

RADIATION RISK ASSESSMENT FROM BACKGROUND RADIATION EXPOSURES IN SELECTED HOSPITALS IN SOUTH – SOUTH NIGERIA.

Abstract

Aim: This work was carried out to determine the radiation risk from background ionizing radiation exposures of selected hospitals in South-South, Nigeria. **Study Design:** This study was purely an experimental work. **Place and Duration of Study:** This study was carried out at University of Port Harcourt Teaching hospital (UPTH), University of Uyo Teaching hospital (UUTH) and Braithwaite Memorial Specialist Hospital (BMSH) between June, 2016 and February, 2017. **Methodology:** The *in-situ* measurement of indoor and outdoor exposure dose rates of the three hospitals were measured with well calibrated radiation meters (Radalert-100 and Digilert-200) and Global positioning system (GPS) for exact position measurement. The radiation meters were set to measure the exposure rate in milli-Roetgen per hour. The measurements were carried out within the radiology department and some other departments of the hospital. **Result:** The average indoor and outdoor exposure dose rates measured at University of Uyo Teaching hospital were 0.013 ± 0.003 and 0.015 ± 0.003 mR h^{-1} , average indoor and outdoor exposure rates measured at the University of Port Harcourt Teaching hospital were 0.015 ± 0.005 and 0.015 ± 0.005 mR h^{-1} and the average indoor and outdoor exposure dose rates for Braithwaite Memorial Specialist Hospital were 0.014 ± 0.003 mR h^{-1} and 0.013 ± 0.003 mR h^{-1} . The world standard threshold value for exposure dose rate is 0.013 mR h^{-1} , the values show that University of Uyo Teaching hospital indoor are within this range, while the others are higher. The average indoor and outdoor absorbed dose rate for all the hospitals exceeded the world average of 89 nGy h^{-1} . Also the results for average excess lifetime cancer risk (ELCR) calculated for indoor and outdoor for the hospitals show that ELCR for both indoor and outdoor exposures were all higher than the world acceptable value of 0.29×10^{-3} , but the annual effective dose levels for the hospitals both indoor and outdoor were all below the 1 mSv y^{-1} maximum permissible limit for the public set by the International Commission on Radiological Protection (ICRP). **Conclusion:** Therefore there is need for the management of the hospitals to monitor radiation levels in order to take necessary precautions to avoid radiation levels getting to unacceptable levels.

Keywords: Exposure, dose rate, ELCR, Background, radiation, Radalert-200

1. Introduction

The general population is exposed regularly to natural low level background radiation, while exposure from man-made sources is mostly from radiation generating medical devices, particularly nuclear medicine and X- rays. Diagnostic imaging and interventional radiological techniques are increasingly used to diagnose a wide range of injuries and diseases, and to give life-saving treatment for many diseases. The use of radiation in medical practices has evolved since its beginning and 30% to 50% of medical decisions are based on radiological examinations. However, it is still limited by its relevant hazards to patients and healthcare providers [1].

Exposure from natural background radiation to humans is natural, continuous and inescapable feature of life on earth. One of the main contributors are terrestrial radioactive materials which originate from the formation of the earth and are present everywhere in the earth's crust and in the human body [2]. Background ionizing radiation which originally was attributed to cosmic sources has over the years increased due to technological advancement. Radiation from hospitals and medical research institutes has been of great

concern due to the known effects of high doses of radiation. Exposure of patients to radiographic examinations and radiation therapy have contributed to increase in background radiation and radiation dose to patients and occupational workers [3].

Humans are continuously exposed to radiation from inside and outside their bodies. These radiations come from the ground, building materials, food, air, the universe and even elements within the human body. Background ionization delivers an average effective dose of 2.4 mSv per person worldwide [4]. Studies on health effects due to ionizing radiation have produced substantial evidences that exposure to high levels of radiation can cause illness or even death. It can also cause retardation in children of mothers exposed to radiation during pregnancy[4]. Several studies have been carried out in Nigeria to measure the natural background radiation levels of hospitals. Okoye and Avwiri[3] carried out a study on the radiation levels at Braithwaite Memorial Specialists Hospital, Port Harcourt. The indoor exposure dose rate ranged from $0.14 \pm 0.02 \mu\text{Sv h}^{-1}$ to $0.16 \pm 0.01 \mu\text{Sv h}^{-1}$. The aim of this study is to measure the background ionizing radiation of the selected hospital and using it to calculate the excess lifetime cancer risk. The values from the selected hospital will be compared and the indoor and outdoor exposure dose rates will be correlated to ascertain the relationship between them.

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2. Materials and Methods

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2.1 Study Area

The study area is the South-South and South-East of Nigeria. These hospitals are:

1. University of Port Harcourt Teaching Hospital, Rivers State (UPTH).

2. Braithwaite Memorial Specialist Hospital Port Harcourt, Rivers State (BMSH).

3. Federal Medical Centre (FMC) Owerri, Imo State.

University of Port Harcourt Teaching Hospital is located on the East West road in Choba, Port Harcourt. It is a 500 bed tertiary health facility founded in 1980. It is a major Tertiary – care teaching and research facility the departments present in the hospital incudes: Radiology, Physiotherapy, Orthopedics, Obstetrics and Gynecology, Dialysis, General Out Patients, Nuclear Medicine, Hematology, Chemical Pathology, Accident and Emergency (Wikipedia.org).The Radiology department is equipped with the following machines: X-ray machines, Computerized Tomography (CT) machine, Magnetic Resonance Imaging (MRI) machine, Scanning machine and mammogram machine.

Braithwaite Memorial Specialist Hospital is one of the hospitals is Located at the Old G.R.A area of Port Harcourt. It is one of the tertiary health facilities in Port Harcourt. It is a 375 bed hospital and has the following departments: Physiotherapy, Pathology, Surgery, Radiology, Internal Medicine, Pharmacy, ENT, Obstetrics and Gynecology, Family Medicine, Accident and Emergency. The radiology department is equipped with X-ray Machines, fluoroscopy machine, mammography machines, helical 6-slice ComputerizedTomography (CT) machine and a Magnetic Resonance Imaging (MRI) machine.

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The FMC Owerri is situated in the central part of Owerri the capital of Imo State. It is the main tertiary health institution in the state and caters for the health needs of the people of the State. The hospital has the following departments: Family Medicine, Surgery, Obstetrics and Gynecology, Pediatrics, Accident and Emergency, Pharmacy and Radiology. The Radiology department is equipped with the following machines: Computerized Tomography (CT) machine, X-ray machines, Fluoroscopy Unit and Mammography machine.



An in-situ measurement of background ionizing radiation indoors and outdoors of the hospitals were measured using well calibrated Radalert-100 and Digilert-200 nuclear radiation meters (S.E. International INC. Summer Town, USA). The radiation meters contain a Geiger –Muller tube capable of detecting alpha, beta, gamma and X-rays within the temperature range of -10°C and 50°C. The radiation meters were set to measure the exposure rate in milli-Roetgen per hour. A geographical positioning system (GPS) was used to take the precise positions where readings were taken outdoor. The measurements were carried out within the radiology department and some other departments of the hospital. Measurements were also carried out outdoors at different point within the hospital premises. Six readings were taken, three each using each of the radiation meters an average was taken and recorded. The mean exposure rates were calculated along with their standard deviations. The absorbed dose rate (nGy/h) was obtained from the external dose rate in (μR/h) using the conversion factor [5]:

$$1\mu\text{R/h} = 8.7\text{nGy/h} = 8.7 \times 10^{-3} \mu\text{Gy}/(1/8760)\text{y} = 76.212\mu\text{Gy/y} \quad (1)$$

4. Results

The in-situ results of the background ionizing radiation and the calculated values of the absorbed dose, annual effective dose equivalent (AEDE) and excess lifetime cancer risk (ELCR) of the three hospitals are presented in Tables 1-6, while Figures 1-3 represent the correlation of the indoor and outdoor exposure dose rates.

4.1 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 and the occupancy factor indoor and outdoor was 0.75(18/24) and 0.25(6/24) respectively. It has been estimated that people spend approximately 18 hours indoors and 6 hours outdoors. The annual effective dose equivalent is determined using the following equations:

$$\text{AEDE (indoor)} (\text{mSv/y}) = \text{Absorbed dose rate (nGy/h)} \times 8760 \text{ h} \times 0.7 \text{ Sv/Gy} \times 0.75 \quad (2)$$

$$\text{AEDE (outdoor)} (\text{mSv/y}) = \text{Absorbed dose rate (nGy/h)} \times 8760 \text{ h} \times 0.7 \text{ Sv/Gy} \times 0.25 \quad (3)$$

The mean indoor annual effective dose equivalent for the three hospitals (BMSH, UUTH and UPTH) are 0.57, 0.50 and 0.60 mSv⁻¹ while the mean outdoor annual effective dose are 0.018, 0.20 and 0.20 mSv⁻¹.

4.2 Excess Lifetime Cancer Risk (ELCR)

The excess lifetime cancer risk was calculated using the following equation [4].

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$$\text{ELCR} = \text{AEDE} \times \text{Average duration of life (DL)} \times \text{Risk Factor (RF)} \quad (4)$$

130 Where AEDE, DL and RF are the annual effective dose equivalent, duration of life (70yrs)
 131 and the risk factor (Sv^{-1}) fatal risk per Sievert. For low dose background radiations which are
 132 considered to produce stochastic effects, ICRP 60 uses values of 0.05 for the public [6].

133 The mean indoor excess lifetime cancer risk (ELCR) estimated for the three hospitals for the
 134 hospitals (BMSH, UUTH and UPTH) are 2.01×10^{-3} , 1.84×10^{-3} and 2.09×10^{-3} respectively
 135 while that of the outdoor are 0.65×10^{-3} , 0.70×10^{-3} and 0.70×10^{-3} respectively. All ELCR
 136 values for the hospitals exceeded the worldwide average value of 0.29×10^{-3} [6].

137 **Table 1: Radiation exposure rate measured at BMSH outdoor and its parameters**

S/N	Location	GPS Reading	Exposure rate outdoor (mR/h)	Aborbed dose (nGy/h)	AEDE (mSv/y)	ELCR $\times 10^{-3}$
1	Radiology	N04 ⁰ 46.792' E007 ⁰ 00.836'	0.012 $\pm$ 0.003	104.4	0.17	0.6
2	Male surgical	N04 ⁰ 46.767' E007 ⁰ 00.834'	0.014 $\pm$ 0.004	121.8	0.19	0.67
3	HODs office	N04 ⁰ 46.734' E007 ⁰ 00.839'	0.010 $\pm$ 0.003	87	0.14	0.49
4	Family medicine	N04 ⁰ 46.778' E007 ⁰ 00.853'	0.014 $\pm$ 0.007	121.8	0.19	0.67
5	Surgery	N04 ⁰ 46.785' E007 ⁰ 00.854'	0.012 $\pm$ 0.002	104.4	0.17	0.6
6	Main gate	N04 ⁰ 46.787' E007 ⁰ 00.869'	0.013 $\pm$ 0.003	113.1	0.18	0.63
7	Generator house	N04 ⁰ 46.795' E007 ⁰ 00.873'	0.014 $\pm$ 0.003	121.8	0.19	0.67
8	Main building	N04 ⁰ 46.799' E007 ⁰ 00.854'	0.016 $\pm$ 0.004	139.2	0.22	0.77
9	Pediatrics	N04 ⁰ 46.813' E007 ⁰ 00.836'	0.011 $\pm$ 0.002	95.7	0.15	0.53
10	ENT	N04 ⁰ 46.820' E007 ⁰ 00.838'	0.014 $\pm$ 0.003	121.8	0.19	0.67
11	Accidents and emergency	N04 ⁰ 46.815' E007 ⁰ 00.827'	0.013 $\pm$ 0.002	113.1	0.18	0.63
12	Blood Trans.unit	N04 ⁰ 46.816' E007 ⁰ 00.803'	0.014 $\pm$ 0.004	121.8	0.19	0.67
13	Histopathology	N04 ⁰ 46.809' E007 ⁰ 00.814'	0.014 $\pm$ 0.003	121.8	0.19	0.67
14	Gene experts	N04 ⁰ 46.832' E007 ⁰ 00.801'	0.013 $\pm$ 0.002	113.1	0.18	0.63
15	Mortuary	N04 ⁰ 46.836' E007 ⁰ 00.794'	0.017 $\pm$ 0.005	147.9	0.23	0.81
16	Dept. of Anesthesia	N04 ⁰ 46.822' E007 ⁰ 00.781'	0.014 $\pm$ 0.003	121.8	0.19	0.67
17	Obstetrics and Gynae	N04 ⁰ 46.841' E007 ⁰ 00.860'	0.015 $\pm$ 0.004	130.5	0.21	0.74
18	Dental clinic	N04 ⁰ 46.848' E007 ⁰ 00.836'	0.012 $\pm$ 0.002	104.4	0.17	0.6

19	Canteen	N04 ⁰ 46.860' E007 ⁰ 00.849'	0.013±0.002	113.1	0.18	0.63
20	Quarters	N04 ⁰ 46.863' E007 ⁰ 00.837'	0.013±0.003	113.1	0.18	0.63
21	Mean		0.013	116.58	0.18	0.65

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139 **Table 2: Radiation exposure rate measured at UUTH outdoor and its parameters**

S/N	Location	GPS Readings	Exposure Rate (mR/h)outdoor	Absorbed Dose (nGy/h)	AEDE (mSv/y)outdoor	ELCR X 10 ⁻³
1	Radiology	N05 ⁰ 00.705' E007 ⁰ 51.618'	0.013±0.002	113.1	0.18	0.63
2	Hospital Gate	N05 ⁰ 00.641' E007 ⁰ 51.678'	0.014±0.001	121.8	0.19	0.67
3	Physiotherapy	N05 ⁰ 00.685' E007 ⁰ 51.680'	0.012±0.002	104.4	0.17	0.60
4	Emergency	N05 ⁰ 00.757' E007 ⁰ 51.681'	0.014±0.002	121.8	0.19	0.67
5	Aminity Ward	N05 ⁰ 00.867' E007 ⁰ 51.637'	0.013±0.002	113.1	0.18	0.63
6	Mortuary	N05 ⁰ 00.873' E007 ⁰ 51.558'	0.016±0.005	139.2	0.22	0.77
7	Pediatrics	N05 ⁰ 00.767' E007 ⁰ 51.561'	0.013±0.003	113.1	0.18	0.63
8	Generator House	N05 ⁰ 00.702' E007 ⁰ 51.523'	0.015±0.001	130.5	0.21	0.74
9	Canteen	N05 ⁰ 00.660' E007 ⁰ 51.568'	0.014±0.002	121.8	0.19	0.67
10	Car Park	N05 ⁰ 00.676' E007 ⁰ 51.630'	0.014±0.003	121.8	0.19	0.67
11	Antenatal Clinic	N05 ⁰ 00.741' E007 ⁰ 51.591'	0.015±0.002	130.5	0.21	0.74
12	Postnatal Clinic	N05 ⁰ 00.776' E007 ⁰ 51.593'	0.015±0.002	130.5	0.21	0.74
13	Main Theatre	N05 ⁰ 00.754' E007 ⁰ 51.589'	0.017±0.005	147.9	0.23	0.81
14	Endoscopy	N05 ⁰ 00.827' E007 ⁰ 51.572'	0.016±0.004	139.2	0.22	0.77
15	Orthopedic	N05 ⁰ 00.816' E007 ⁰ 51.606'	0.013±0.003	113.1	0.18	0.63
16	Eye Clinic	N05 ⁰ 00.805' E007 ⁰ 51.618'	0.018±0.002	156.6	0.25	0.88
17	Ophthalmology	N05 ⁰ 00.785' E007 ⁰ 51.624'	0.014±0.002	121.8	0.19	0.67
18	ICU	N05 ⁰ 00.781' E007 ⁰ 51.626'	0.014±0.002	121.8	0.19	0.67
19	Accident And Emergency	N05 ⁰ 00.739' E007 ⁰ 51.641'	0.014±0.003	121.8	0.19	0.67
20	General Out Patient Dept.	N05 ⁰ 00.713' E007 ⁰ 51.615'	0.013±0.002	113.1	0.18	0.63
21	Front Of Hospital	N05 ⁰ 00.691' E007 ⁰ 51.625'	0.013±0.001	113.1	0.18	0.63
22	Sterling Bank	N05 ⁰ 00.700' E007 ⁰ 51.681'	0.014±0.002	121.8	0.19	0.67

Mean

0.015±0.003

124.2

0.20

0.70

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142 **Table 3: Radiation exposure rate measured at UPTH outdoor and its**
143 **parameters**

S/N	Location	GPS Readings	Exposure Rate (mR/h)	Absorbed Dose (nGy/h)	AEDEoutdoor (mSv/y)	ELCR X 10 ⁻³
1	Main Gate	N04°53.322' E006°55.524'	0.014±0.003	121.8	0.19	0.67
2	Car park By Lounge	N04°53.880' E006°55.725'	0.013±0.006	113.1	0.18	0.63
3	Genesis Restaurant	N04°53.917' E006°55.739'	0.016±0.004	139.2	0.22	0.77
4	Nurses House	N04°53.879' E006°55.769'	0.012±0.003	104.4	0.17	0.60
5	By School Of Nursing Sign	N04°53.848' E006°55.798'	0.016±0.005	139.2	0.22	0.77
6	House Officers Quarters	N04°53.883' E006°55.815'	0.015±0.005	130.5	0.21	0.74
7	Pediatrics	N04°53.928' E006°55.768'	0.015±0.006	130.5	0.21	0.74
8	Main Building	N04°53.941' E006°55.652'	0.019±0.007	165.3	0.26	0.91
9	Dept. Of Nuclear Medicine	N04°53.845' E006°55.689'	0.013±0.004	113.1	0.18	0.63
10	Radiology	N04°53.988' E006°55.677'	0.017±0.005	147.9	0.23	0.81
11	General Out Patient Dept.	N04°54.005' E006°55.750'	0.014±0.005	121.8	0.19	0.67
12	Pharmacy	N04°53.957' E006°55.766'	0.011±0.002	95.7	0.15	0.53
13	Public Laundry	N04°53.972' E006°55.757'	0.010±0.004	87.0	0.14	0.49
14	Diet Shop/Eatery	N04°53.985' E006°55.776'	0.016±0.007	139.2	0.22	0.77
15	Oxygen Plant	N04°54.008' E006°55.752'	0.012±0.006	104.4	0.17	0.60
16	Store	N04°54.015' E006°55.740'	0.013±0.002	113.1	0.18	0.63
17	Senior Staff Canteen	N04°54.003' E006°55.706'	0.015±0.003	130.5	0.21	0.74
18	Nigerian Center For Disease Control	N04°54.045' E006°55.685'	0.016±0.005	139.2	0.22	0.77
19	Generator Area	N04°54.035' E006°55.678'	0.017±0.002	147.9	0.23	0.81
20	Mortuary	N04°54.074' E006°55.678'	0.017±0.002	147.9	0.23	0.81
21	Pathology Class	N04°54.092' E006°55.642'	0.012±0.003	104.4	0.17	0.60
22	Dump Site	N04°54.108'	0.012±0.004	104.4	0.17	0.60

		E006 ⁰ 55.683'				
23	Accident And Emergency	N04 ⁰ 54.031' E006 ⁰ 55.633'	0.013±0.003	113.1	0.18	0.63
24	Physiotherapy	N04 ⁰ 54.004' E006 ⁰ 55.623'	0.014±0.005	121.8	0.19	0.67
25	Sterling Bank	N04 ⁰ 53.946' E006 ⁰ 55.627'	0.016±0.007	139.2	0.22	0.77
26	Dental Center	N04 ⁰ 53.957' E006 ⁰ 55.667'	0.014±0.003	121.8	0.19	0.67
27	Hemolysis	N04 ⁰ 53.972' E006 ⁰ 55.727'	0.017±0.007	147.9	0.23	0.81
28	Ante Natal Clinic	N04 ⁰ 53.976' E006 ⁰ 55.726'	0.015±0.005	130.5	0.21	0.74
29	Health Records	N04 ⁰ 53.984' E006 ⁰ 55.724'	0.016±0.006	139.2	0.22	0.77
30	Car Park Opposite Main Building	N04 ⁰ 53.930' E006 ⁰ 55.659'	0.016±0.004	139.2	0.22	0.77
	Mean		0.015±0.005	126.4	0.20	0.70

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146 **Table 4: Radiation exposure rate measured at BMSH indoor and its parameters**

S/N	Location	Exposure rate (mR/h) indoor	Absorbed dose (nGy/h)	AEDE (mSv/y) indoor	ELCR x 10 ⁻³
1	Radiology reception	0.016±0.001	139.2	0.65	2.28
2	Radiology Gen. office	0.013±0.003	113.1	0.53	1.86
3	CT waiting area	0.013±0.003	113.1	0.53	1.86
4	CT scan room	0.010±0.003	87	0.41	1.44
5	MRI room	0.015±0.004	130.5	0.61	2.14
6	MRI control room	0.012±0.003	104.4	0.49	1.72
7	Mammogram room	0.013±0.003	113.1	0.53	1.86
8	Fluoroscopy room	0.015±0.003	130.5	0.61	2.14
9	X-ray room	0.016±0.004	139.2	0.65	2.28
10	Male surgical	0.015±0.003	130.5	0.61	2.14
11	Family medicine	0.015±0.003	130.5	0.61	2.14
12	Surgery	0.014±0.004	121.8	0.57	2
13	Main building reception	0.013±0.002	113.1	0.53	1.86
14	Pediatric pharmacy	0.013±0.004	113.1	0.53	1.86
15	ENT	0.014±0.006	121.8	0.57	2
16	Pediatrics waiting area	0.015±0.003	130.5	0.61	2.14
17	ICU	0.015±0.002	130.5	0.61	2.14
18	Burns unit	0.015±0.002	130.5	0.61	2.14

19	Accident and emergency	0.015±0.005	130.5	0.61	2.14
20	Post natal ward	0.014±0.003	121.8	0.57	2
	Mean	0.014	122.24	0.57	2.01

Table 5: Radiation exposure rate measured at UPTH indoor and its parameters

S/ N	Location	Exposure Rate (mR/h)indoor	Absorbed Dose (nGy/h)	AEDE (mSv/y)indoor	ELCR X 10 ⁻³
1	Pediatrics Reception	0.012±0.007	104.4	0.49	1.72
2	Pediatrics Emergency	0.013±0.004	113.1	0.53	1.86
3	Dept. Of Nuclear Medicine	0.012±0.003	104.4	0.49	1.72
4	X-Ray Room 1	0.017±0.008	147.9	0.69	2.42
5	Special X-Ray Room	0.015±0.004	130.5	0.61	2.14
6	X-Ray Control Area	0.016±0.003	139.2	0.65	2.28
7	CT Control Area	0.020±0.008	174.0	0.81	2.84
8	CT Scan Room	0.015±0.005	130.5	0.61	2.14
9	Dark Room	0.010±0.003	87.0	0.41	1.44
10	MRI Control Room	0.012±0.005	104.4	0.49	1.72
11	MRI Room	0.015±0.004	130.5	0.61	2.14
12	Film Viewing Room	0.017±0.005	147.9	0.69	2.42
13	Mammography	0.014±0.004	121.8	0.57	2.00
14	Radiology Waiting Room	0.016±0.006	139.2	0.65	2.28
15	General Out Patient Dept.	0.017±0.005	147.9	0.69	2.42
16	Accident And Emergency	0.014±0.005	121.8	0.57	2.00
17	Family Planning	0.015±0.005	130.5	0.61	2.14
18	Hemodialysis	0.016±0.002	139.2	0.65	2.28
19	Dental Center	0.011±0.002	95.7	0.45	1.58
20	Ante Natal Clinic	0.013±0.005	113.1	0.53	1.86
21	Anatomical Pathology	0.017±0.004	147.9	0.69	2.42
22	Labour Ward	0.015±0.008	130.5	0.61	2.14
23	Gynae Ward	0.013±0.002	113.1	0.53	1.86
24	Obstetrics And Gynecology Dept.	0.013±0.003	113.1	0.53	1.86
25	Social Welfare	0.018±0.005	156.6	0.73	2.56
	Mean	0.015±0.005	127.4	0.60	2.09

153 **Table 6: Radiation exposure rate measured at UUTH indoor and its parameters**

S/ N	Location	Exposure Rate (mR/h)	Absorbed Dose (nGy/h)	AEDE (mSv/y)indoor	ELCR X 10 ⁻³
1	X-Ray Room	0.010±0.004	87.0	0.41	1.44
2	Digital Printer Room	0.012±0.003	104.4	0.49	1.72
3	CT Scan Room	0.012±0.005	104.4	0.49	1.72
4	Control Room For CT Scan	0.019±0.007	165.3	0.77	2.70
5	Radiology General Office	0.012±0.001	104.4	0.49	1.72
6	Radiology Corridor	0.009±0.002	78.30	0.37	1.30
7	Ultrasound Room	0.008±0.002	69.6	0.33	1.16
8	Radiology Waiting Room	0.015±0.003	130.5	0.61	2.14
9	Hospital Reception	0.016±0.003	139.2	0.65	2.28
10	Pharmacy	0.015±0.002	130.5	0.61	2.14
11	General Outpatient	0.015±0.006	130.5	0.61	2.14
12	MOPD Clinic	0.016±0.004	139.2	0.65	2.28
13	Casualty	0.013±0.002	113.1	0.53	1.86
14	Accident And Emergency	0.012±0.002	104.4	0.49	1.72
15	Male Ward	0.012±0.002	104.4	0.49	1.72
16	Female Ward	0.012±0.001	104.4	0.49	1.72
17	Eye Clinic	0.013±0.001	113.1	0.53	1.86
18	Antenatal Ward	0.013±0.002	113.1	0.53	1.86
19	Post Natal Ward	0.012±0.002	104.4	0.49	1.72
20	Community Health	0.012±0.002	104.4	0.49	1.72
21	Endoscopy	0.012±0.002	104.4	0.49	1.72
22	Orthopedic	0.013±0.002	113.1	0.53	1.86
23	ENT Clinic	0.013±0.002	113.1	0.53	1.86
24	Physiotherapy	0.012±0.002	104.4	0.49	1.72
25	Children Emergency	0.013±0.002	113.1	0.53	1.86
	Mean	0.013±0.003	111.8	0.53	1.84

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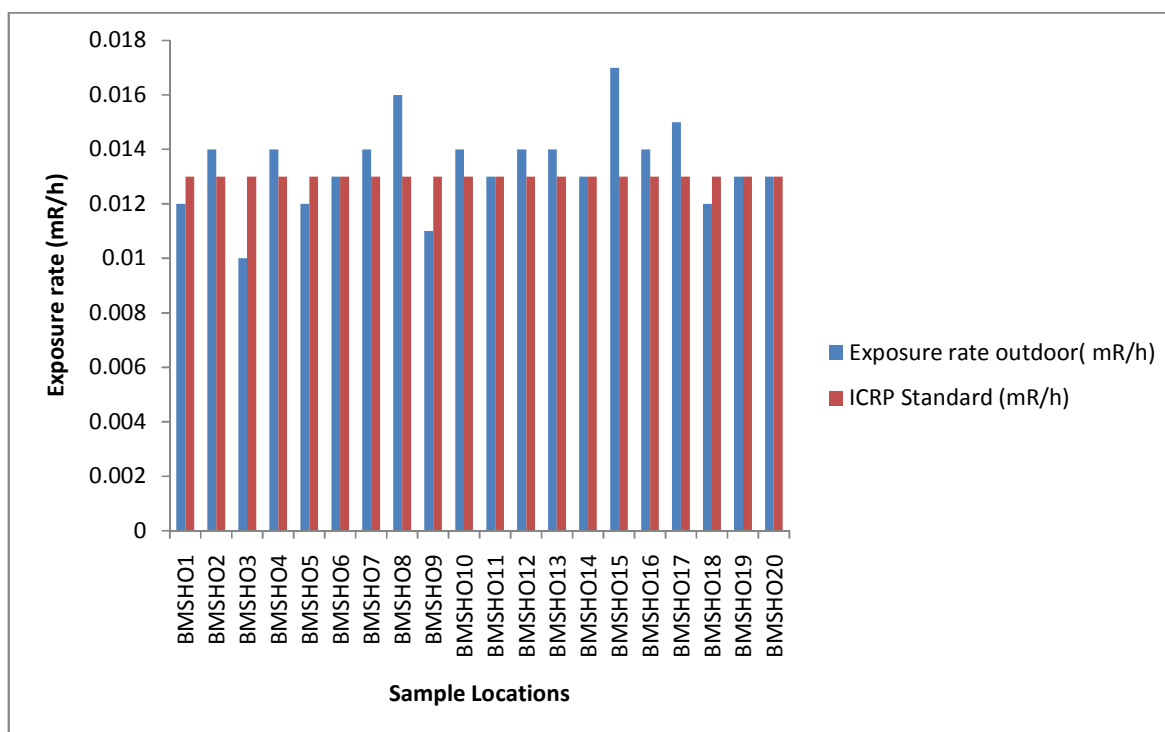


Fig. 1 Comparison of radiation outdoor Exposure Rate at BMSH with ICRP standard

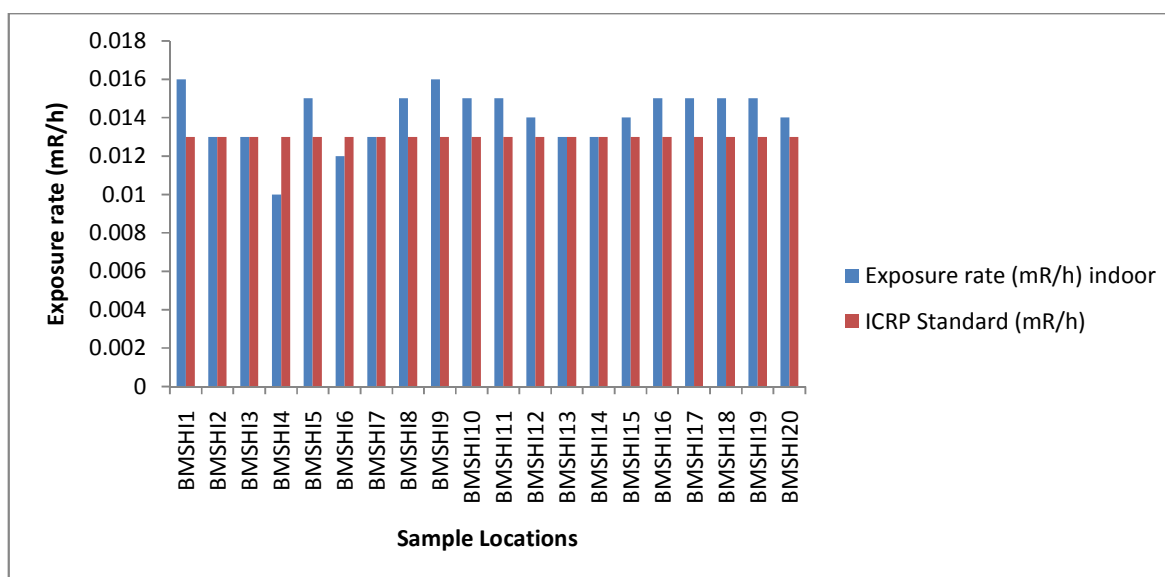


Fig. 2 Comparison of Indoor exposure rate at BMSH with ICRP standard

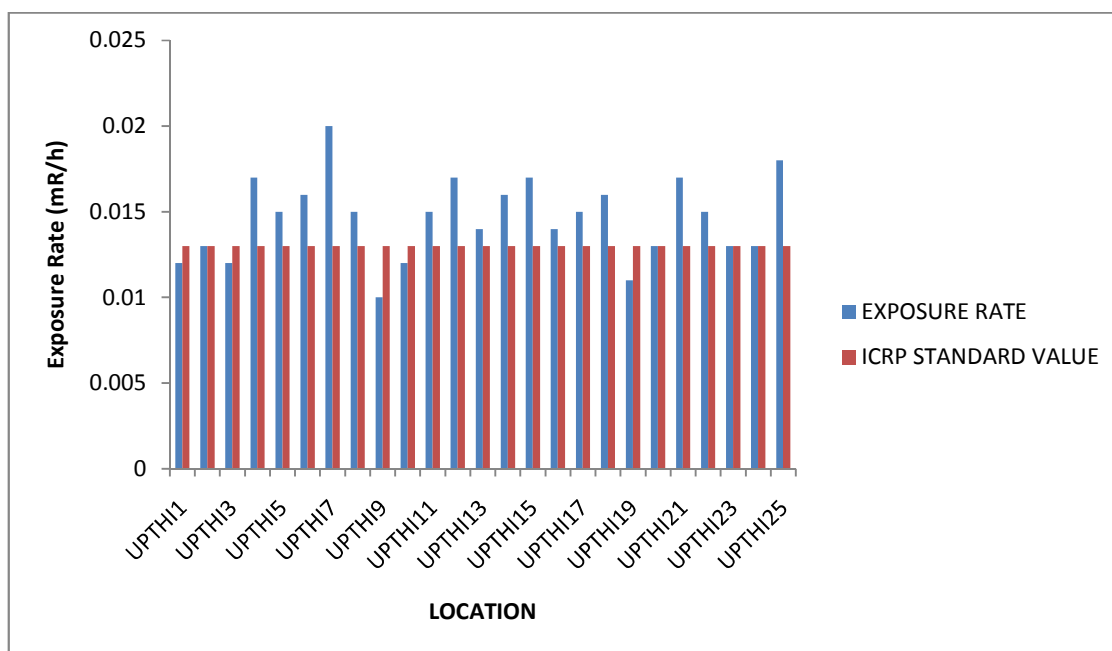


Fig.3 Comparison of Indoor exposure rate at UPTH with ICRP standard

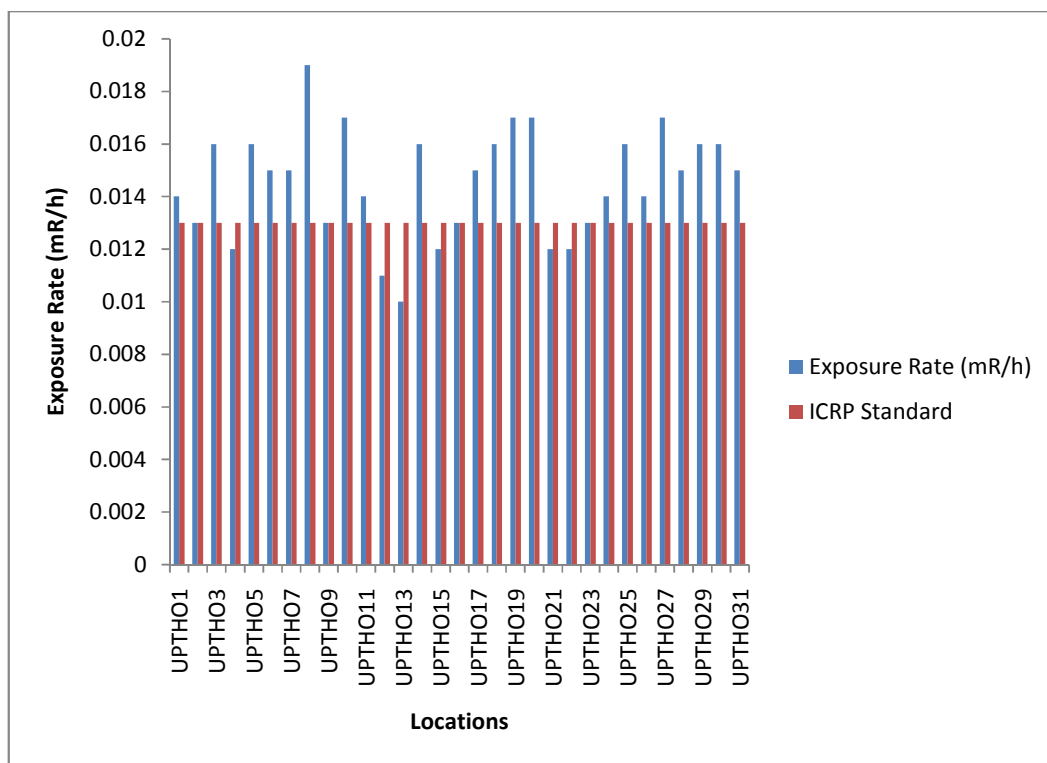


Fig.4 Comparison of outdoor exposure rate at UPTH with ICRP standard

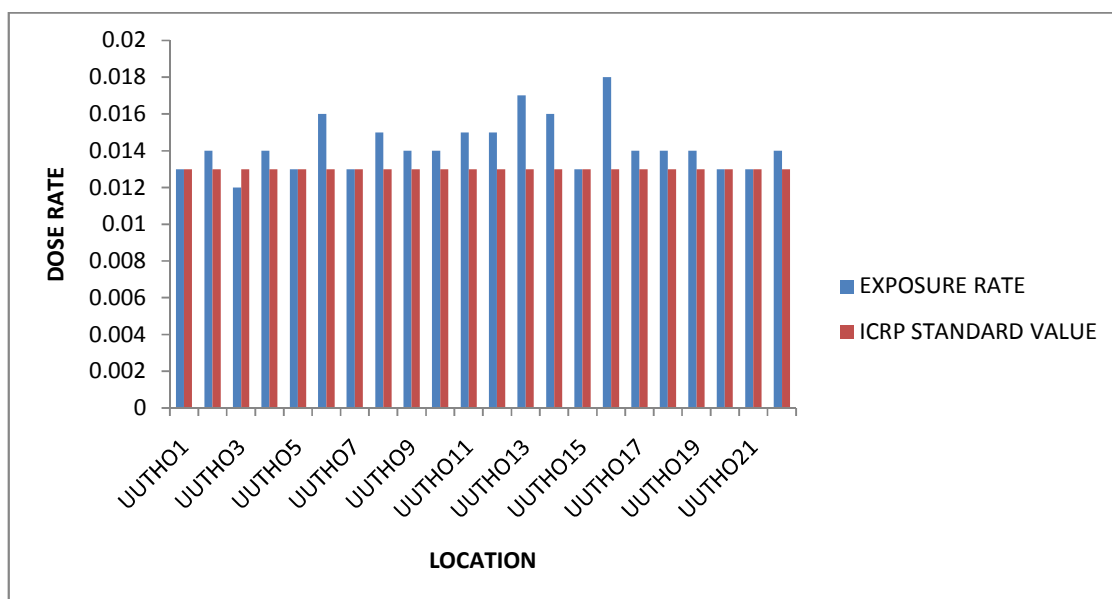


Fig.5 Comparison of outdoor exposure rate at UUTH with ICRP standard

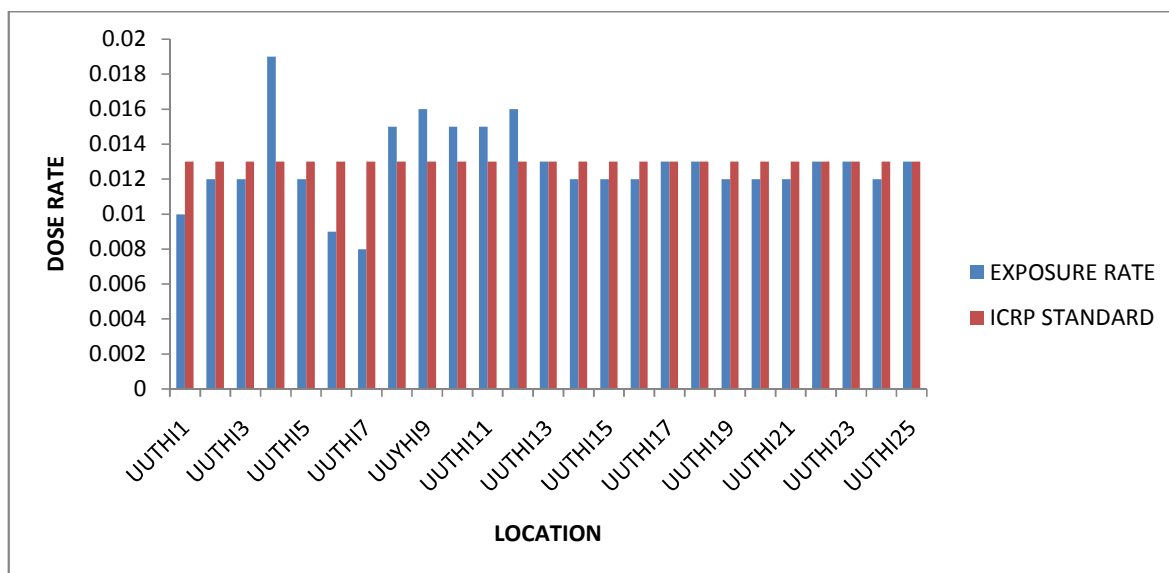


Fig.6: Comparison of Indoor exposure rate at UUPTH with ICRP standard

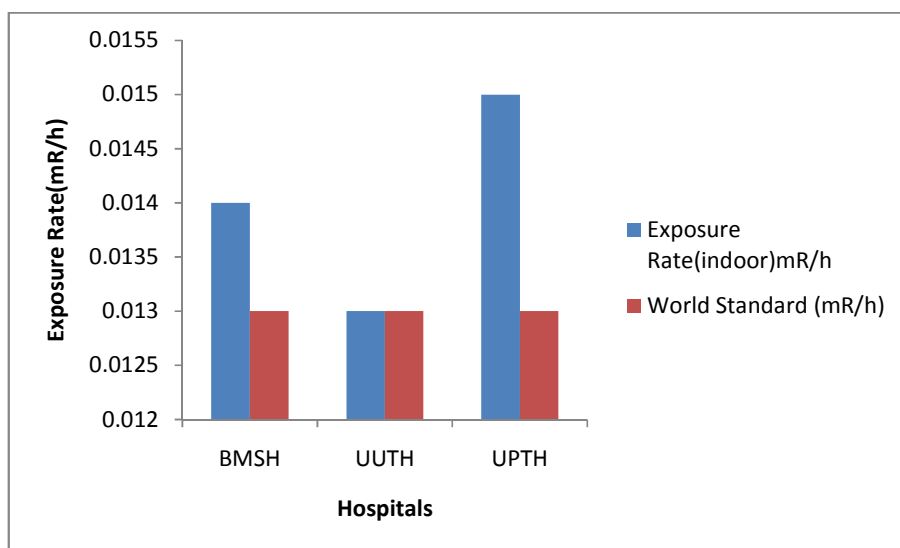


Fig.7: Comparison of Mean indoor Exposure Rates of BMSH, UPTH and UUTH with standard

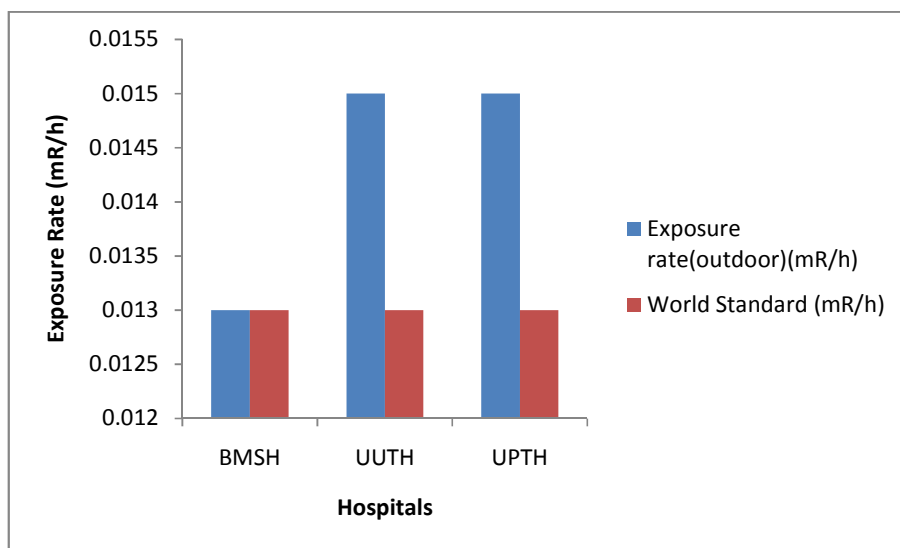


Fig.8: Comparison of Mean outdoor Exposure Rates of BMSH, UPTH and UUTH with ICRP standard

4.3 Discussion

The background ionizing radiation levels and the associated radiation risk parameters for the Braitewright Memorial hospital (BMSH), University of Port Harcourt Teaching Hospital (UPTH) and University of Uyo Teaching Hospital (UUTH) Uyo, are represented in Tables 1 – 6.

From Table 1 and 2 the indoor exposure rate measured at BMSH ranged from 0.010 to 0.016 mR/h with a mean of 0.014 mR/h^{-1} while the outdoor exposure rate ranges from 0.010 mR/h^{-1} to 0.017 mR/h^{-1} with a mean of 0.013 mR/h^{-1} . The results are similar to that obtained by Okoye and Avwiri[3] in the same hospital. This shows that the radiation levels in the hospital is maintained. 50% of the values outdoor are higher than the standard exposure dose rate of

0.013 mR/h, while 65% of the indoor values are above the standard exposure value. The highest exposure rate was recorded at the radiology reception, this could be due to proximity to the radiation sources.

In Table 3 and 4, the indoor exposure rate for UUTH ranged from 0.008 to 0.016 mRh⁻¹ with a mean of 0.013mRh⁻¹ while that of the outdoor ranges from 0.013 mR/h to 0.018 mR/h with a mean of 0.015 mRh⁻¹. 68% of the locations (outdoor) had exposure dose rate higher than the standard value of 0.013mR/h, while 64% of the locations indoor had values higher than the standard.

In Table 5 and 6 the indoor exposure rate for UPTH ranged from 0.008 to 0.020 mR/h with a mean of 0.015mR/h while the outdoor exposure rate ranges from 0.010 to 0.019 mR/h with a mean of 0.015 mR/h. 63% of the outdoor exposure rate measured were higher than the ICRP standard value of 0.013mR/h, while 24% of the indoor exposure rate measured exceeded the standard value. The mean outdoor values for BMSH and UUTH are within the ICRP standard of 0.013mR/h, while the others are higher. The exposure values from the hospitals are slightly lower than those from studies carried out by Saeed et al [7] and Jwanbot et al.[8]. The values when compared with results obtained by James et al [9] were higher but are still within the global standards.

5.0 Conclusion

The background exposure rate for BMSH, UUTH and UPTH were measured using two radiation meters and a global positioning system (GPS). The results obtained were used to calculate the associated radiation risk parameters which are used to estimate the associated health hazard indices. The following results were obtained:

1. The highest exposure rate of 0.020 mR/h was recorded at the CT (computed tomography machine) control area. This might be due to radiation leakage from the equipment and the scattered radiation during x-ray imaging.
2. The indoor and outdoor absorbed dose rate obtained for the BMSH, UUTH and UPTH are 122.24 nGyh⁻¹ and 116.58nGy/h, 111.8 nGyh⁻¹ and 124.2 nGyh⁻¹ and 127nGyh⁻¹ and 126.4 nGyh⁻¹ respectively.
3. The mean values of the absorbed dose rates for the hospitals are greater than the world population weighted average rate of 89 nGyh⁻¹.
4. Estimated mean indoor and outdoor annual effective dose equivalent for Braithwaite Memorial Hospital (BMSH) are 0.57 mSvy⁻¹ and 0.018mSvy⁻¹ respectively. The mean indoor and outdoor annual effective dose determined for UUTH are 0.5 mSvy⁻¹ and 0.20 mSvy⁻¹ respectively while that calculated for UPTH are 0.60 mSvy⁻¹ and 0.20 mSvy⁻¹.
5. Excess lifetime cancer risk (ELCR) calculated from the indoor annual effective doses for BMSH, UUTH and UPTH are 2.01×10^{-3} , 1.84×10^{-3} and 2.09×10^{-3} respectively while that calculated from the outdoor annual effective doses for the three hospitals are 0.65×10^{-3} , 0.70×10^{-3} and 0.70×10^{-3} respectively.

The results showed high levels of background radiation in the three hospitals studied, though it might not pose any immediate radiation related sickness to patients and staff of the hospitals, but long term exposure could pose some radiological risk.

235 Therefore continuous monitoring and routine quality control of the equipment is
236 needed.
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238 **References**
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