MEASUREMENT OF OUTDOOR AND INDOOR BACKGROUND IONIZING RADIATION OF O.B. LULU BRIGGS HEALTH CENTER, UNIVERSITY OF PORT HARCOURT, CHOBA, RIVERS STATE

ABSTRACT

Measure of outdoor and indoor background ionizing radiation of OB Lulu Briggs Health Centre in the University of Port Harcourt, Rivers State, Nigeria was carried out using a well-calibrated Radalert-100 (Radiation meter) and Digilert-200 meters and Global Positioning System (Garmin 765). The outdoor and indoor background ionizing radiation profile placed at 30 selected places which include both outdoor and indoor BIR. The mean of the average exposure rates of OB Lulu Briggs are (0.012±0.001 and 0.013±0.001) mR/h respectively. The mean of absorbed dose rate in OB Lulu Briggs Health Centre are (105.6 and 96.28) nGy/h respectively. The estimated value of the annual effective dose equivalent (AEDE) for outdoor and indoor exposure are (0.17 and 0.27) mSv/y, obtained in OB Lulu Briggs Health Centre area respectively. The mean excess lifetime cancer risk (ELCR) calculated for OB Lulu Briggs Health Centre have values of (0.60 and 0.92) x 10^{-3} respectively. The obtained values for BIR in OB Lulu Briggs Health Centre are not above the recommended standard limit of 0.013mR/h by ICRP. AEDE that was calculated in the entire Lulu Briggs is within safe values, the ELCR and the ADR estimated were higher than the world permissible values of 0.29 x 10^{-3} and 84.0nGy/h respectively. The calculated dose to organs for OB Lulu Briggs showed that the testes have the highest organ dose of (0.140667 and 0.218053) mSv/y.

Keywords: Annual effective dose equivalent, Digilert 200, Excess Lifetime Cancer Risk, absorbed dose rates, Background ionization radiation.

INTRODUCTION

The environment is an intricate ecological system, consisting of many different and connected parts and an undesirable or harmful impact on any part of the environment invariably affects other parts (1). The environment is very critical for the survival of humans as such the environment is very important to human existence. It can be polluted if it is exposed to harmful substances thereby causing damaging effect on man such as cancer and genetic mutation etc.,

Ionizing radiation is a form of energy that acts by removing electrons from atoms and molecules thereby ionizing them. The absorption of such energy over a very long-time results to tissue damage and disruption of cellular function at the molecular levels of the given interest. Chronic exposure might lead to radiation related sicknesses such as sterility, cancer, atrophy of kidney etc., various products in Lulu Briggs have nuclides in them that might emit radiation of varying levels. This might enhance the background radiation status of such hospital.

Abubakar *et al* (7) measured and obtained the indoor ionizing radiation profile placed at 22 selected presumable hotspots within the Radiology department of Federal Medical Centre (FMC) Asaba. The calculated mean indoor post exposure dose value was in the range of 0.09 – 0.20

μSv/hr (0.60-2.01 mSv/yr). The highest point with increased radiation dose was found to being the diagnostic x-ray room (2.01±4.11 mSv/yr), while the lowest point was detected at the intern's common room with a value of 0.60±0.3 mSv/yr. The overall mean of the Mean Indoor Post Exposure (mMIPE) was arrived at 0.88±0.28mSv/yr.

Ononugbo *et al* (5) also evaluated the effective dose and excess lifetime cancer risk from indoor and outdoor gamma rate of the University of Port Harcourt Teaching Hospital, Rivers State. The average values for indoor and outdoor gamma doses were found to be greater than the world population weighted average for indoor gamma dose rate of 89 $nGyh^{-1}$. The result shows that ELCR for both indoor and outdoor exposure were higher than the world acceptable value of 0.29×10^{-3}, though the annual effective dose levels in all of the locations (indoor and outdoor) were below the $1mSvy^{-1}$ maximum permissible limit for the public set by International Commission on Radiological protection (3).

Behzad Fouladi Dehaghi *et al* (8) investigated on the background ionization radiation in radiography centers in Ahvaz, Iran. The measured locations included behind the door of the X-ray room, outdoor, waiting room for the people, and the reception section in each center. The indoor radiation levels were 0.13 ± 0.004, 0.11 ± 0.004, 0.13 ± 0.004, 0.16 ± 0.007, and 0.16 ± 0.006 μSv/h for centers *a, b, c, d,* and *e*, respectively, and the outdoor radiation levels were 0.12 ± 0.02, 0.11 ± 0.01, 0.10 ± 0.00, 0.12 ± 0.01, and 0.13 ± 0.00 μSv/h, respectively. The mean equivalent dose in this study was lower than the standard level (1 mSv/y).

Monitoring radiological parameters in the environment especially industrial area where man's activities tend to pose more risks of relation exposure is very essential to maintain the radiation within the average limit as recommended by International Commission on Radiological protection (ICRP) and United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR).This work aim to bring the relationship between the radiation activities and Background Ionizing Radiation level of OB Lulu Briggs Health Centre in University of Port Harcourt.

2. MATERIALS AND METHODS

2.1 STUDY AREA

Lulu Briggs Health Centre is a Health Centre in the University of Port Harcourt, Rivers State, Nigeria. It is situated along East/West Road located in the Niger Delta. Its coordinates are $04^o54.126^oN$ and $006^o54.537^oE$.

Fig1: Map of Study Area

The background radiation was measured both indoor and outdoor of the Lulu Briggs Health Centre University of Port Harcourt. An in-situ approach of background ionizing radiation measurement was adopted to enable samples maintain their original environmental characteristics. A well calibrated Rad-monitor, Radalert-100 nuclear radiation monitoring meter (S.E. International Incorporation, Summer Town, USA), containing a Geiger-Muller tube capable of detecting alpha particles, beta particles, gamma rays and X-rays was used within the temperature range of -10^{o}C to 50^{o}C and a global positioning system (GPS) was used to measure the precise location of sampling outside the Lulu Briggs Health Centre in University of Port Harcourt, Choba. While randomly selected locations inside Lulu Briggs Health Centre in University of Port Harcourt, Choba were used for indoor sampling. The Geiger-Muller tube generates a pulse current each time radiation passes through the tube and causes ionization. Each pulse is electronically detected and registered as a count. The radiation meters were calibrated with a Cs-137 source of specific energy and set to measure exposures rate in milli-Roentgen per hour (mR/h). the meter has an accuracy of ±15%. The tube of the radiation monitoring meter was raised to a standard height of 1.0m above where the GPS reading was taken at that spot. Measurements were taken within the hours necessary since exposure rate meter has a peak response to environmental radiation within these hours, then the background radiation level was recorded. The switch (knob) was turned to return the meter to zero after each measurement. The generated data were converted to absorbed dose rate nGy/h using the relation for the external exposure rate by (6).

$$1\mu Rh^{-1} = 8.7nGyh^{-1} = 8.7 \times 10^{-3}\mu Gy/(\frac{1}{8760y})$$

1.1

3. RESULTS

3.1 Equivalent Dose Rate (EDR)

To estimate the whole-body equivalent dose rate over a period of one year, we used the National Council on Radiation Protection and Measurement's recommendation (6).

$$1mRh^{-1} = \frac{0.96\times24\times365}{100}mSvy^{-1}$$

1.2

3.2 Absorbed Dose Rate (ADR)

It is the energy imparted to matter (human body) from any type of radiation for a given period. The data obtained for the external exposure rate in mRh^{-1} were converted into absorbed dose rates $nGyh^{-1}$ using the conversion factor (2).

$$1\mu Rh^{-1} = 8.7nGyh^{-1}\frac{8.7\times10^{-3}}{(\frac{1}{8760y})} = 76.212\mu Gyy^{-1}$$

1.3

3.3 Annual Effective Dose Equivalent (AEDE)

The annual effective dose equivalent received by patients and staff of the three hospitals were estimated from the absorbed dose rate, a dose conversion factor of 0.7 Sv/Gy while the occupancy factor outdoor was 0.25. It has been estimated that people spend approximately 6 hours outdoors. The annual effective dose equivalent is determined using the following equations (2).

AEDE (outdoor) (mSv/y) = Absorbed dose rate (nGy/h) x 8760 h x 0.7Sv/Gy x 0.25 1.4

3.4 Excess Lifetime Cancer Risk (ELCR)

Excess lifetime cancer risk measures the stochastic effects produced by low dose background radiation. It is the additional cancer risk induced by exposure to ionizing radiation. Based on the calculated values of lifetime cancer risk is calculated values of lifetime cancer risk is calculated using the equation.

ELCR = AEDE x Average duration of life (DL) x risk factor (RF) 1.5

Where AEDE = Annual Effective Dose Equivalent
DL = Duration of life (70 years)
RF = Risk factor 0.05 (fatal cancer risk per Sievert)

3.5 Effective Dose Rate D_{organ} in $mSvy^{-1}$ to different organs and tissues

The effective dose rate to a particular organ can be calculated using the relations:

$$D_{organ}(mSvy^{-1} = O \times AEDE \times F$$

1.6

Where O (occupancy factor) = 0.8

F (conversion factor for organ dose from ingestion = 0.64(lungs), 0.58(ovaries), 0.69(bone marrow), 0.82(testes), 0.62(kidneys), 0.46(liver), 0.68(whole body). ICRP

The model of the annual effective dose to organs estimates the amount of radiation intake by a person (4).

Table 1: Outdoor BIR and Radiological Parameters of Lulu Briggs Health Centre

Sampling Point	BIR (mR/hr)	Equivalent Dose (mSv/y)	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
LU1	0.010	0.841	87.0	0.14	0.49
LU2	0.013	1.093	113.10	0.19	0.67
LU3	0.017	1.429	147.9	0.23	0.81
LU4	0.013	1.093	113.10	0.19	0.67
LU5	0.010	0.841	87.0	0.14	0.49
LU6	0.015	1.261	130.5	0.21	0.74
LU7	0.012	1.009	104.4	0.17	0.60
LU8	0.010	0.841	87.0	0.14	0.49
LU9	0.010	0.841	87.0	0.14	0.49
LU10	0.011	0.925	95.7	0.16	0.57
LU11	0.010	0.841	87.0	0.14	0.49
LU12	0.010	0.841	87.0	0.14	0.49
LU13	0.015	1.261	130.5	0.21	0.74
LU14	0.014	1.177	121.8	0.20	0.70
LU15	0.012	1.009	104.4	0.17	0.60
Mean	0.012±0.001	1.02±0.001	105.6±0.001	0.17±0.001	0.60±0.001
World Average	0.013	1.093	84.00	0.48	0.29

Table 2: Indoor BIR and Radiological Parameters of Lulu Briggs Health Centre

Sampling Point	BIR (μR/hr)	Equivalent Dose (mSv/y)	Absorbed dose (nGy/hr)	AEDE (mSv/y)	ELCR x 10^{-3}
DFR Pharmacy	0.014	1.177	104.4	0.48	1.68
Laboratory	0.014	1.177	104.4	0.48	1.68
TSIP Pharmacy	0.010	0.841	87.0	0.14	0.49
File Record Office	0.013	1.093	69.60	0.11	0.37
Waiting Room Ground floor	0.013	1.093	69.60	0.11	0.37
Mini Bed Area 1	0.013	1.093	69.60	0.11	0.37
Eye section	0.010	0.841	87.0	0.14	0.49
Stair Case Left	0.010	0.841	87.0	0.14	0.49
Stair Case Right	0.011	0.925	95.7	0.44	1.54
Mini Bed Area 2	0.016	1.346	156.6	0.29	0.96
Waiting Area First Floor	0.014	1.177	104.4	0.48	1.68

Finance Office	0.013	1.093	69.60	0.11	0.37
General Office	0.013	1.093	69.60	0.11	0.37
Upstairs Left	0.012	1.009	139.2	0.25	0.77
Upstairs Right	0.015	1.261	130.5	0.60	2.10
Mean	13.0±0.001	1.071±0.001	96.28±0.001	0.27±0.001	0.92±0.001
World Average	0.013	1.093	84.00	0.48	0.29

Table 3: Dose to different organ of outdoor of Lulu Briggs Health Centre

Sampling Point	D_{organ} (mSv/y)						
	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
LU1	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU2	0.1216	0.1102	0.1311	0.1558	0.1178	0.0874	0.1292
LU3	0.1472	0.1334	0.1587	0.1886	0.1426	0.1058	0.1564
LU4	0.1216	0.1102	0.1311	0.1558	0.1178	0.0874	0.1292
LU5	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU6	0.134	0.122	0.145	0.172	0.130	0.097	0.143
LU7	0.109	0.099	0.118	0.140	0.106	0.079	0.116
LU8	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU9	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU10	0.102	0.093	0.110	0.131	0.099	0.073	0.109
LU11	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU12	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
LU13	0.134	0.122	0.145	0.172	0.130	0.097	0.143
LU14	0.130	0.118	0.140	0.166	0.126	0.094	0.138
LU15	0.109	0.099	0.118	0.140	0.106	0.079	0.116
Mean	0.109733	0.0996	0.118433	0.140667	0.1064	0.079067	0.116733

Table 4: Dose to different organ of indoor of Lulu Briggs Health Centre

Sampling Point	D_{organ} (mSv/y)						
	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
DFR Pharmacy	0.3072	0.2784	0.3312	0.3936	0.2976	0.2208	0.3264
Laboratory	0.3072	0.2784	0.3312	0.3936	0.2976	0.2208	0.3264
TSIP Pharmacy	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
File Record Office	0.070	0.064	0.076	0.090	0.068	0.051	0.075
Waiting Room Ground floor	0.070	0.064	0.076	0.090	0.068	0.051	0.075
Mini Bed Area 1	0.070	0.064	0.076	0.090	0.068	0.051	0.075
Eye section	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
Stair Case Left	0.0896	0.0812	0.0966	0.1148	0.0868	0.0644	0.0952
Stair Case Right	0.2816	0.2552	0.3036	0.3608	0.2728	0.2024	0.2992
Mini Bed Area 2	0.1856	0.145	0.2001	0.2378	0.1798	0.1334	0.1972
Waiting Area First Floor	0.3072	0.2784	0.3312	0.3936	0.2976	0.2208	0.3264

Finance Office	0.070	0.064	0.076	0.090	0.068	0.051	0.075
General Office	0.070	0.064	0.076	0.090	0.068	0.051	0.075
Upstairs Left	0.160	0.145	0.173	0.205	0.155	0.115	0.170
Upstairs Right	0.344	0.348	0.414	0.492	0.372	0.276	0.4692
Mean	0.16744	0.1528	0.183607	0.218053	0.164853	0.164853	0.185027

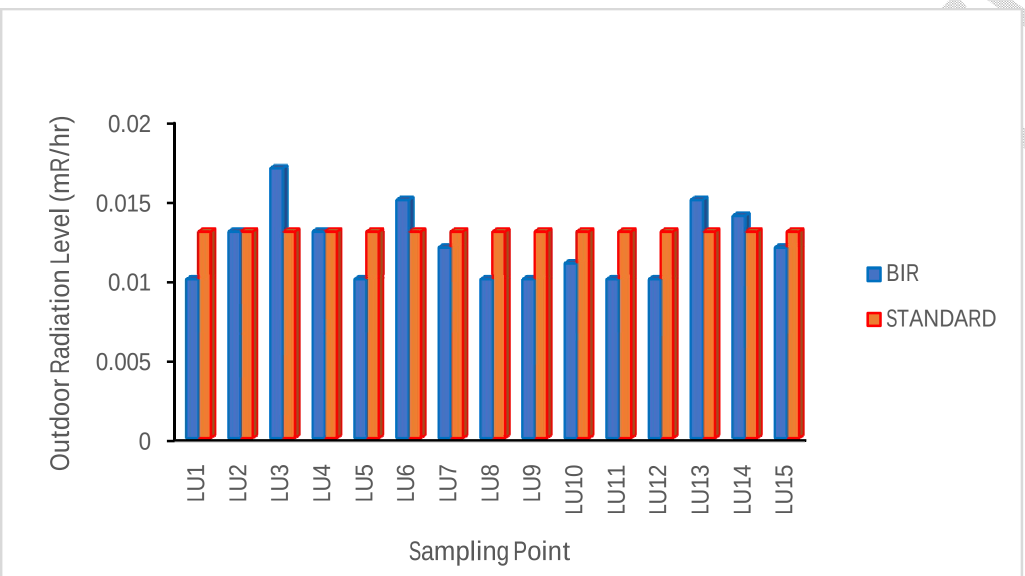

Fig 2: Comparison of Outdoor Radiation level of OB Lulu Briggs Health Centre with the Standard Radiation Level.

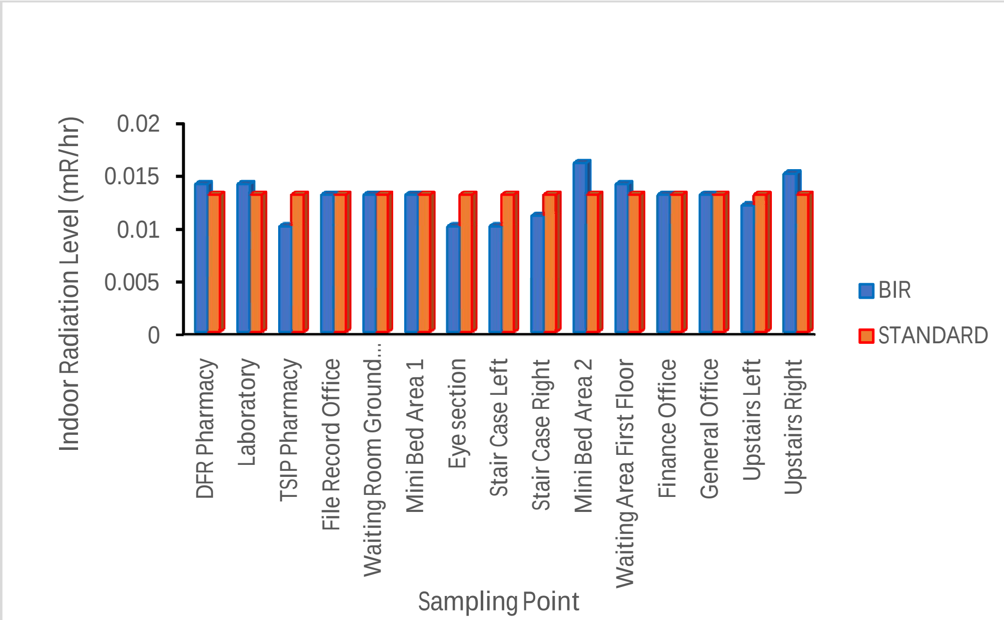

Fig 3: Comparison of Indoor Radiation level of OB Lulu Briggs Health Centre with the Standard Radiation Level.

The results obtained are presented in Tables 1 to 2. The average exposure rate, absorbed dose rate, equivalent dose rate, annual effective dose equivalent, excess lifetime cancer risk and organ dose of the thirty locations are in the tables. Figures 2 and 3 show the results when compared with the value of the background ionizing level for outdoor and indoor of OB Lulu Briggs Health Centre. The average exposure rate (mR/hr) of Lulu Briggs for both outdoor and indoor range from 0.010mR/hr to 0.017mR/hr and 0.010mR/hr to 0.016mR/hr with total mean values 0.012 ± 0.001mR/hr and 0.013 ± 0.001mR/hr respectively. About four sampling point which are LU3 (0.017), LU6 (0.015), LU13 (0.015), LU14 (0.014) for that of the outdoor and about six sampling point for that of the indoor area which include: DRF Pharmacy (0.014), Laboratory (0.014), Staircases (0.016), Staircase Right (0.014), General Office (0.015), Upstairs left (0.014) where higher than ICRP standard value of 0.013mR/hr but nevertheless the mean for the average exposure rate (mR/hr) was not higher than the ICRP standard value as shown in tables 1 and 2. The reason for that higher ICRP standard value in those sampling point was as a result of presence of products that emits radionuclides and due to poor waste management system. The absorbed dose rate of radiation of outdoor and indoor from study area range from 87.000nGy/hr to 147.900nGy/hr and 69.600nGy/hr to 156.600nGy/h. The mean value for both outdoor and indoor were higher than the standard value of 84nGy/h but lower than Ononugbo *et al* (5). For the AEDE calculated the values ranged between 0.14mSv/y to 0.23mSv/y and 0.11mSv/y to 0.60mSv/y for outdoor and indoor respectively with mean values of 0.17mSv/y and 0.27mSv/y. These mean values obtained were lower than the standard value of 0.48mSv/y due to no presence of industrial radioactive operations in the area. The calculated ELCR values show that the chances of contracting cancer for the workers of the study does not show immediate effect but have future cancer implication. The calculated effective dose delivered to the adult body for OB Lulu Briggs Health Centre are shown in tables 3 and 4. The testes recorded the highest dose (0.140667mSv/y and 0.218053mSv/y) for both outdoor and indoor, while the liver records the least values. The obtained results show that the estimated dose to different organs are all below the international tolerance limits on dose to body organs of 1.0mSv/y.

Conclusion

In conclusion, the study reveals that the BIR maintains the standard limit of 0.013mR/hr. these results however do not indicate that BIR monitoring and evaluation should stop but it should be carried out from time to time. There should be improvement on waste management system in order to maintain or reduce ionizing radiation emission from waste.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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