Terrestrial Radiation of Some Selected Active Telecommunication Sites in Port Harcourt, Rivers State, Nigeria

ABSTRACT

A study on terrestrial background ionization radiation was carried out around active selected telecommunications sites in Port Harcourt. This study was done using Radalert 100 and the geographical position system (GPS). The exposure rate ranged from 0.033 to 0.141 with a mean value of 0.123±0.20 (mR/h) which is lower than the acceptable limit of 0.0133 (mR/h). The absorbed dose ranged from 287.1 nG/h to 1226.7 nGy/hr with a mean value of 1066.64±1769.6 nGy/hr, which is quite higher than the acceptable limit of 89.0 nGy/h. The annual effective dose ranged between 0.44 and 1.88 mSv/y, with a mean value of 1.642.7 mSv/y which is quite higher than the safe limit of 1.0 mSv/y. The excess lifetime Cancer Risk (ELCR) varied from 1.54 x10^{-3} to 6.58x10^{-3} with a mean value of 5. 72±9.5 mSv/y. The result from this study is higher than the acceptable limit of 0.29 x10^{-3} as recommended by UNSCEAR. This means that people living within these areas may be exposed to cancer in later life. The effective dose of the various organs (ED Organs) are within the recommended safe limit of ICRP. The testes and the bone marrow are the most sensitive to radiation with the percentage distribution of 18.0% and 16.0%. Since the Annual effective dose, absorbed dose, and excess lifetime cancer risk are higher than the world standard, the chances of contracting cancer related illnesses are significant. It is recommended that monitoring of the exposure rate to ionizing radiation within the environment should be carried out. Also, individuals should on regular basis request for specific organ dose test.

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Keywords: background ionizing radiation, radiological risk parameters, organ dose

1.0 INTRODUCTION

"Electromagnetic radiation is widely used in modern technologies such as the use of Telecommunication masts, radar antenna, and advance forms of signal transmitting and receiver devices. Consequently, some of these devices may emit electromagnetic radiation so powerful to ionize biological tissues. Also, terrestrial radiation are emanate from the decay of radioactive materials in the earth itself. This radiation can be found in rocks, Uranium deposits and in the earth's crusts. Radiation is a form of electromagnetic energy that moves in waves and takes many forms, such as radio waves, microwaves, heat waves, ultraviolet light, infrared light, x-rays, and gamma rays" [1- 4].

"Man has been exposed to varying amounts of radiation from naturally occurring radioactive materials (NORMS); in addition to natural radioactivity, anthropogenic sources of radiation emanating from the use of technically enhanced radioactive materials (TENORMs) elevate the background ionization of the environment. Radionuclides as a form of radioactivity can be injected into the body for treatment or medical diagnosis, the fallout from nuclear weapons, radiation from consumer products such as paints, radiation from nuclear power plants, can affect man through different pathways. All of the aforementioned sources can result in either exterior or interior ionizing radiation exposure to vital organs of the human body" [4-6].

“Background radiation is a measure of the natural and anthropogenic sources of ionizing radiation present in the environment at a particular location. Man is exposed to ionizing radiation spontaneously emitted by naturally occurring atomic nuclei ever since his existence on the earth. Some examples of radiations are alpha, beta, X-ray, gamma, and all the electromagnetic waves in the electromagnetic spectrum. They are emitted by different radioactive materials, which differ in their energy and penetrating power. Humans were exposed to radiation not only from natural sources until recent times when the growth of nuclear energy created other sources of exposure that emanated from weapon tests, radioactive releases from nuclear reactor operations, and accidents. Other sources of radiation exposure due to radioactive waste include waste deposals from industries, medical, and agricultural use of radioisotopes. Still, the major contribution to the average annual background radiation arises from the natural source” [7-8].

“Exposures from a natural source are due to eternal sources of extra-terrestrial origin (cosmic rays), radioactive nuclides present in the earth’s crust, in water, in the atmosphere and building materials, internal exposure from radionuclides taken into the body through ingestion of food material, inhalation exposure due to radon and thoron. Some of these exposures are relatively constant and uniform to all individuals throughout the world, while others vary depending on the location and due to elevated levels of naturally occurring radiation. All exposures except those from direct cosmic radiation are produced by the radioactivity of the natural radionuclides present in the environment”. (9).

The goal of this study is to assess background ionizing radiation in Port Harcourt areas where the used of telecommunications devices are significant. This is to ascertain the level of background ionization radiation of terrestrial radiation within these areas.

2.0 MATERIALS AND METHODS

“A well calibrated handheld radiation survey meter Radalert 100, containing a Geiger Muller tube capable of detecting Alpha, Beta, Gamma and X-rays within the temperature range of -10ºC to 50ºC was used to measure the exposure level in the field measurement. Readings were taken within the hours of 13:00 and 16:00 hours, because the radiation meter has a peak sensitivity to environmental radiation within these hours” [10]. The device of the radiation meter was raised to a gonadal height of 1.0m above the ground during the field measurement. A geographical positioning system (GPS) was employed in recording the coordinates of the sample location. *In-situ* measurement were taken at a given sample point, in three different points, then the average of the three points were then computed to give the mean value of background radiation about a sample location.

2.1 Radiological Parameters

2.1.1 ***Absorbed Dose***

“This is defined as a measure energy deposited in a medium by ionizing radiation. The unit of measure derived from the SI system is the gray (Gy), which is defined as one joule of energy absorbed per kilogram of matter, usually measured in Gy/y” [11]

$$1\mu R/ = 876.212\ \mu Gy/y \quad (1)$$

2.1.2 ***Annual Effective Dose (AED)***

Measures the average sum of the equivalent dose in all specified tissues and organs of the human body and represents the probability of radiological health risk to the entire body, which results from low levels of ionizing radiation is estimated using the equation below.

$$AEDE\ (mSv/y) = Absorbed\ dose(nGy/h) \times 8760 \times 0.7Sv/Gy \times 0.25 \quad (2)$$

Where:

0.7 Sv/Gy is the dose the conversion coefficient from absorbed dose in air to the effective dose received by adults and an occupancy factor of 0.25 for outdoor exposure was used [12,13].

2.1.3 ***Excess Lifetime Cancer Risk (ELCR)***

Is the probability of developing cancer as the result of exposure to a specific carcinogen and appears as an incremental increase in cancer cases in the exposed population over what would occur in the absence of exposure.

$$ELCR=AEDE \times (DL) \times (RF) \quad (3)$$

Where:

Where AEDE, DL and RF is the annual effective dose equivalent, duration of life (70 years) and the risk factor (Sv/y), fatal cancer risk per Sievert. For low dose background radiations which are considered to produce stochastic effects, ICRP 60 uses 0.05 for the public [14].

2.1.4 ***The Effective Dose (ED_{ORGANS})***

The effective dose (EDorgans) to various organs of the body estimates the amount of absorbed radiation dose to several organs of the body and tissues. The ED organ of the body due to inhalation was calculated using the expression below [15,16]

$$EDorgans\ (mSv/y) = AEDR \times F_{risk} \quad (4)$$

Where:

F_{risk} is the risk factor of organ dose from air dose [15]

3.0 RESULTS AND DISCUSSION

The result of the *in-situ* background radiation is presented in Table 1, the Radiological Risk Parameters of the Terrestrial background ionizing is presented in Table 2. The exposure rate ranged from 0.033 to 0.141 with a mean value of 0.123±0.20 (mR/h), this value is quite lesser than the acceptable standard of 0.0133 (mR/h) as illustrated in Figure 2. The contour map of the study location indicates that the among the samples points measured the South east tends to have the highest level of Background ionization radiation of the sample area. Port Harcourt, this may be attributed to the fact that some natural sources of background ionizing radiation may be prevalent within the south than the South-west, west, north-west and north-east which measurement show a general decrease of the value of background radiation from 0.114 mR/h to 0.066 mR/h as indicated in Figure 1.

The calculated absorbed dose ranges from 287.1nG/h to 1226.7 nGy/hr with a mean value of 1066.64±1769.6 nGy/hr, which is quite higher than the acceptable limit of 89.0 nGy/h as presented in Figure 3,This value indicate that people living within these areas have a high risk of exposed to the danger of radiological health hazard. The result of this study is phase to the research carried out by Ugbede [17] by estimating the background ionizing radiation exposure level in selected farms in communities of Ishielu LGA, Ebonyi State,

The Annual effective dose is shown in Figure 4, the computed annual effective dose ranges from 0.44 to 1.88 with a mean value of 1.64±2.7 mSv/y. This value is quite higher than the safe limit of ICRP [13]. The result of this study is in harmony with the research carried out by Jwanbot, et al. [18] who estimate the indoor and outdoor gamma dose rate exposure levels in major commercial building materials distribution outlets in Jos, Plateau State-Nigeria. All these values are higher than the ICRP recommended value for public exposure of 1.0 mSv/y. It implies that people living around these areas may be exposed to high levels of ionizing radiation. However, there is presently no record of any health hazards associated to radiation exposure within the sample area.

The calculated ELCR values varied from 1.54 $x10^{-3}$ to $6.58x10^{-3}$ with a mean value of 5.72±9.5 mSv/y. This result is higher than the acceptable limit of 0.29 $x10^{-3}$ UNSCEAR as illustrated in Figure 5. This result indicates that even though visible signs are not pronounce the chances of contracting health issue relating to cancer is significant according to UNSCEAR [14]. The result of this study is lesser than the results carried out by Shanthi et al. [19] from high-background radiation area of southwest India.

“The effective dose of the various organs (ED organs) helps to estimate the amount of radiation that affects a particular organ. To calculate the effect on some organs of the body that absorbs radiation, an effective radiation dose and the risk factor for different organs are used using equation (4). The risk factor of ED organs for liver, kidney, testes, ovaries, lungs, bone and bone marrow are 0.1794, 0.2418, 0.3198, 0.2262, 0.2496, 0.2691 and 0.2652 mSv/year respectively. The effective dose tabulated in Table 3, The estimated results are within the acceptable value of 1.0 mSv/year agrees with the research carried out by Agbalagba et al. [15], and Ugbede and Benson [16] and it does not pose any immediate hazard to the populace living around the the study area”.

Figure 2 shows the shows the percentage distribution of ED organs for various organs of the body due to exposure the exposure level in the area. The results show that testes and and the bone marrow are most sensitive to radiation with the percentages of 18.0% and 16.0%, respectively see Figure 6. The result of this work is in harmony with the previously reported work carried out by Joseph et al. [20] in Human exposure levels to ionizing radiation in Agbara Industrial Estate in Ogun state.

Table 1. *In-Situ* measurement of background ionization radiation at the various Telecommunication masts

S/N	Geographical Coordinates		1st Reading	2nd Reading	3rd Reading	Average Radiation level
	Latitude (N)	Longitude (E)	(mR/h)	(mR/h)	(mR/h)	(mR/h)
PH- 1	4□ 49' 59.9268"	6□ 59' 45.4200"	0.126	0.124	0.093	0.114
PH- 2	4□ 50' 7.36800"	6□ 59' 50.6760"	0.095	0.095	0.110	0.100
PH -3	4□ 49' 57.2520"	7□ 0' 3.528000"	0.070	0.096	0.092	0.086
PH- 4	4□ 49' 34.6800"	6□ 59' 50.0640"	0.042	0.072	0.051	0.055
PH- 5	4□ 48' 24.0120"	7□ 0' 24.08400"	0.028	0.038	0.033	0.033
PH- 6	4□ 48' 18.6120"	7□ 0' 19.54800"	0.028	0.038	0.033	0.033
PH- 7	4□ 48' 17.8560"	7□ 0' 19.83600"	0.036	0.043	0.066	0.048
PH- 8	4□ 45' 43.7400"	7□ 1' 8.148000"	0.168	0.144	0.110	0.141
PH -9	4□ 45' 24.2280"	7□ 2' 12.84000"	0.144	0.123	0.081	0.116
PH -10	4□ 45' 28.1880"	7□ 2' 25.72800"	0.072	0.086	0.112	0.090
PH -11	4□ 45' 28.1880"	7□ 2' 25.72800"	0.096	0.112	0.108	0.105
PH- 12	4□ 45' 16.6680"	7□ 2' 19.64400"	0.028	0.090	0.078	0.065
PH- 13	4□ 44' 25.9080"	7□ 1' 45.44400"	0.113	0.113	0.112	0.113
PH- 14	4□ 45' 44.4240"	7□ 1' 56.56800"	0.096	0.054	0.060	0.070
PH- 15	4□ 48' 51.0120"	7□ 2' 38.25600"	0.085	0.075	0.062	0.074
PH- 16	4□ 48' 14.0400"	7□ 3' 0.180000"	0.118	0.114	0.110	0.114
PH-17	4□ 48' 7.77600"	7□ 3' 15.76800"	0.147	0.133	0.102	0.127
PH-18	4□ 48' 53.3160"	7□ 2' 31.09200"	0.075	0.048	0.056	0.060
PH- 19	4□ 49' 15.4200"	7□ 2' 27.38400"	0.047	0.086	0.094	0.076
PH- 20	4□ 48' 11.8080"	7□ 2' 20.11200"	0.068	0.079	0.082	0.076
PH -21	4□ 54' 54.2556"	6□ 59' 49.9164"	0.048	0.057	0.068	0.058
PH -22	4□ 54' 52.4844"	6□ 59' 47.4000"	0.072	0.065	0.067	0.068
PH- 23	4□ 55' 54.1380"	7□ 0' 7.729200"	0.144	0.072	0.082	0.099
PH- 24	4□ 55' 3.81000"	6□ 59' 48.1416"	0.072	0.115	0.144	0.110
PH- 25	4□ 54' 7.29360"	6□ 59' 54.3228"	0.096	0.086	0.088	0.090
PH- 26	4□ 54' 7.11000"	6□ 59' 54.7404"	0.048	0.072	0.077	0.066

Table 2. Radiological Risk Parameters of Telecommunication Marks

S/N	Sample Points	Average Radiation level (mR/h)	Absorbed Dose (nGy/hr)	AED (mSv/y)	ELCR x 10^{-3}
1	PH- 1	0.114	991.8	1.52	5.32
2	PH- 2	0.100	870.0	1.33	4.67
3	PH -3	0.086	748.2	1.15	4.01
4	PH- 4	0.055	478.5	0.73	2.57
5	PH- 5	0.033	287.1	0.44	1.54
6	PH- 6	0.033	287.1	0.44	1.54
7	PH- 7	0.048	417.6	0.64	2.24
8	PH- 8	0.141	1226.7	1.88	6.58
9	PH -9	0.116	1009.2	1.55	5.41
10	PH -10	0.090	783.0	1.20	4.20
11	PH -11	0.105	913.5	1.40	4.90
12	PH- 12	0.065	565.5	0.87	3.03
13	PH- 13	0.113	983.1	1.51	5.27
14	PH- 14	0.070	609.0	0.93	3.27
15	PH- 15	0.074	643.8	0.99	3.45
16	PH- 16	0.114	991.8	1.52	5.32
17	PH-17	0.127	1104.9	1.69	5.93
18	PH-18	0.060	522.0	0.80	2.80
19	PH- 19	0.076	661.2	1.01	3.55
20	PH- 20	0.076	661.2	1.01	3.55
21	PH -21	0.058	504.6	0.77	2.71
22	PH -22	0.068	591.6	0.91	3.17
23	PH- 23	0.099	861.3	1.32	4.62
24	PH- 24	0.110	957.0	1.47	5.13
25	PH- 25	0.090	783.0	1.20	4.20
26	PH- 26	0.066	574.2	0.88	3.08
	AVERAGE	**0.123±0.20**	**1066.64±1769.6**	**1.64±2.7**	**5.72±9.5**
	Standard	**0.133**	**89.0**	**1.0**	**0.29**

Table 3. Effective dosed of various organs of the body

S/N	Organs	Ed Organs
1.	Liver	0.754
2.	kidney	1.017
3.	Testes	1.345
4.	Ovaries	0.951
5.	Lungs	1.050
6.	Bone marrow	1.132
7.	Whole body	1.115

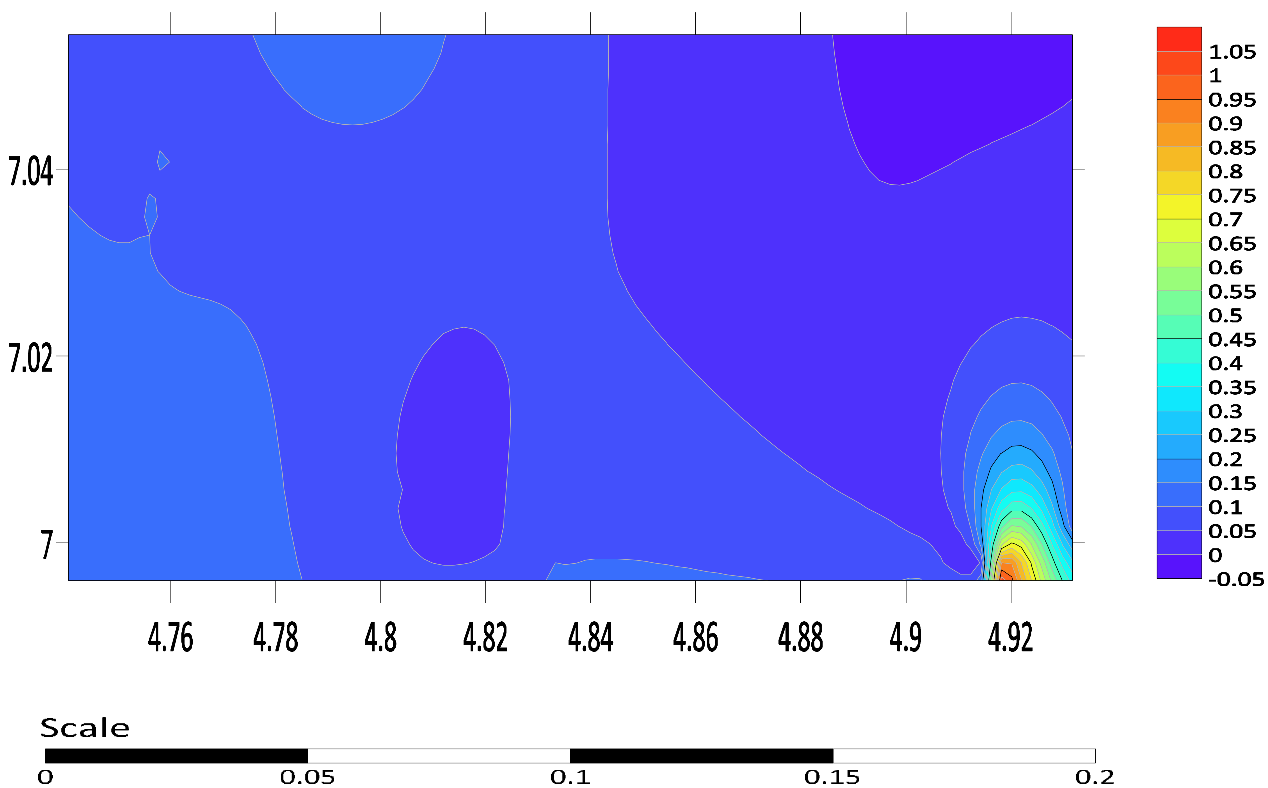

Figure 1. Contour map of background ionization radiation of Terrestrials radiation in port harcourt.

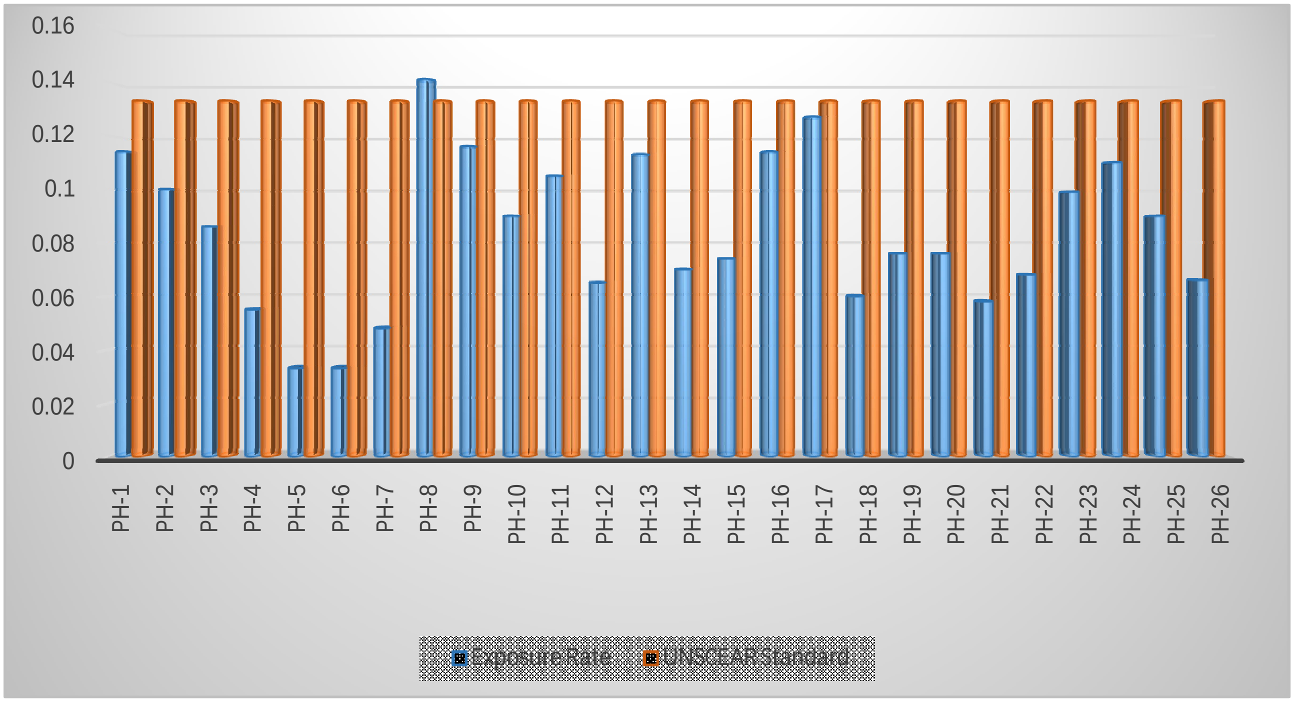

Figure 2. Comparison of exposure rate with the world average., UNSCEAR, 2008

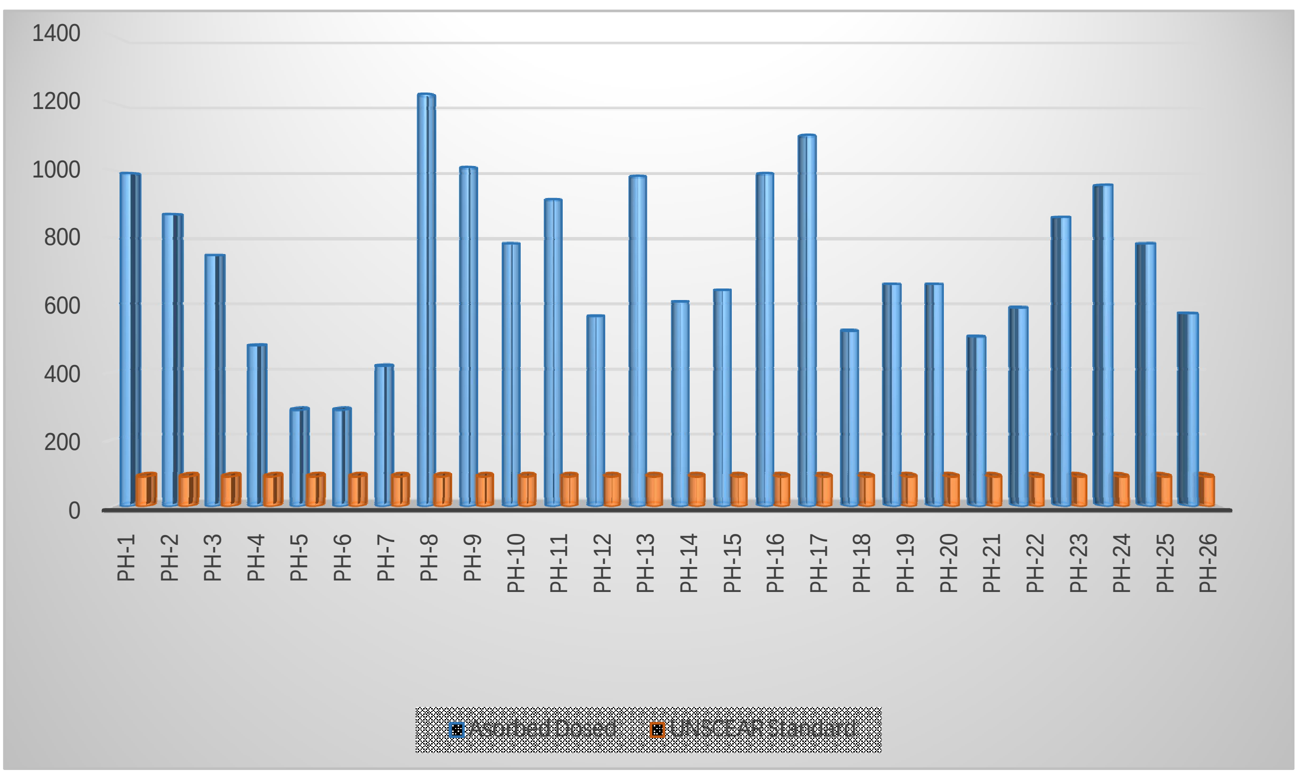

Figure 3. Comparison of absorbed dose rate with world average., UNSCEAR, 2008

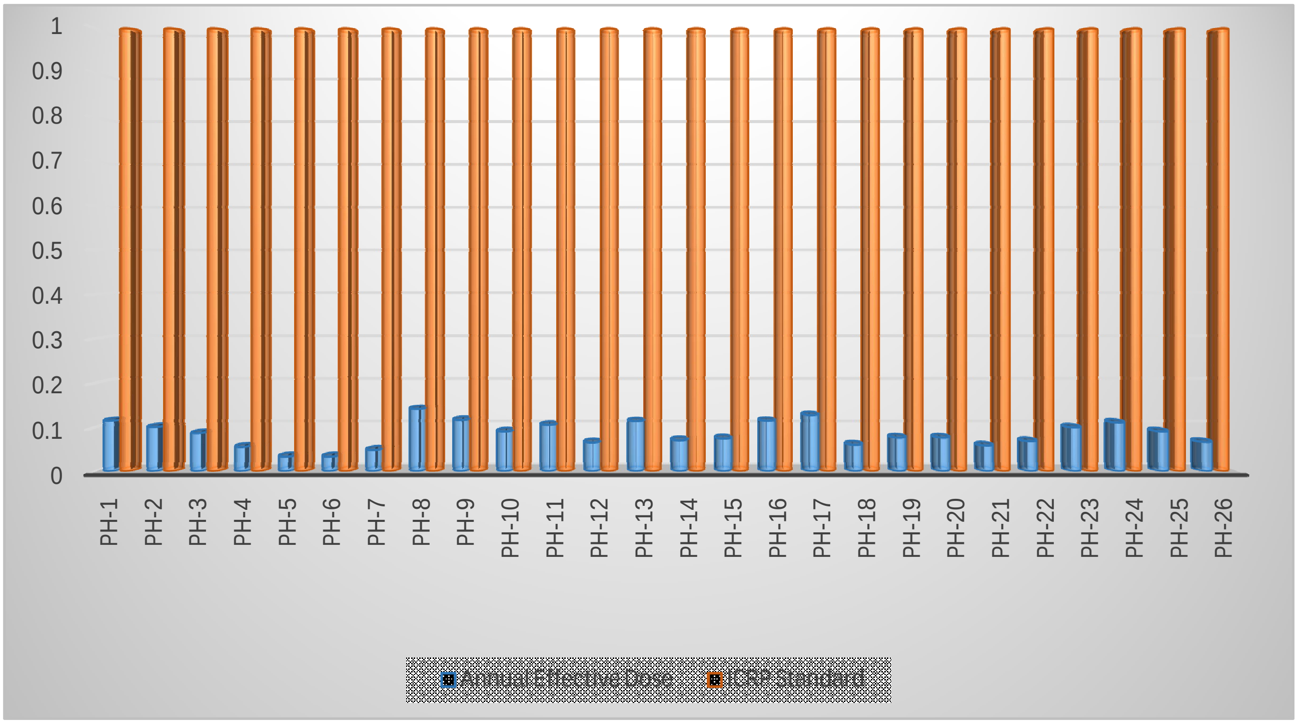

Figure 4. Comparison of annual effective dose equivalent with ICRP, 2003

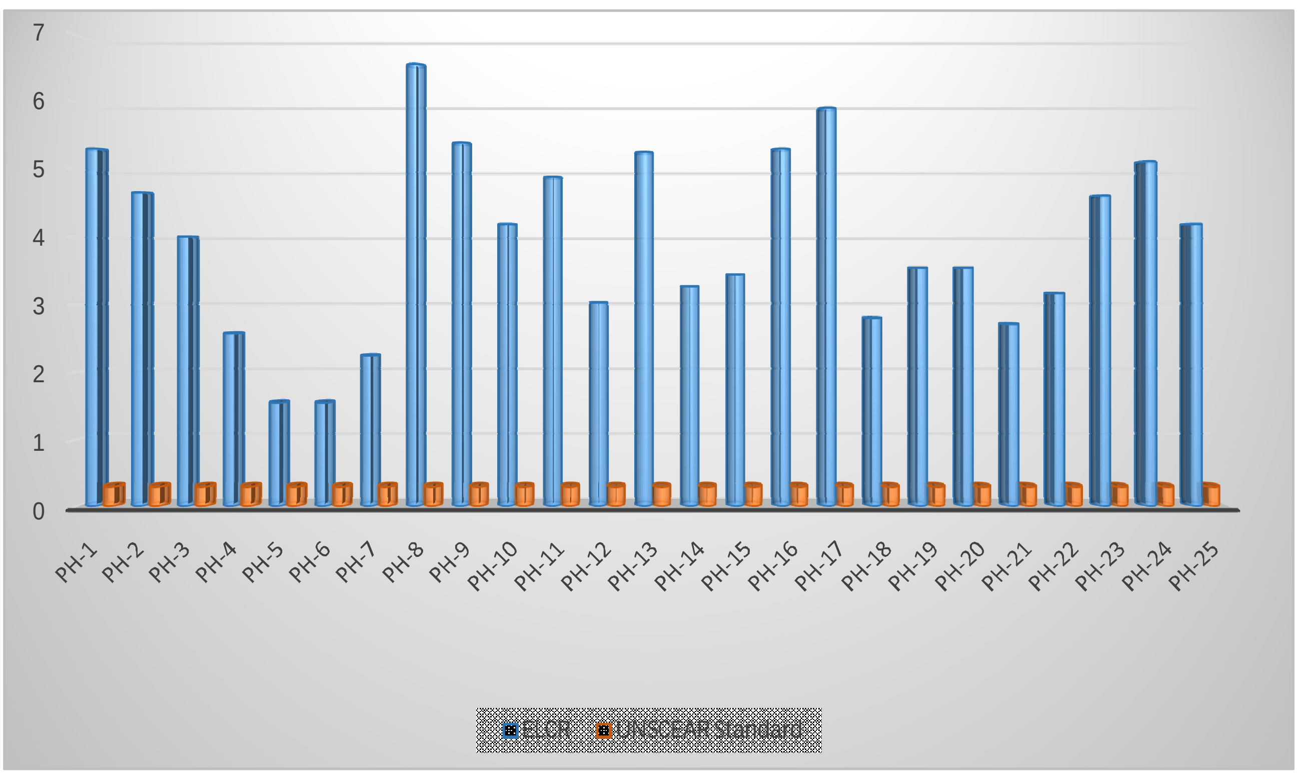

Figure 5. Comparison of ELCR with world average value., UNSCEAR, 2008

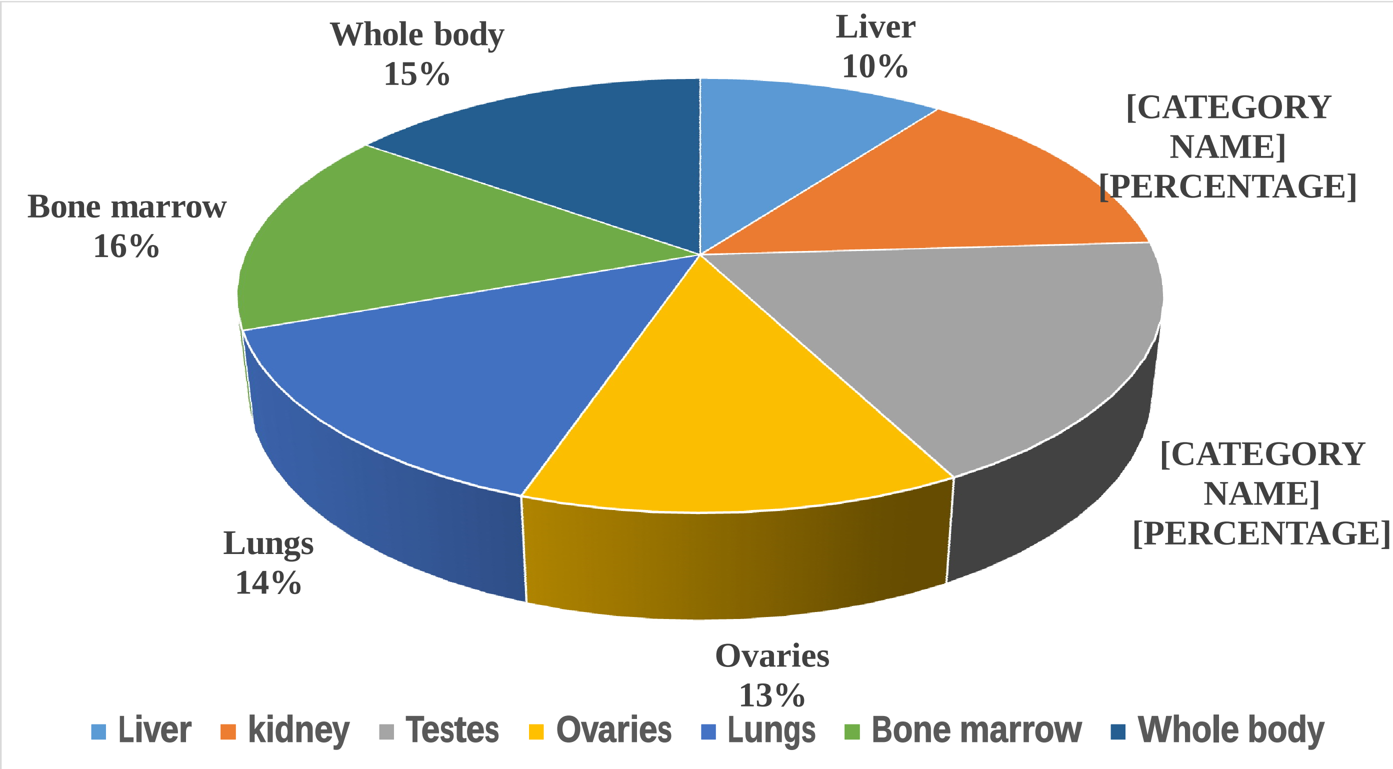

Figure 6. Effective dose to various organs of the human body

4. CONCLUSION

The Terrestrial background ionizing radiation in Port Harcourt has been measured using Radalert 100. The GPS was used for the measurement of geographical coordinate. The result measured showed that the average background radiation in mR/hr is lower than the ICRP recommended values. Therefore, people in Port Harcourt are not in danger of any radiological hazard. However, the computed radiological health risk parameters of the absorbed dosed, annual effective dose and excess lifetime cancer risk are all above safe limits and it present an indication that these areas may not be free from radiological health hazard. Therefore, routine-check of the background ionization radiation needs a proper follow-up, and such information should easily be assessed by the populace.

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