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Indoor Background Ionizing Radiation Levels in Three Selected Departments of Federal Teaching Hospital, Gombe, Gombe State

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Abstract

This study has assessed the level of indoor background ionizing radiation in the pharmacy, radiotherapy/oncology, and radiology departments of Federal Teaching Hospital, Gombe. To achieve the required objectives, the RADOS 200 survey meter was used to captured the radiation level. The meter was held 1 meter above ground level and the readings were taken at various locations (as determined by a hand GPS) within each department. The cumulative mean background radiation exposures in the pharmacy, radiotherapy/oncology and radiology departments were estimated to be 0.0891 ± 0.0126 μSv/hr, 0.0780 ± 0.0173 μSv/hr and 0.0900 ± 0.0143 μSv/hr respectively. In conclusion, results obtained in this study show that the indoor background ionizing radiation for the sampled location comply with the 0.133 μSv/hr maximum dose limit for the public as recommended by the International Commission on Radiological Protection (ICRP).

Keywords: Rados survey meter, sampled location, the dose limit, cumulative mean

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Introduction

Radiation is simply defined as energy in motion that is emitted from a source and travels through space in all directions. Non-ionizing radiation is defined as radiation with a low enough energy to produce no or minimal harm to obstructing bodies (atoms). The other type of radiation, known as ionizing radiation, is the most dangerous since its energy exceeds 10 eV, which is large enough to break atoms, resulting in the formation of ions and causing biological injury (Oladele *et al.*, 2018). This means that, depending on the amount of ionizing radiation ingested, the cells in a person's body will be impacted (Owusu-Banahene *et al.*, 2018). The early aftermaths of the discovery of x-rays can be traced back to the revelation of the dangers of ionizing radiation for both workers and the general public. Radiation-induced skin ailments such as erythema and ulcerations were the first examples recorded in 1896, while cancer cases were first recorded in 1902 (Abubakar *et al.*, 2017). Radiation can also cause sterility, skin burns, gene mutations, tumors, organ and tissue damage, and even death in high dose situations (Tikyaa *et al.*, 2017).

On a daily basis, humans are exposed to ionizing radiation in the atmosphere or surroundings (background radiation), which comes from both natural and man-made sources (James *et al.*, 2015). Among all anthropogenic sources of ionizing radiation, radiation exposure from radiology modalities has been the highest (Taskin *et al.,* 2009). As a result, background radiation levels must be measured in areas where they are used to guarantee that radiation levels are below safe limits (Achuka *et al.,* 2019). Due to high level of leaking radiation, the patient, operator, and general public were exposed to more radiation. (Muhammad *et al.,* 2018). The bremsstrahlung process, which creates x-rays, is used in the majority of radiology modalities. X-rays are thought to account for around 14% of total global radiation exposure from both man-made and natural sources (González *et al.,* 2004). Achuka *et al.,* (2019) studied the assessment of the level of radiation exposure from radiography facilities in selected radio diagnostic centers in the south western part of Nigeria using Digilert 200, the result showed that the mean background exposure in the sample centers, were found to vary from 0.137 to 0.183 *µSv/h*. The background radiation doses from the exposure level in all the centers were found to exceed the recommended limits. Also, another study carried out by James *et al.,* (2015) involved the measurement of indoor and outdoor background ionizing radiation level at Kwali General Hospital, Abuja, Nigeria using a well calibrated Geiger muller counter; Atomtex AT1117M radiation monitor. The results obtained showed that the dose equivalents ranged from 0.100±0.001 µSv/h to 0.124±0.007 µSv/h with an average of 0.107±0.003 µSv/h for indoor measurement. The study further revealed that the obtained values are slightly below the standard background radiation. Also, since radioisotopes, like various isotopes of iodine, are employed in the pharmacy department, the area might contain a certain amount of ionizing radiation. All of the aforementioned departments, as well as radiotherapy and oncology, are present at Federal Teaching Hospital Gombe. The International Commission on Radiological Protection, on the other hand, suggests that occupational radiation exposure be limited to 0.133 µSv/h (ICRP, 2007).

Materials and Methods

The following are the materials that were used for the research. A well-calibrated multi-purpose survey meters (RADOS 200) was used to measure the background radiation. The device can detect gamma rays, X-rays and Beta Radiation. And it was calibrated with a calibration factor of 0.1 at Ahmadu Bello University's Center for Energy Research and Training in Zaria, under the International Atomic Energy Agency, (IAEA, 2016). A Global Positioning System (GPS) was used to determine the exact location of each of the sampling points within the study area.

Methods

Taking Readings with the Survey meter (Dose Rate Measurement)

The zero error of the survey was first checked and recorded alongside the calibration factor of the instrument. At each strategic point within the study area, the survey meters were placed at a height of 1 meter from the ground level. Then the readings were taken three times at each location within each department and the average values were obtained in each case. The figures/tables were calculated and analyzed using Microsoft Excel software.

Calculation of the Standard Deviation to the Mean

The standard deviation from each mean value obtained will be estimated using the relation:

$$S.D = \sqrt{\frac{1}{N}\sum_{i=0}^{N}(x_i - \mu)^2}$$

Where: N = number of readings in each instance

X_i = individual values from the survey meter

µ = mean value.

Comparing Findings with the Recommended Values

The cumulative mean values for radiation levels from each of the sampled departments were compared to each other to determine areas of minimum and maximum radiation dose rates and the contribution of radiation to each sampled department were obtained using a pie chart.

Results

The indoor mean background radiation estimated from three different measured dose rates obtained using the survey meters and are presented in tables 1, 2, and 3 respectively. The measurements show that the maximum cumulative mean indoor ionizing radiation was observed in the radiology department and the minimum in the radiotherapy/oncology with values of 0.0900 ± 0.0143 µSv/hr and 0.0780 ± 0.0173 µSv/hr respectively as shown in table 4. The percentage distribution of radiation level to each selected department are shown in Figure 1.

Table 1: Background Radiation Estimates in the Pharmacy Department

Location Code	Name	GPS Reading	Survey Meter Readings (µSv/hr) 1st	2nd	3rd	Mean (µSv/hr)	S. D	Mean ± S. D
P1	HOD Office	Lat.10°17'52"N Lon.11°8'18"E	0.06	0.07	0.08	0.0700	0.0082	0.0700 ± 0.0082
P2	Toilet	Lat.10°17'58"N Lon.11°8'17"E	0.04	0.04	0.03	0.0367	0.0047	0.0367 ± 0.0047
P3	Cloak Area	Lat.10°18'0"N Lon.11°8'16"E	0.04	0.06	0.07	0.0567	0.0125	0.0567 ± 0.0125
P4	Semi-packaging Area	Lat.10°17'55"N Lon.11°8'17"E	0.10	0.12	0.09	0.1033	0.0125	0.1033 ± 0.0125
P5	Aseptic Room	Lat.10°17'59"N Lon.11°8'25"E	0.15	0.13	0.16	0.1467	0.0125	0.1467 ± 0.0125
P6	NHIS Pharmacy	Lat.10°17'51"N Lon.11°8'17"E	0.14	0.12	0.07	0.1100	0.0294	0.1100 ± 0.0294
P7	A & E/ GOPD	Lat.10°17'52"N Lon.11°8'17"E	0.11	0.09	0.10	0.1000	0.0082	0.1000 ± 0.0082

'NHIS'-National Health Insurance Scheme, 'A & E'/'GOPD'- Accident and Emergence/General Outpatient Department

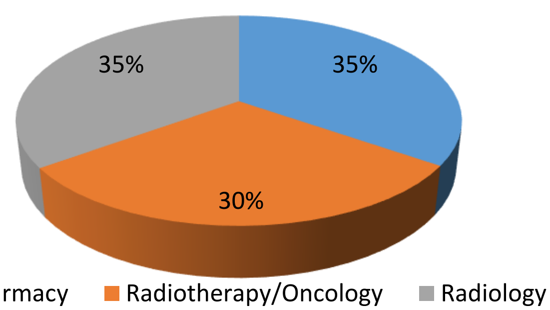

Figure 1. Mean Distribution of Background Ionizing Radiation within Each of the Sampled Departments

Table 2: Background Radiation Estimates in the Radiotherapy/Oncology Department

Location Code	Name	GPS Reading	Survey Meter Readings (µSv/hr)			Mean (µSv/hr)	S. D	Mean ± S. D
			1st	2nd	3rd			
R1	Control Room	Lat.10º17'53"N Lon.11º8'19"E	0.03	0.06	0.11	0.0667	0.0330	0.0667 ± 0.0330
R2	Toilet	Lat.10º17'52"N Lon.11º8'22"E	0.08	0.10	0.09	0.0900	0.0082	0.0900 ± 0.0082
R3	Resident Room	Lat.10º17'50"N Lon.11º8'19"E	0.07	0.09	0.10	0.0867	0.0125	0.0867 ± 0.0125
R4	Medical Physicist Office	Lat.10º17'51"N Lon.11º8'19"E	0.06	0.07	0.09	0.0733	0.0125	0.0733 ± 0.0125
R5	Reception	Lat.10º17'53"N Lon.11º8'19"E	0.05	0.07	0.10	0.0733	0.0205	0.0733 ± 0.0205

Table 3: Background Radiation Estimates in the Radiology Department

Location Code	Name	GPS Reading	Survey Meter Readings (µSv/hr)			Mean (µSv/hr)	S. D	Mean ± S.D
			1st	2nd	3rd			
R1	Radiographers Room	Lat.10º17'52"N Lon.11º8'17"E	0.03	0.06	0.11	0.1267	0.0205	0.1267 ± 0.0205
R2	Processing Room	Lat.10º17'35"N Lon.11º8'33"E	0.08	0.10	0.09	0.1133	0.0170	0.1133 ± 0.0170
R3	X-ray Room	Lat.10º17'47"N Lon.11º8'33"E	0.07	0.09	0.10	0.0533	0.0125	0.0533 ± 0.0125
R4	Patients' Waiting Room	Lat.10º17'47"N Lon.11º8'20"E	0.06	0.07	0.09	0.0633	0.0047	0.0633 ± 0.0047
R5	Dark Room	Lat.10º17'35"N Lon.11º8'34"E	0.05	0.07	0.10	0.0933	0.0170	0.0933 ± 0.0170

Table 4: Cumulative Mean Dose Rate (CMDR) and Cumulative Standard Deviation (CSD) in the Three Sampled Departments

Department	Cumulative Mean Dose Rate (µSv/hr)	Cumulative Standard Deviation	C.M.D.R ± C.S.D
Pharmacy	0.0891	0.0126	0.0891±0.0173
Radiotherapy/Oncology	0.078	0.0173	0.0780 ±0.0173

Discussion

In the department of pharmacy, mean values ranged from 0.0367±0.0047 to 0.1467±0.0125 µSv/hr as seen in table 1. The aseptic room (compounding unit) in this department records the highest overall mean value (0.1467±0.0125 µSv/hr). This is probably due to the reagents used in compounded sterile preparations whose components include ingredients used in drug manufacturing including those that may not appear on the drug label. The average mean value in the department is 0.0891 ± 0.0126 µSv/hr as seen in table 4.

The radiotherapy/oncology department has the lowest cumulative mean value (0.0780±0.0173 µSv/hr) as seen in table 4 and Figures 1. The mean value ranged from 0.0667±0.0330 to 0.0900±0.0082 µSv/hr as shown in table 2. The control room's low dose rate might be attributed to the adequate shielding barrier, especially against the brachytherapy room. In totality, the low mean value in the radiotherapy/oncology department could be as a result of the fact that the brachytherapy room has not been in use for almost six months as of the time of this report due to insufficient radiation source (Iridium-192) needed for treatment. However, a significant amount of background radiation was still recorded and this might be because of close proximity of the radiology department and is very much in operation.

In the radiology department, mean readings ranged from 0.0533±0.0125 to 0.1267±0.0205 µSv/hr are shown in table 3. Although, the cumulative mean value (0.0900±0.0143 µSv/hr) shares an approximately equal amount with that of the pharmacy department (0.0891±0.0126 µSv/hr), as shown in table 4. Also, the radiation level in the pharmacy department especially the aseptic room (compounding unit) is higher than the background radiation exposure limit as this may likely pose a great health problem to the public and workers in the nearest future.

The results obtained in this study are quite lower than the results obtained by Achuka *et al.*, (2019) in radio diagnostic centers in the south western part of Nigeria which showed that the mean background exposure in the sample centers, were found to vary from 0.137 to 0.183 *µSv/h*. Also results obtained in Kwali General Hospital by (James *et al.*,2015) showed that the dose equivalents ranged from 0.100±0.001 to 0.124±0.007 µSv/h with an average of 0.107±0.003 µSv/h for indoor measurement, these are quite similar to the results in the present study. The results revealed that the indoor dose levels in all the locations were far below the maximum permissible limit of 0.133 µSv/hr (ICRP maximum permissible limit) for the public. Hence, the radiation levels in these selected departments may not indicate any possible harm to the workers and public. These results can serve as a reference for estimating the indoor background radiation in other locations. All mean values are within the reference limit, this study still recommends continual periodic area monitoring to ensure that radiation levels remain within the recommended limit.

The assessment of the indoor background ionizing radiation level in the pharmacy, radiotherapy/oncology, and pharmacy departments of Federal Teaching Hospital, Gombe has been carried out. The mean dose rates in those departments were determined. The results obtained showed that ALARA (As Low as Reasonably Achievable) procedures were continually obeyed in the sampled departments since all mean values were all within the 0.133 µSv/hr reference limit.

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References

Abubakar, A., Sadiq, A.A., Musa, M.G., Hassan, J and Malgwi, D.F. (2017). Assessment of Indoor Ionizing Radiation

Profile in Radiology Department, FMC Asaba, Delta State, Nigeria. *IOSR Journal of Dental and Medical Sciences* 16 (1): 98 – 101.

Achuka, J.A., Usikalu, M.R., Aweda, M.A., Onumejor, C.A and Babarimisa (2019). Background Radiation Dose in Selected X-ray Facilities in southwest Nigeria. *Journal of Physics: Conf. series* 1299: 012103

González, A.B. and Darby, S. (2004). Risk of Cancer from Diagnostic X-rays: Estimates for the UK and 14 other Countries, Lancet. 363(9406): 345-351

International Atomic Energy Agency, IAEA (2016). Exposure to Radiation from Natural Sources. Nuclear Safety and Security.

International Commission on Radiological Protection, ICRP (2007). Radiological Protection in Medicine. Annals of the ICRP 37(2-4): 1 – 332

James, I.U., Moses, I.F., Vandi, J.N and Ikoh, U.E. (2015). Measurement of Indoor and Outdoor Background Ionising Radiation Levels in Kwali General Hospital Abuja. *Journal of Applied Science and Environmental Management.* 19 (1): 89 – 93

Muhammad, N. A., Nuraddeen, N. G. and Michael, A. O. (2018). Quality Control Analysis of Diagnostic Radiology Equipment In 44 Nigerian Army Reference Hospital Kaduna, Kaduna State, Nigeria. *FUDMA Journal of Sciences (FJS)*, 2(4): 61 - 66

Nigerian Radiation Safety in Diagnostic and Interventional Radiology (2006). Nigerian Radiation Safety in Diagnostic and Interventional Radiology Regulations. Nuclear Safety and Radiation Protection Act (1995 No. 19)

Oladele, B.B, and Arogunjo, A.M. (2018). Assessment of Background Radiation Levels in Selected Diagnostic Radiology Department Across Ondo State, Nigeria. *Nigeria Journal of Pure and Applied Physics*, 8(1): 16-19.

Owusu-Banahene, J., Darko, E.O., Charles, D.F., Maruf, A., Hanan, I and Amoako, G. (2018). Scatter Radiation Dose Assessment in the Radiology Department of Cape Coast Teaching Hospital-Ghana. *Open Journal of Radiology* 8: 299-300.

Taskin, H., Karavas, M., Ay, P., Topuzoglu, A., Hindiroglum, S and Karahan, G. (2009). Radionuclide Concentrations in Soil and Lifetime Cancer Risk due to Gamma Radioactivity in Kirklareli, Turkey. *Journal of Environmental Radioactivity*, 100: 49-53.

Tikyaa, E.V, Atsue, T and Adegboyega, J. (2017). Assessment of The Ambient Background Radiation Levels at The Take-Off Campus of Federal University Dutsin-Ma, Katsina State, Nigeria. *FUDMA Journal of Sciences (FJS) Maiden Edition*, 1: 58 - 68