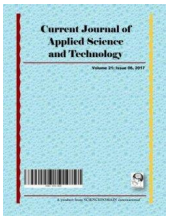

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Radiation Risk Assessment from Background Radiation Exposures in Selected Hospitals in South – South Nigeria

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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 IEN managed the literature searches. Both authors read and approved the final manuscript.

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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.

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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 mRh^{-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 mRh^{-1} and the average indoor and outdoor exposure dose rates for Braithwaite Memorial Specialist Hospital were 0.014±0.003 mRh^{-1} and 0.013±0.003 mRh^{-1}. The world standard threshold value for exposure dose rate is 0.013 mRh^{-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 $nGyh^{-1}$. 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 $0.29x10^{-3}$, but the annual effective dose levels for the hospitals both indoor and outdoor were all below the 1 $mSvy^{-1}$ maximum permissible limit for the public set by the International Commission on Radiological Protection (ICRP).
Conclusion: 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± 0.02 μSvh^{-1} to 0.16± 0.01 μSvh^{-1}. The aim of this study is to measure the background ionizing radiation of the selected hospitals and using it to calculate the excess lifetime cancer risk and other radiological parameters. 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.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is the South-South, Niger Delta region 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. University of Uyo Teaching Hospital (UUTH) Uyo.

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. The Radiology department is equipped with the following machines: X-ray machines, Computerized Tomography (CT) machine, Magnetic Resonance Imaging (MRI) machine and mammogram machine.

Braithwaite Memorial Specialist Hospital is one of the hospitals Located at the Old G.R.A area of Port Harcourt. It is one of the tertiary health facilities in Port Harcourt. It is the 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 Computerized Tomography (CT) machine and a Magnetic Resonance Imaging (MRI) machine.

The University of Uyo Teaching Hospital (UUTH) Uyo is the main tertiary health institution in the state and caters for the health needs of the people of the institution and the general public in 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 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 2.5 Mev with 80% detection efficiency, beta at 50Kev 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. The measurements were carried out within the radiology department and some other departments of the hospital. Measurements were also carried out outdoors at different positions within the hospital premises. 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 [5]:

$$1\mu R/h = 8.7nGy/h = 8.7x10^{-3}\mu Gy/(1/8760)y = 76.212\mu Gy/y \quad (1)$$

3. 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 Tables1-6, while Figs. 1-3 represent the comparison of the indoor and outdoor exposure dose rates measured with ICRP, [6].

3.1 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:

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

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

The mean indoor annual effective dose equivalent for the three hospitals (BMSH, UUTH

and UPTH) are 0.57, 0.50 and 0.60 $mSvy^{-1}$ respectively while the mean outdoor annual effective dose are 0.018, 0.20 and 0.20 $mSvy^{-1}$ respectively.

3.2 Excess Lifetime Cancer Risk (ELCR)

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

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

Where AEDE, DL and RF are the annual effective dose equivalent, duration of life (70yrs) and the risk factor (Sv^{-1}) fatal risk per Sievert. For low dose background radiations which are considered to produce stochastic effects, ICRP 60 uses values of 0.05 for the public [7].

Table 1. Outdoor exposure dose rate measured at BMSH and calculated radiological parameters

S/N	Location	GPS reading	Exposure rate outdoor (mR/h)	Aborbed dose (nGy/h)	AEDE (mSv/y)	ELCR x 10^{-3}
1	Radiology	N04°46.792' E007°00.836'	0.012±0.003	104.4	0.17	0.6
2	Male surgical	N04°46.767' E007°00.834'	0.014±0.004	121.8	0.19	0.67
3	HODs office	N04°46.734' E007°00.839'	0.010±0.003	87	0.14	0.49
4	Family medicine	N04°46.778' E007°00.853'	0.014±0.007	121.8	0.19	0.67
5	Surgery	N04°46.785' E007°00.854'	0.012±0.002	104.4	0.17	0.6
6	Main gate	N04°46.787' E007°00.869'	0.013±0.003	113.1	0.18	0.63
7	Generator house	N04°46.795' E007°00.873'	0.014±0.003	121.8	0.19	0.67
8	Main building	N04°46.799' E007°00.854'	0.016±0.004	139.2	0.22	0.77
9	Pediatrics	N04°46.813' E007°00.836'	0.011±0.002	95.7	0.15	0.53
10	ENT	N04°46.820' E007°00.838'	0.014±0.003	121.8	0.19	0.67
11	Accidents and emergency	N04°46.815' E007°00.827'	0.013±0.002	113.1	0.18	0.63
12	Blood Trans.unit	N04°46.816' E007°00.803'	0.014±0.004	121.8	0.19	0.67
13	Histopathology	N04°46.809' E007°00.814'	0.014±0.003	121.8	0.19	0.67
14	Gene experts	N04°46.832' E007°00.801'	0.013±0.002	113.1	0.18	0.63
15	Mortuary	N04°46.836' E007°00.794'	0.017±0.005	147.9	0.23	0.81
16	Dept. of Anesthesia	N04°46.822' E007°00.781'	0.014±0.003	121.8	0.19	0.67
17	Obstetrics and Gynae	N04°46.841' E007°00.860'	0.015±0.004	130.5	0.21	0.74
18	Dental clinic	N04°46.848' E007°00.836'	0.012±0.002	104.4	0.17	0.6
19	Canteen	N04°46.860' E007°00.849'	0.013±0.002	113.1	0.18	0.63
20	Quarters	N04°46.863' E007°00.837'	0.013±0.003	113.1	0.18	0.63
21	Mean		0.013	116.58	0.18	0.65

Table 2. Outdoor exposure dose rate measured at UUTH and its radiological 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°00.705' E007°51.618'	0.013±0.002	113.1	0.18	0.63
2	Hospital Gate	N05°00.641' E007°51.678'	0.014±0.001	121.8	0.19	0.67
3	Physiotherapy	N05°00.685' E007°51.680'	0.012±0.002	104.4	0.17	0.60
4	Emergency	N05°00.757' E007°51.681'	0.014±0.002	121.8	0.19	0.67
5	Aminity Ward	N05°00.867' E007°51.637'	0.013±0.002	113.1	0.18	0.63
6	Mortuary	N05°00.873' E007°51.558'	0.016±0.005	139.2	0.22	0.77
7	Pediatrics	N05°00.767' E007°51.561'	0.013±0.003	113.1	0.18	0.63
8	Generator House	N05°00.702' E007°51.523'	0.015±0.001	130.5	0.21	0.74
9	Canteen	N05°00.660' E007°51.568'	0.014±0.002	121.8	0.19	0.67
10	Car Park	N05°00.676' E007°51.630'	0.014±0.003	121.8	0.19	0.67
11	Antenatal Clinic	N05°00.741' E007°51.591'	0.015±0.002	130.5	0.21	0.74
12	Postnatal Clinic	N05°00.776' E007°51.593'	0.015±0.002	130.5	0.21	0.74
13	Main Theatre	N05°00.754' E007°51.589'	0.017±0.005	147.9	0.23	0.81
14	Endoscopy	N05°00.827' E007°51.572'	0.016±0.004	139.2	0.22	0.77
15	Orthopedic	N05°00.816' E007°51.606'	0.013±0.003	113.1	0.18	0.63
16	Eye Clinic	N05°00.805' E007°51.618'	0.018±0.002	156.6	0.25	0.88
17	Ophthalmology	N05°00.785' E007°51.624'	0.014±0.002	121.8	0.19	0.67
18	ICU	N05°00.781' E007°51.626'	0.014±0.002	121.8	0.19	0.67
19	Accident and Emergency	N05°00.739' E007°51.641'	0.014±0.003	121.8	0.19	0.67
20	General Out Patient Dept.	N05°00.713' E007°51.615'	0.013±0.002	113.1	0.18	0.63
21	Front Of Hospital	N05°00.691' E007°51.625'	0.013±0.001	113.1	0.18	0.63
22	Sterling Bank	N05°00.700' E007°51.681'	0.014±0.002	121.8	0.19	0.67
	Mean		0.015±0.003	124.2	0.20	0.70

The mean indoor excess lifetime cancer risk (ELCR) estimated for the three hospitals for the hospitals (BMSH, UUTH and UPTH) are 2.01 x 10^{-3}, 1.84 x 10^{-3} and 2.09 x 10^{-3} respectively while that of the outdoor are 0.65 x 10^{-3}, 0.70 x 10^{-3} and 0.70 x 10^{-3} respectively. All ELCR values for the hospitals exceeded the worldwide average value of 0.29 x 10^{-3} [7].

4. DISCUSSION

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

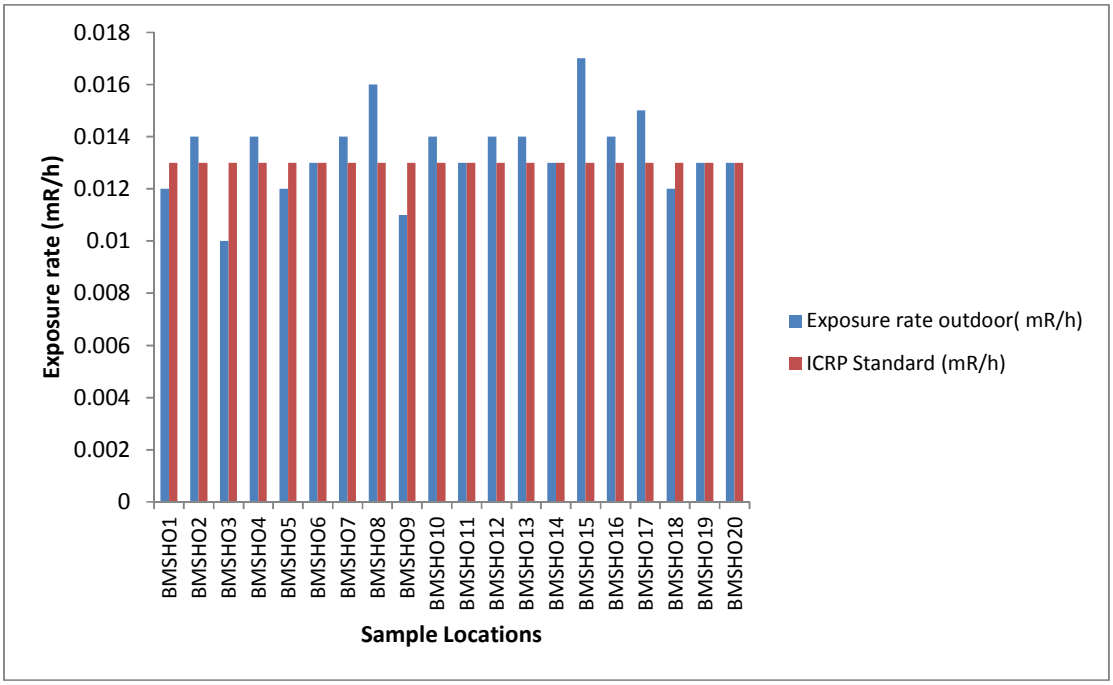

Fig. 1. Comparison of radiation outdoor exposure rate at BMSH with ICRP standard

Table 3. Outdoor exposure dose rate measured at UPTH and its radiological parameters

S/N	Location	GPS readings	Exposure rate (mR/h)	Absorbed dose (nGy/h)	AEDE outdoor (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'	0.016±0.007	139.2	0.22	0.77

S/N	Location	GPS readings	Exposure rate (mR/h)	Absorbed dose (nGy/h)	AEDE outdoor (mSv/y)	ELCR X 10^{-3}
		E006°55.776'				
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' E006°55.683'	0.012±0.004	104.4	0.17	0.60
23	Accident And Emergency	N04°54.031' E006°55.633'	0.013±0.003	113.1	0.18	0.63
24	Physiotherapy	N04°54.004' E006°55.623'	0.014±0.005	121.8	0.19	0.67
25	Sterling Bank	N04°53.946' E006°55.627'	0.016±0.007	139.2	0.22	0.77
26	Dental Center	N04°53.957' E006°55.667'	0.014±0.003	121.8	0.19	0.67
27	Hemolysis	N04°53.972' E006°55.727'	0.017±0.007	147.9	0.23	0.81
28	Ante Natal Clinic	N04°53.976' E006°55.726'	0.015±0.005	130.5	0.21	0.74
29	Health Records	N04°53.984' E006°55.724'	0.016±0.006	139.2	0.22	0.77
30	Car Park Opposite Main Building	N04°53.930' E006°55.659'	0.016±0.004	139.2	0.22	0.77
	Mean		0.015±0.005	126.4	0.20	0.70

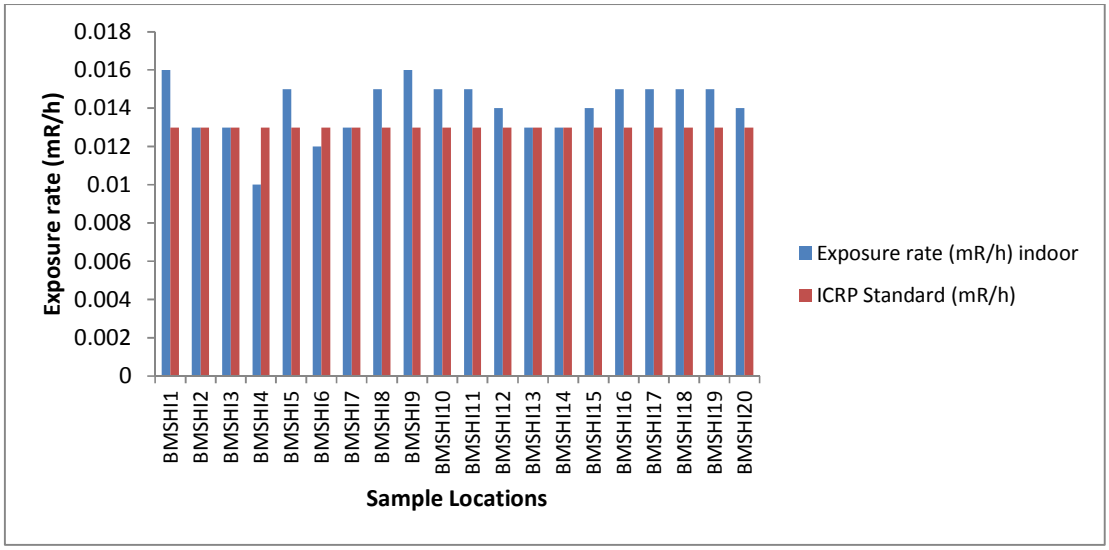

Fig. 2. Comparison of indoor exposure rate at BMSH with ICRP standard

Table 4. Indoor exposure dose rate measured at BMSH and its radiological 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

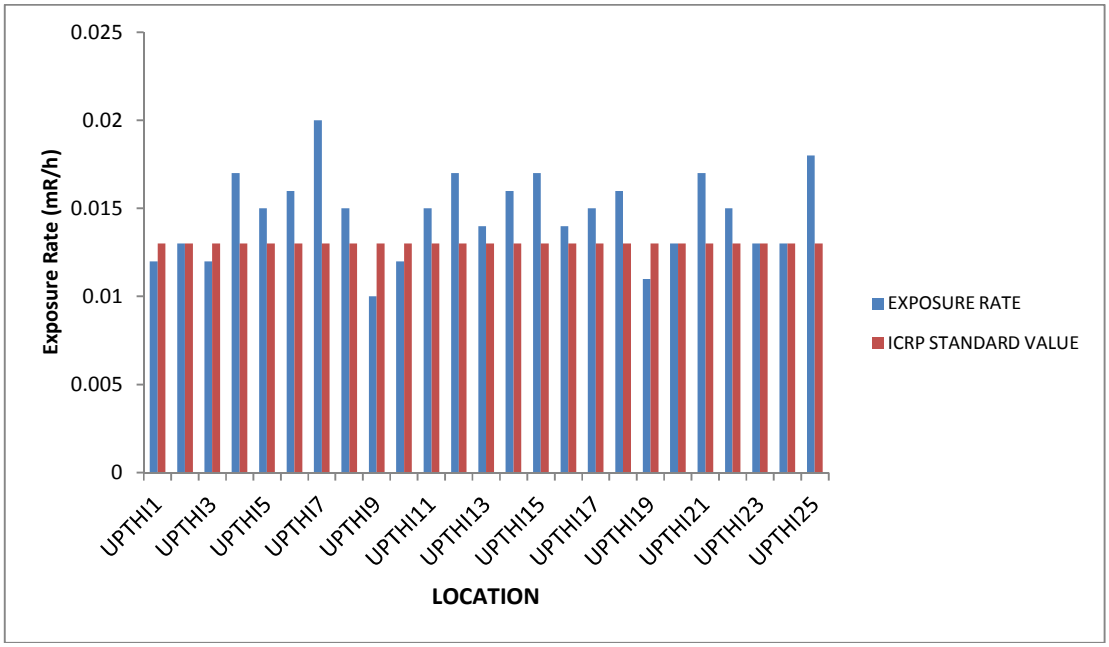

Fig. 3. Comparison of Indoor exposure rate at UPTH with ICRP standard

From Tables 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 mRh^{-1} while the outdoor exposure rate ranges from 0.010 mRh^{-1} to 0.017 mRh^{-1} with a mean of 0.013 mRh^{-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 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. This implies that patient waiting at the radiological reception and the staff are usually exposed to

relatively high radiation during x-ray examination which may be due to lack of use of proper shielding materials. Recall that studies has shown that exposure to ionizing radiation can cause injuries and clinical symptoms; which may include a chromosomal transformation, cancer induction, free radical formation, bone necrosis and radiation catractogenesis [7].

Table 5. Indoor exposure dose rate measured at UPTH and estimated radiological parameters

S/N	Location	Exposure rate (mR/h)indoor	Absorbed Dose (nGy/h)	AEDE (mSv/y) indoor	ELCR X10^{-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

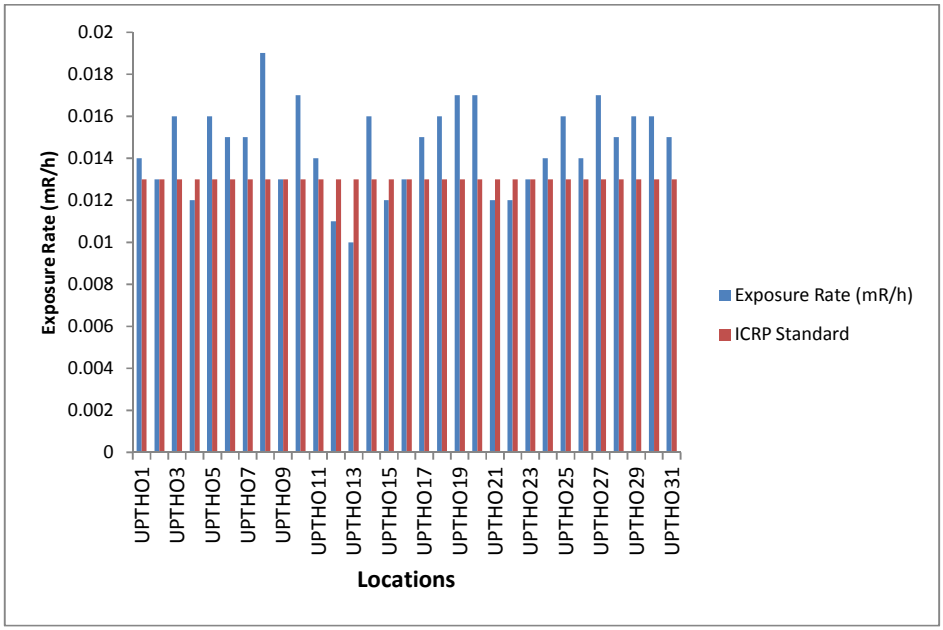

Fig. 4. Comparison of outdoor exposure rate at UPTH with ICRP standard

Table 6. Indoor exposure dose rate measured at UUTH and its radiological 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**

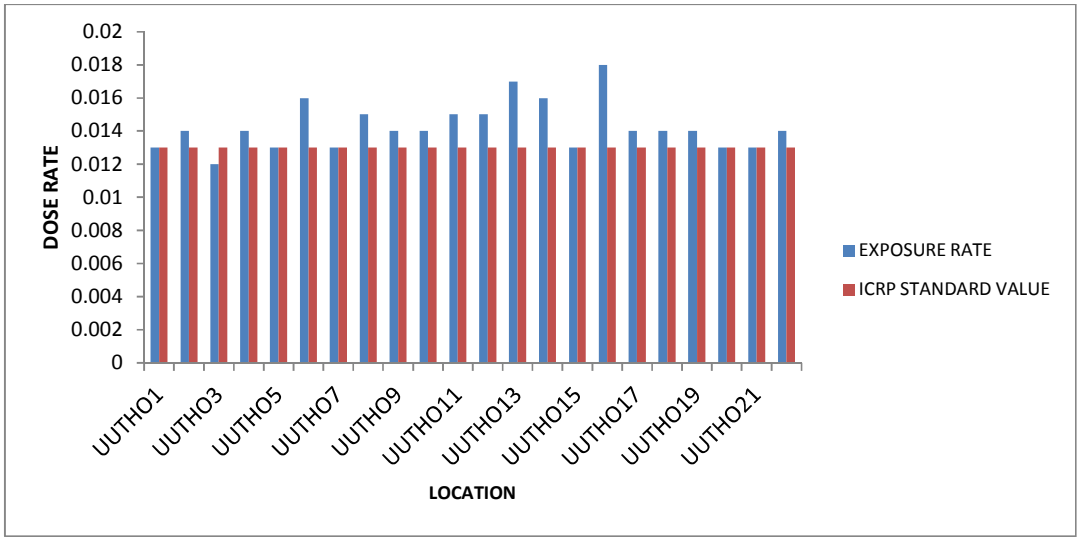

Fig. 5. Comparison of outdoor exposure rate at UUTH with ICRP standard

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 0.013 mR/h, while 64% of the locations indoor had values higher than the standard. The mean outdoor exposure rate measured here are higher than the mean indoor exposure rate which means that the slight increase in the background radiation might not be from the radiological activities of the hospital but rather from other sources like geological composition of the area, industrial activities within the hospital environment.

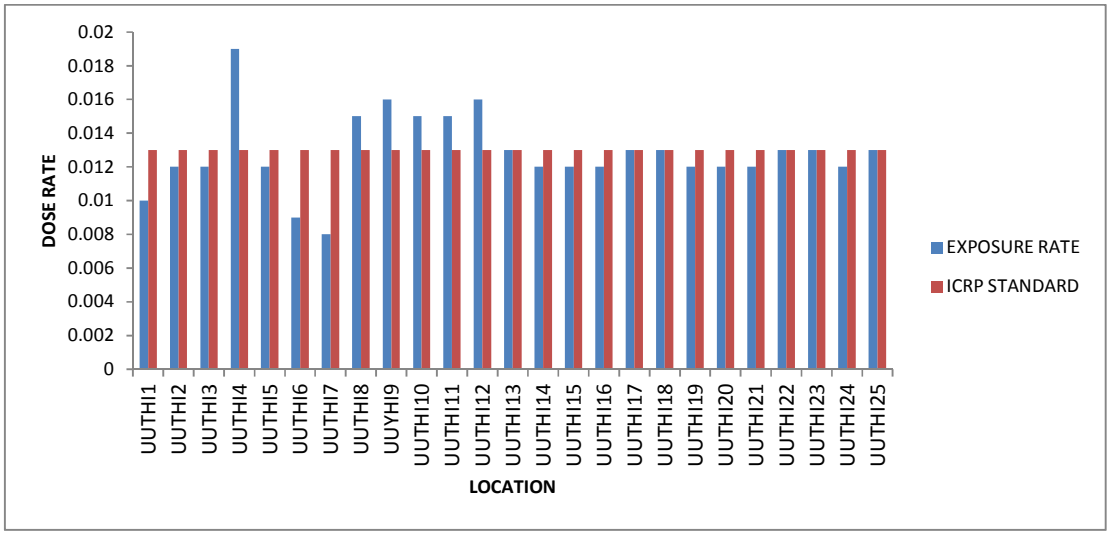

Fig. 6. Comparison of Indoor exposure rate at UUPTH with ICRP standard

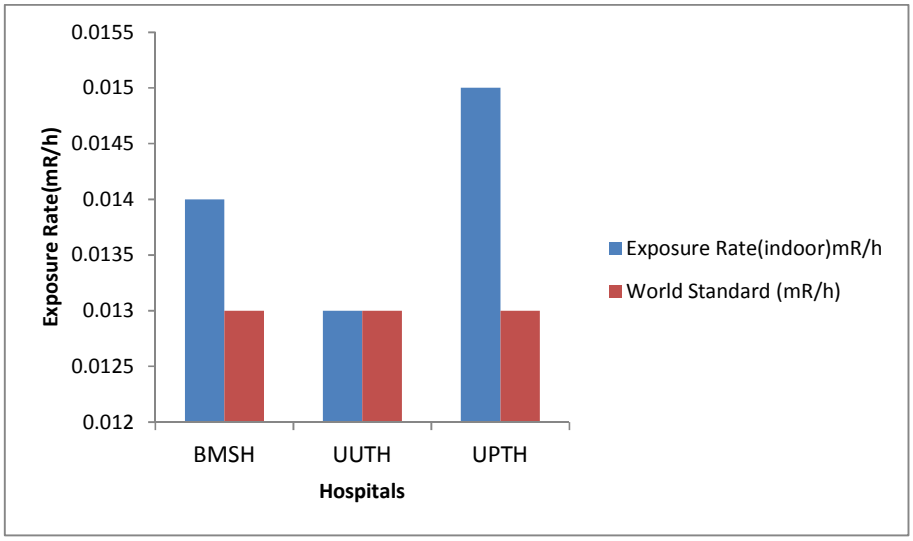

Fig. 7. Comparison of Mean indoor Exposure Rates of BMSH, UPTH and UUTH with standard

In Table 5 and 6 the indoor exposure rate for UPTH ranged from 0.008 to 0.020 mR/h with a mean of 0.015 mR/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 0.013 mR/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. [8] and Jwanbot et al. [9]. The values when compared with results obtained by James et al. [10] were higher but are still within the global standards. The absorbed dose and excess lifetime cancer risk estimated from the exposure rate of each of the hospitals for both indoor and outdoor were all higher than their safe values while annual effective dose were much lower than the safe value of 1.0 $mSvy^{-1}$. The implication of these results is that there are slight enhancement of the background radiation of the studied hospital. There was poor correlation between the indoor and outdoor radiation exposure of the three hospitals, which show that the radiation measured indoor is not dependent on the radiation from environment (outdoor).

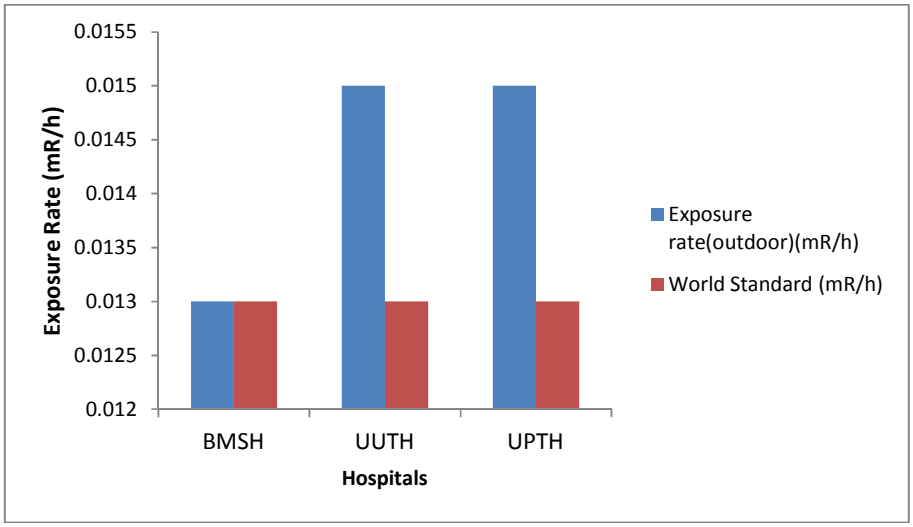

Fig. 8. Comparison of mean outdoor exposure rates of BMSH, UPTH and UUTH with ICRP standard

5. CONCLUSION

This work was carried out to determine the radiation risk from background ionizing radiation exposures of selected hospitals in South-South, Nigeria. 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 results of background radiation (indoor and outdoor) obtained from this study ranged from 0.018 mSv/yr – 0.60 mSv/yr. These values are below the ICRP recommended dose limit for the public, 1 mSv/yr but the absorbed dose and excess lifetime cancer risks estimated were higher than their recommended safe values. Hence, the background radiation level at these hospitals are relatively enhanced. Therefore, measures should be put in place at these hospitals, through regular workplace monitoring and quality control of radiation facilities, to ensure that acceptable limit is not exceeded. Also radiation safety officers of those hospitals should ensure that radiological staff use their personal protective equipment and dosimeters for proper personnel monitoring.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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