.711
5	SLT office	N454.299 E655.327	12.0	0.049	104.40	0.128	0.448
6	Center of Ofrima	N454.299 E655.326	16.0	1.35	139.20	0.171	0.599
7	Ofrima gate	N454.248 E655.294	8.00	0.67	69.60	0.085	0.298
8	Fine arts studio 1	N454.244 E655.309	15.5	1.30	134.90	0.165	0.578
9	Fine arts studio 2	N454.238 E655.326	9.00	0.76	78.30	0.096	0.336
10	Inside park 1	N454.247 E655.341	19.0	1.60	165.30	0.203	0.711
11	Back of Anatomy 1	N454.292 E655.349	12.5	1.05	108.75	0.133	0.466
12	Back of Anatomy 2	N454.283 E655.329	11.5	0.97	100.05	0.123	0.431
13	Beside MBA 1	N454.274 E655.316	14.5	1.22	126.15	0.155	0.543
14	Centre of Ofrima park	N454.260 E655.325	18.0	1.51	156.60	0.192	0.672
15	Beside MBA 1	N454.277 E655.395	14.5	1.22	126.15	0.155	0.543
16	Beside MBA 2	N454.283 E655.329	6.5	0.55	56.55	0.069	0.241
17	Front of MBA2	N454.289 E655.421	16.0	1.35	139.20	0.171	0.599
18	Back of MBA 1	N454.275 E655.391	17.0	1.43	147.90	0.181	0.634
19	Ofrima Park corner	N454.262 E655.329	19.0	1.60	165.30	0.186	0.651
20	Deans parking lot	N454.259 E655.322	15.2	1.28	132.24	0.162	0.567
		Mean	**14.14**	**1.14**	**117.24**	**0.150**	**0.525**

The values of indoor radiation levels obtained in all the science laboratories at Ofrima are similar to the reported values in laboratories of the town Campus University of Uyo by Esen et al. [5] and Felix et al. [19]. Some of the radiation parameters estimated (absorbed dose, equivalent dose, excess lifetime cancer risk) exceeded their world permissible values. Owing to the differences in instrument, equipment, chemical, and reagents in various laboratories, there are varying levels of radiation in all the laboratories. The highest annual effective equivalent of 1.075 was recorded at FIML3 which is higher than the permissible value of 1.0 m Svy^{-1} for the general public.

The outdoor ambient radiation levels around science laboratories and their radiological parameters are presented in Table 4. The exposure rate ranges from 6.50 to 19.0 μRh^{-1}.

The minimum value of 6.5 μRh^{-1} was recorded at MBA2 while the highest value of 19.0 μRh^{-1} was recorded at Ofrima Park and back of MBA2. This could be due to its proximity to food/industrial MCB laboratory that recorded maximum exposure rate of 26.0μRh^{-1} due to sophisticated machines that emits radiation to the environment. The equivalent dose rate ranges from 0.55 to 1.60 $mSvy^{-1}$ with mean value of 1.14 $mSvy^{-1}$. Absorbed dose ranges from 56.55 to 165.30 $nGyh^{-1}$ with mean value of 117.24 $nGyh^{-1}$ while the annual effective dose equivalent ranges from 0.069 to 0.203 mSvy-1 with mean value of 0.150 mSvy-1. The excess lifetime cancer risk ranges from 0.241×10^{-3} to 0.711×10^{-3} with mean value of 0.53×10^{-3}. The average indoor ambient radiation levels in all the science laboratories are slightly higher than that measured by Felix et al. [18] and Al mugren, [19]. Exposure to high levels of radiation is known to cause cancer but the effects on human health from very low doses of radiation such as the doses from background radiation are very hard to determine because there are many other factors that can mask or distort the effects of radiation. For instances, among people exposed to high radon levels, cigarette smokers are much more likely to get lung cancer than non- smokers [20]. Lifestyle choices, geographical locations and individual sensitivity are difficult to account for when trying to understand the health effects of background radiation. The excess lifetime cancer risk estimated from the indoor and outdoor annual effective dose exceeded the world safe values of 0.29×10^{-3}. The indoor and outdoor average annual effective dose equivalent of 0.762 $mSvy^{-1}$ and 0.150 $mSvy^{-1}$ was obtained from all the laboratories and its environment. It is evident from the result that average indoor annual effective dose equivalent are higher than that of the outdoor annual effective dose equivalent and that obtained by Esen et al. [5]. The mean equivalent doses obtained in this study are consistently less than the world average dose of 2.4 $mSvy^{-1}$ for humans [8].

4. CONCLUSION

Environment radioactivity of science laboratories of Abuja campus of University of Port-Harcourt was measured using radiation monitoring meters (Radalert-100 and digilert-200). From the result findings, radiation level above permissible limits was observed in physics laboratories, pharmacognosy & phytotherapy laboratory, MCB major laboratory, Biosystematics/plant Taxonomy Research laboratory and food/industrial microbiology laboratories. The absorbed doses and excess lifetime cancer risk estimated in all the studied laboratories exceeded their safe limits of 84.0 $nGyh^{-1}$ and 0.29×10^{-3} respectively.

For the purpose of assessing the exposure risks of the laboratory staff and students that uses such laboratories, there should be a regular and periodic monitoring of the background ionizing radiation level in such laboratories. The attendants should always open the windows to avoid buildup of radon gas in the laboratories. Radioactive sources in the laboratories should be marked with radiation sign and put in an isolated areas. The result of this study will serve as baseline data for future radioactive studies in science laboratories.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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