Faculty of Natural and Applied Sciences Journal of Applied and Physical Sciences
Print ISSN: 3026-9857
www.fnasjournals.com
Volume 2; Issue 2; March 2025; Page No. 39-48.

Assessment of Background Ionizing Radiation Levels at Selected Dumpsites in Obio/Akpor Local Government Area, Rivers State, Nigeria

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Abstract
The assessment of background ionizing radiation level of dumpsite along international Airport road of Obio/akpor has been conducted using a well calibrated radiation metre (Radalert 200). Twenty (20) selected sampling points was considered within the dumpsite for the measurement of the radiation exposure. The background ionizing radiation (BIR) of the Dump site variation is within 0.010 to 0.017 mR/hr and mean of 0.014$\pm$0.002 (mR/hr), The absorbed dose varies from 87.0 to147.9 nGy/hr with mean of 121.8 nGy/hr, with a mean of 0.21 mSv/yr, the Annual Effective Dose Equivalent (AEDE) is lower than the UNSCEAR (2000). It ranges from 0.14 to 0.27 mSv/yr. The testes have the largest organ dosage, according to the computed doses of the other bodily organs. of 0.162mSy^{-1} with eighteen percentages (18%) and ovary have the lowest of 0.115mSy^{-1} with thirteen percentages (13%) as shown in figure 5, the organ dose value were below the recommended safe limit. The excess lifelong risk of cancer (ELCR) varies from 0.49 to 0.91×10^{-3} with mean of 0.74×10^{-3} which is greater than stipulated standard. Conclusively the high value of the associated radiological parameters and radiation exposure value within the dumpsite may be dangerous to residents and workers within the dumpsite. Therefore, the dumpsites should be properly monitor by the regulatory authorities in order to alleviate the health effects on the workers.

Keywords: Radiation, Absorb Dosage, Effective Dose, Excess Life Cancer Risk, Organ dosage

Introduction

Our environment contains radiation both natural and sources from man-made in form cosmic radiation, and the presence of radioactivity concentration within the environment which include the naturally occurring radioactive substances such as radon, radium, and the dropout during the nuclear weapons testing (Ajayi et al., 1999). Human environs is bounded by the naturally-occurring radioactive substance with in the soil and stones, and are immersed through cosmic ray and entered the earth's atmospheric environment (Ebong, et al., 1992). The artificial sources such as Man-made radionuclides have entered the environment due to our daily activities such as medical procedures that use radionuclides for body imaging, and for the generation of electricity with application of radioactive uranium as fuel (Ajayi et al., 1999). Research has shown in few decades; that the natural index of radionuclides has been on the increased size due to human activities in order to make life more comfortable. In recent decades, studies have demonstrated that human activities aimed at improving living conditions have resulted in a rise in the natural index of radionuclides. Human waste disposal such as medical waste, industrial waste, research waste and commercial waste has also added to the percentage environment radiation exposures of human directly or indirectly. Humans and animals within the immediate environment are frequently and inevitably exposed to differences radiation doses within the surrounding, (Ugbede et al., 2017). These radiations that human are exposed to on daily basis could either be external sources from ^{40}K, ^{226}Ra and ^{232}Th in soil or from the internal sources include the radionuclides that enter the body through food, water, inhalation of radon and its daughter atoms in earth and gasses emanating from the selected waste dump, (Usikalu, et al., 2017). The present of radon within our environment is of great concern since it is one of the radionuclide that contribute high amount radiation and causes some of the damage in human body organs (Kreuzer 2010). The soil and rock used to build the home also contributed to human exposure to radiation sources in the near surroundings and served as a source of migration through the gradual transfer of radionuclides in the residential area. The presence of ^{232}Th, ^{40}K and ^{238}U, is the main source of the accumulation of radioactive compounds in soil; as a result of their release, there may be radiological risks both inside and externally (Anekwe et al., 2017). The ALARA concept, which governs radiation protection and practice, guarantees that human radiation exposure is as minimal as is practically possible.

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Therefore, determining exposure to ionizing radiation is a crucial goal for radiation protection scientists and controlling organizations (Osimobi et al., 2015).

Absorbed dose Rate

The absorbed dose rate is calculated in nGy/hr using the equation below.

Absorbed Dose = Exposure dose Rate x 8.7 (nGy/hr) (1)

The Annual Effective Dose Equivalent (AEDE)

The radiation yearly effective dose equivalent assessment is estimated using the equation two below. The values obtained from the absorbed dose was utilized to obtained the AEDE using equation (2).

AEDE = Dose rate ×8760 ×0.75 ×0.25 (2)

Excess Life Cancer Risk (ELCR)

The obtained results of yearly effective dose are utilized in estimating excess lifetime cancer risk due to the over exposure to radiation and its protection, also to predict the possibility of residents within the immediate environment of developing cancer due to the high radiation dose.

ELCR= AEDE× (DL)×RISK factor (RF) (3)

The average duration of life (DL) is 70 years and Cancer risk factor (RF) value of 0.05 was applied in estimating the ELCR.

Equivalent Dose

The equivalent dose for the whole body over a period of one year was estimating using the equation (4) below:

$$1\text{mR/h} = \frac{0.96x24x365}{100}\ \text{mSv/yr} \quad (4)$$

Effective Dose to Body Organs

This is estimation of the amount of radiation dose in take to difference human organs and its tissues. The calculated value of effective dose for the body organ is obtained using Equation (5) as given by Darwish et al. (2015).

Dorgan (mSv/yr) =AEDE X F (5)

According to the (ICRP 1996), the conversion factors of the listed organs are, respectively, 0.64, 0.58, 0.69, 0.82, 0.62, 0.46, and 0.68 for the lungs, ovaries, bone marrow, testes, kidney, liver, and entire body.

Study Area

This research work is carried out within Obio/Akpor Local Government Area of Rivers State. The dump site along international Airport road Rumuokporku was selected for the purpose of the study. One of the more populous cities in Rivers State, which is in Nigeria's southern geopolitical area, is Obio/Akpor. It has 464,789 inhabitants, according to (NPC 2006), and is located between latitudes N 04º30'0" and N 05º30'0" and longitudes E 006º30'0" and E 007º30'0". The head quarter is situated at Rumuodumaya with a landmass of 311.72 km^2 and surrounded by others area approachable through air, land and water and the study area is identified on the map with red showing Obio/Akpor area.

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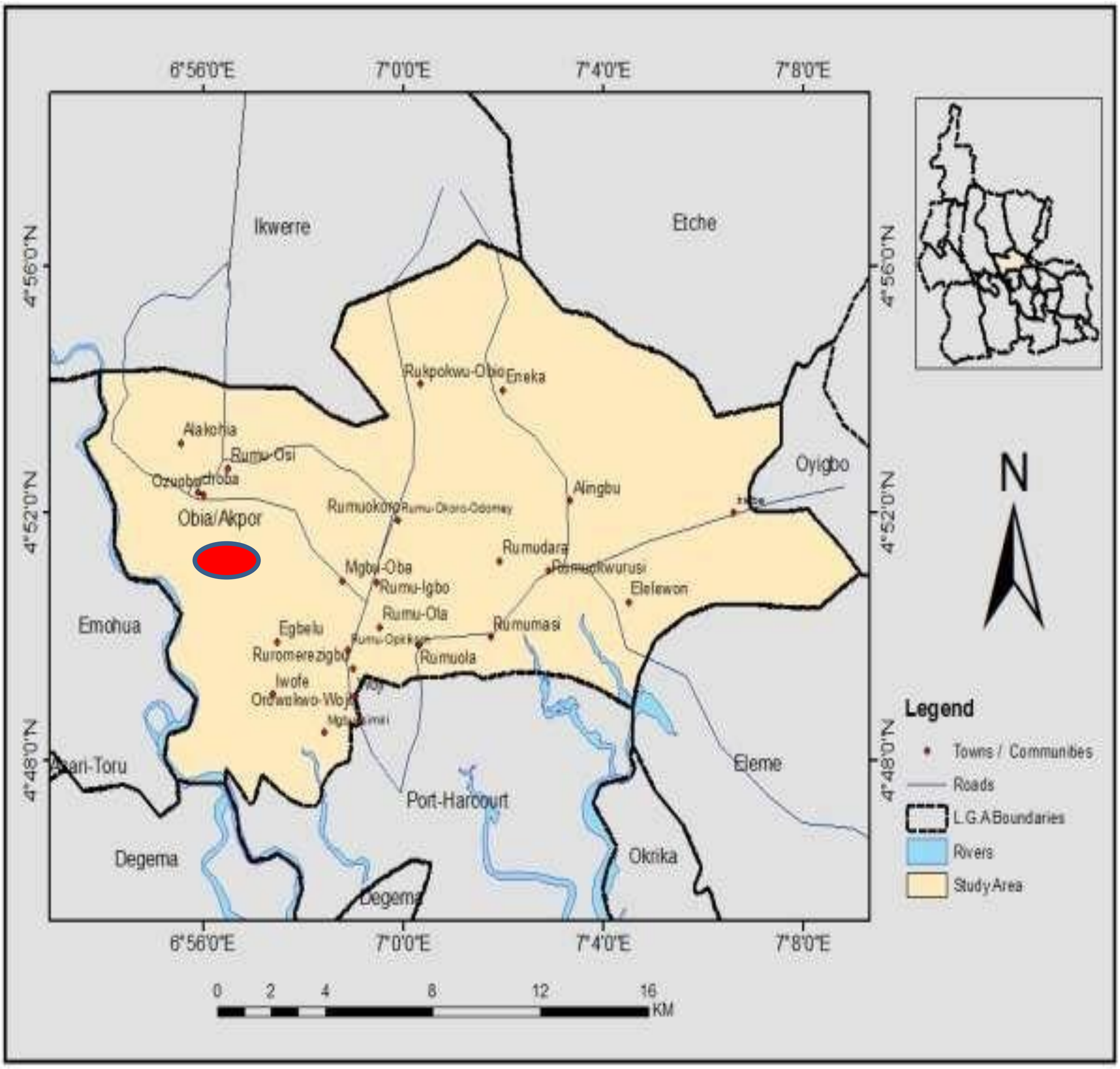

Fig.1: Map of Research Area

Materials and Methods

A radiation meter that had been properly calibrated for precise results was used to measure the dump site in-situ. Using the Geiger-Muller tube in the nuclear radiation monitory metrer, the alpha, beta, and gamma radiation in the environment were all identified. The physical coordinates of the chosen sample locations within the research region were ascertained using the Global Positioning System. The medical condition risk indicators were calculated using mathematical calculations based on the measured background ionizing radiation levels. The in-situ measurement was carried out in Obio/Apkor Local Government Area of Rivers State and twenty (20) sampling points were considered for the purpose of the study. The radiation meter was place one meter (1m) above the ground level during measurement and the exposure dosage was measured in milli-Roetgen per hour using the radiation measuring detector.

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Results

Table: 1. Background Radiations of Dump site along international Air Port road

S/N	Sampling Points	Gps Reading	Exposure Dose Rate ($mRhr^{-1}$)	Equivalent Dose (mSv/yr)	Absorbed Dose (nGy/hr)	AEDE Outdoor (mSv/yr)	ELCR $\times 10^{-3}$
1	Middle of the Road	N04^{0}54.103’ E006^{0}57.812’	0.013$\pm$0.001	1.093	113.1	0.19	0.67
2	Gate	N04^{0}54.075’ E006^{0}57.822’	0.015$\pm$0.002	1.262	130.5	0.21	0.74
3	Left side of the Dump	N04^{0}54.077’ E006^{0}57.833’	0.017$\pm$0.002	1.429	147.9	0.23	0.81
4	Right side of the Dump	N04^{0}54.067’ E006^{0}57.800’	0.013$\pm$0.001	1.093	113.1	0.19	0.67
5	Resident Point 1	N04^{0}54.100’ E006^{0}57.902’	0.010$\pm$0.002	0.841	87.0	0.14	0.49
6	Residents Store	N04^{0}54.100’ E006^{0}57.924’	0.012$\pm$0.002	1.009	104.4	0.17	0.60
7	Plastic Point 1	N04^{0}54.108’ E006^{0}57.932’	0.015$\pm$0.003	1.261	130.5	0.21	0.74
8	Plastic Point 2	N04^{0}54.110’ E006^{0}57.940’	0.010$\pm$0.001	0.841	87.0	0.14	0.49
9	Food Stand	N04^{0}54.110’ E006^{0}57.942’	0.016$\pm$0.002	1.346	139.2	0.22	0.77
10	Entrance Road	N04^{0}54.102’ E006^{0}57.952’	0.017$\pm$0.003	1.429	147.9	0.23	0.81
11	Old Dump Point 1	N04^{0}54.098’ E006^{0}57.955’	0.015$\pm$0.003	1.261	130.5	0.21	0.74
12	Old Dump Point 2	N04^{0}54.095’ E006^{0}57.957’	0.013$\pm$0.001	1.093	113.1	0.19	0.67
13	New Dump Point	N04^{0}54.096’ E006^{0}57.956’	0.014$\pm$0.002	1.177	121.8	0.20	0.70
14	First Borrow Pit	N04^{0}54.102’ E006^{0}57.959’	0.016$\pm$0.002	1.346	139.2	0.22	0.77
15	Second Borrow Pit	N04^{0}54.088’	0.016$\pm$0.003	1.346	139.2	0.22	0.77

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		E006^{0}57.944’					
16	Back of first Pit	N04^{0}54.079’ E006^{0}57.954’	0.015±0.002	1.261	130.5	0.21	0.74
17	Back of second Pit	N04^{0}54.091’ E006^{0}57.967’	0.015±0.003	1.261	130.5	0.21	0.74
18	Resident Point 2	N04^{0}54.079’ E006^{0}57.961’	0.014±0.001	1.177	121.8	0.20	0.70
19	Middle of the Dump	N04^{0}54.085’ E006^{0}57.905’	0.013±0.001	1.093	113.1	0.19	0.67
20	Road Opposite the Gate	N04^{0}54.100’ E006^{0}57.950’	0.011±0.002	0.925	95.7	0.16	0.57
	Mean		**0.014±0.002**	**1.18**	**121.8**	**0.197**	**0.69**
	UNSCEAR 2000		**0.013**	**1.0**	**84.0**	**1.0**	**0.29X10^{-3}**

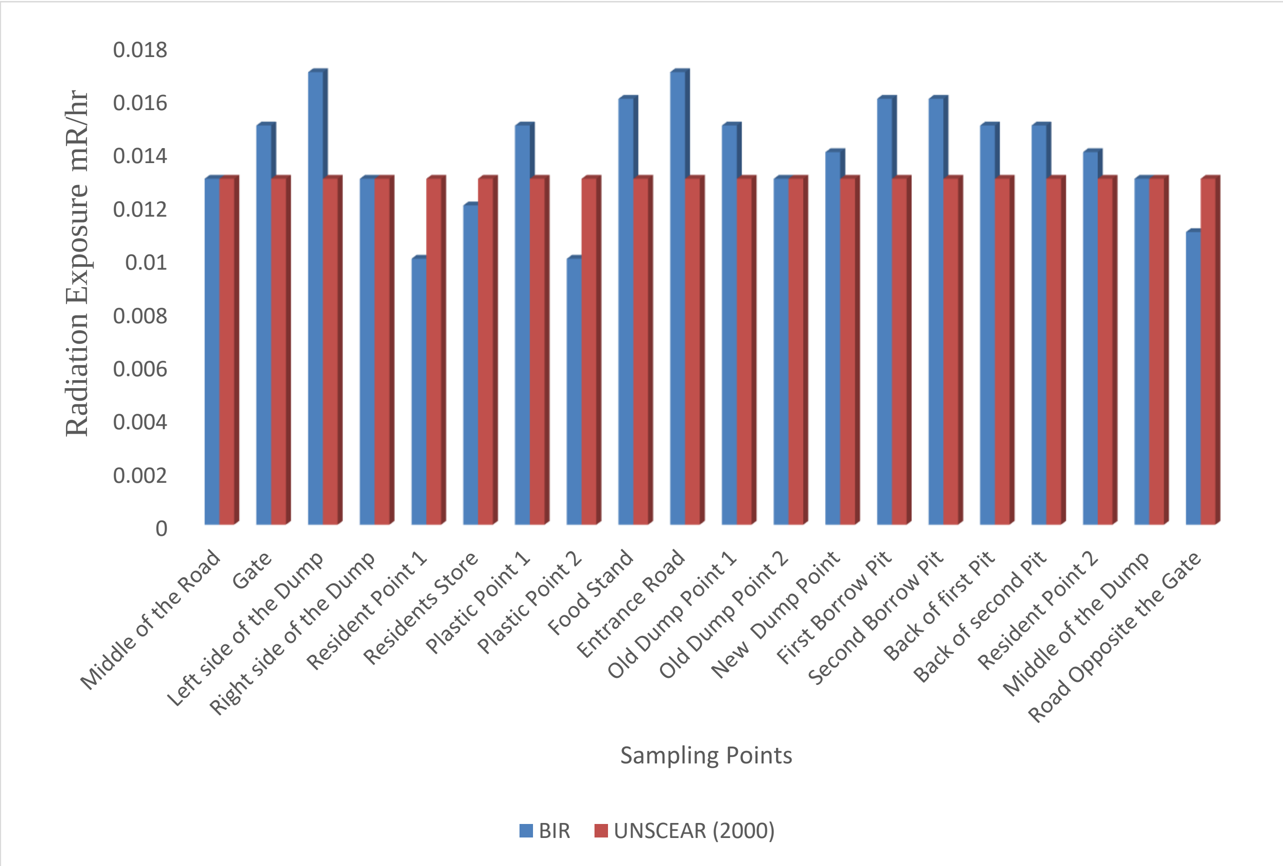

Fig:1 Comparison of Background ionizing radiation of the dumpsite with (UNSCEAR 2000)

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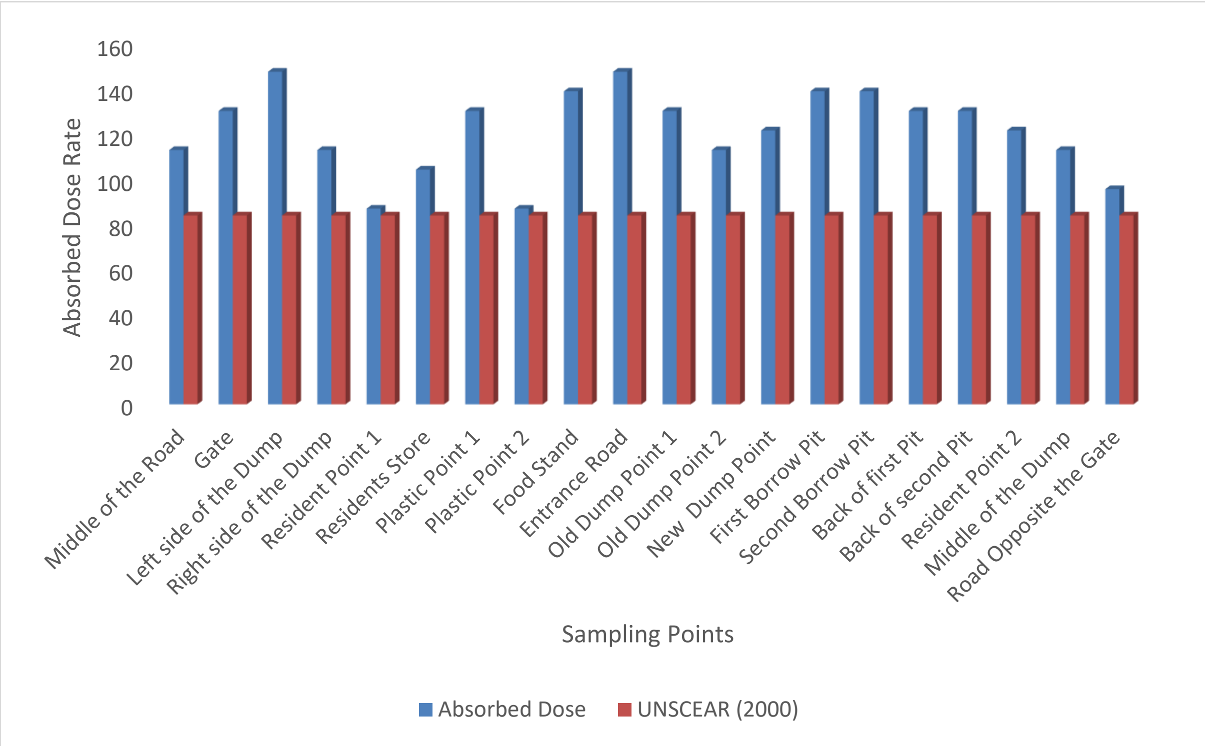

Fig:2 Comparisons of dose rate of the dumpsite with (UNSCEAR 2000)

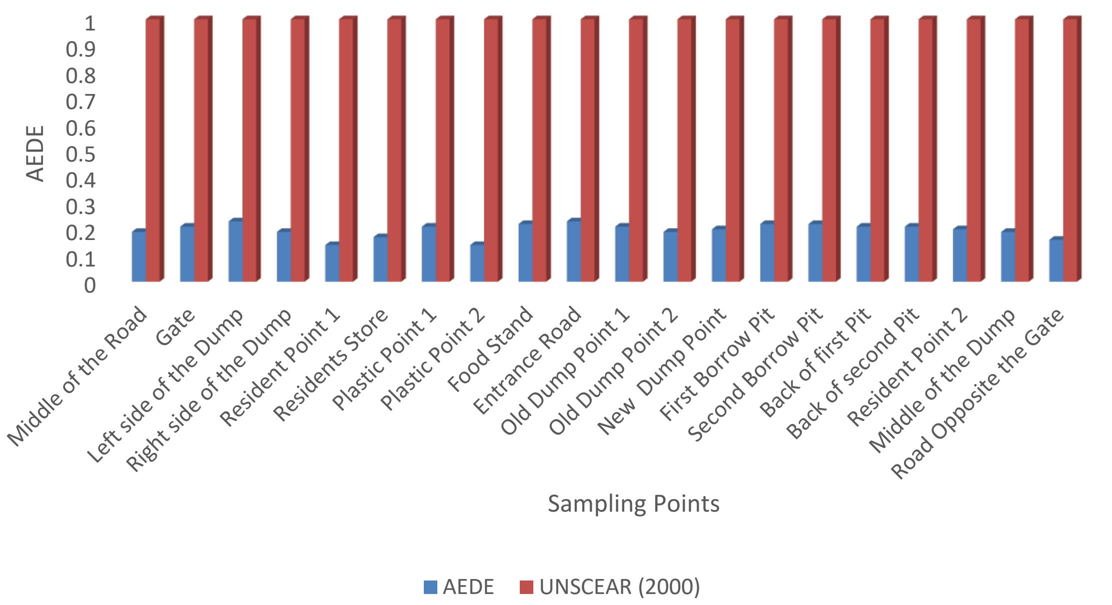

Fig:3 Comparisons of AEDE of the dumpsite with (UNSCEAR 2000)

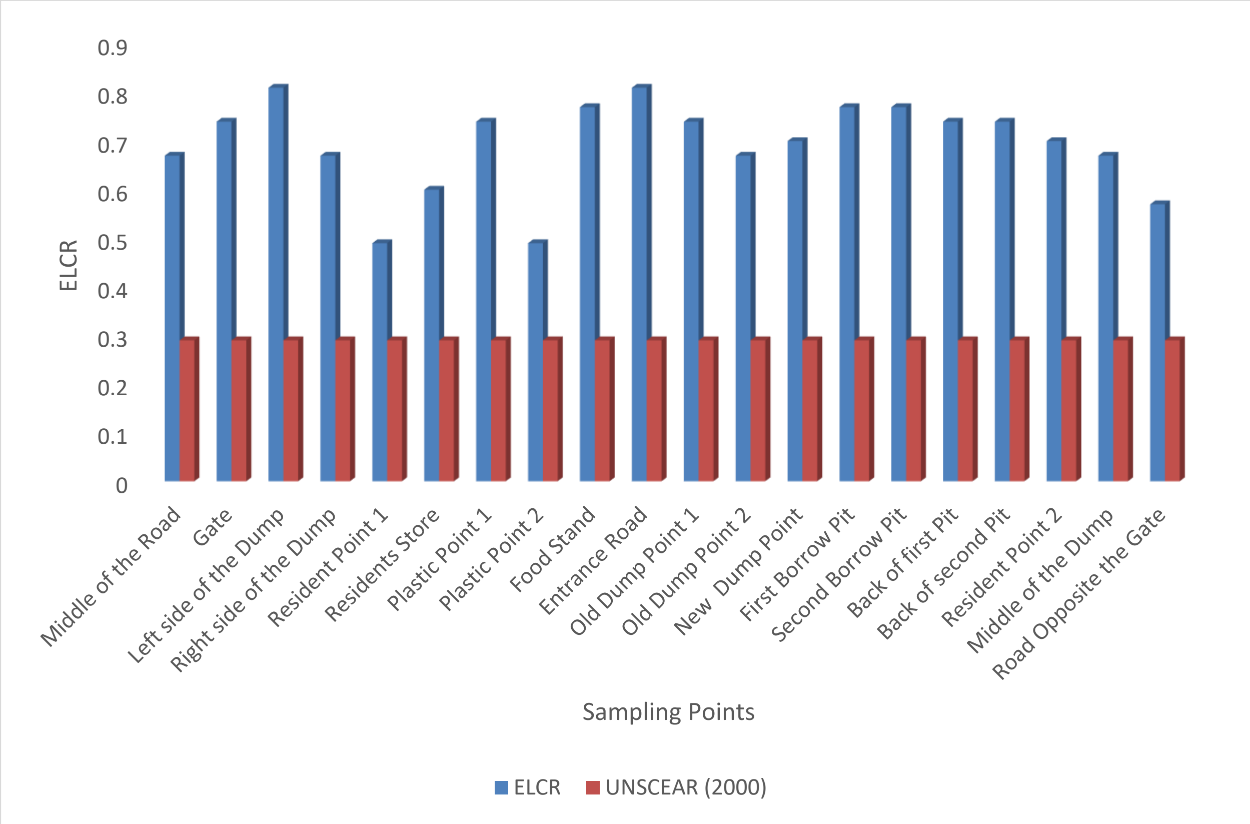

Fig:4 Comparisons of ELCR of the dumpsite with (UNSCEAR 2000)

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Table 2. Different Body Organ

Code	**Dose of different body Organ**						
	Lungs	**Ovaries**	**Bone marrow**	**Testes**	**kidney**	**liver**	**Entire body**
Do1	0.122	0.110	0.131	0.156	0.117	0.087	0.129
Do2	0.134	0.122	0.145	0.172	0.130	0.097	0.143
Do3	0.147	0.133	0.159	0.189	0.143	0.106	0.156
Do4	0.122	0.110	0.131	0.156	0.117	0.087	0.129
Do5	0.089	0.081	0.096	0.114	0.086	0.064	0.095
Do6	0.109	0.099	0.118	0.140	0.106	0.079	0.116
Do7	0.134	0.122	0.145	0.172	0.130	0.097	0.143
Do8	0.089	0.081	0.096	0.114	0.086	0.064	0.095
Do9	0.143	0.130	0.155	0.184	0.139	0.103	0.152
Do10	0.147	0.133	0.159	0.189	0.143	0.106	0.156
Do11	0.134	0.122	0.145	0.172	0.130	0.097	0.143
Do12	0.122	0.110	0.131	0.156	0.117	0.087	0.129
Do13	0.130	0.118	0.140	0.166	0.126	0.094	0.138
Do14	0.143	0.130	0.155	0.184	0.139	0.103	0.152
Do15	0.143	0.130	0.155	0.184	0.139	0.103	0.152
Do16	0.134	0.122	0.145	0.172	0.130	0.097	0.143
Do17	0.134	0.122	0.145	0.172	0.130	0.097	0.143
Do18	0.130	0.118	0.140	0.166	0.126	0.094	0.138
Do19	0.122	0.110	0.131	0.156	0.117	0.087	0.129
Do20	0.102	0.093	0.110	0.131	0.099	0.073	0.109
Mean	**0.127**	**0.115**	**0.137**	**0.162**	**0.123**	**0.091**	**0.135**

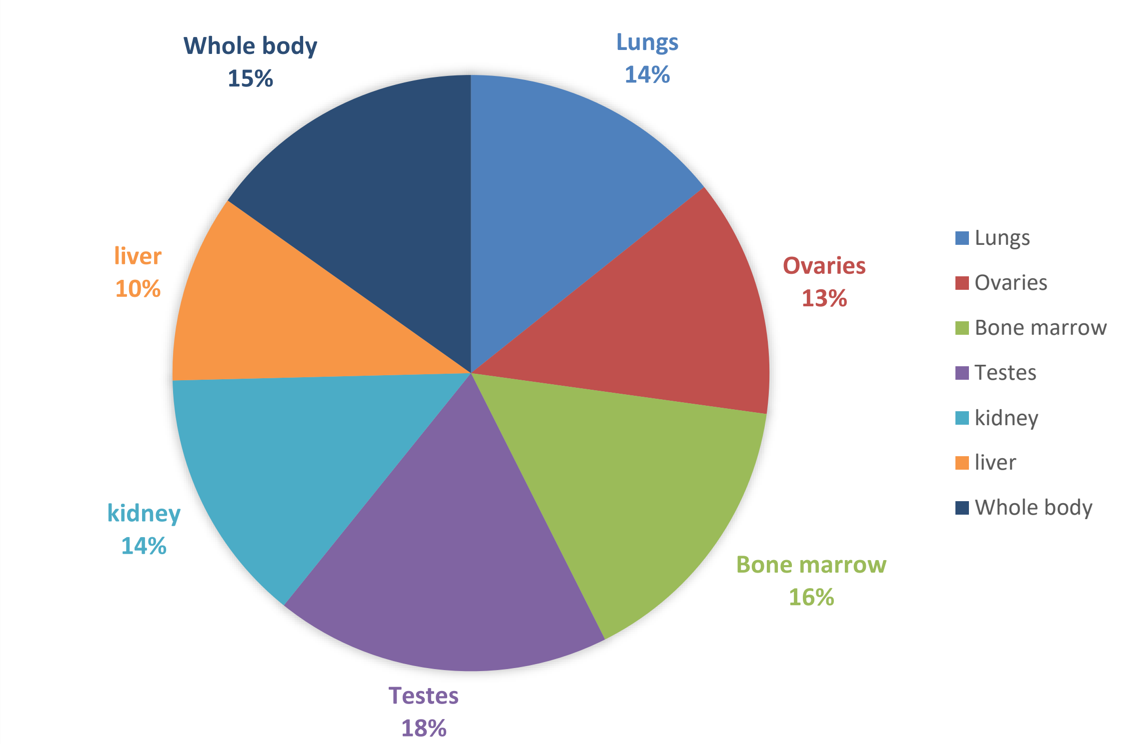

Fig:5. Percentage of background ionizing radiation to the different body organ

Discussion

The total number of twenty (20) selected sampling points was considered within the dumpsite and the background ionizing radiation exposure reading was taken at each of the selected locations using a well calibrated Radiation metre and a Global Positioning System (GPS). The background ionizing radiation (BIR) of the Dump spot varies from 0.010 to 0.017 mR/hr and a mean of 0.014$\pm$0.002 (mR/hr), figure 4.1 shows the comparison of the radiation exposure dose rate with the recommended value of 0.013(mR/hr). The BIR results of some of the selected sampling points is higher than the (UNSCEAR 2000) standard and lower than the value reported by Avwiri et al., (2017) on hazards to radiological health because to gamma dose rates within Okposi okwu and Uburu salt lakes, Ebonyi state. The highest values of radiation were recorded within the Gate, left hand side of the Dump spot, plastic point, Food stand, entrance road, old dump point, first and second borrow pit and back of first and second pit while the lower radiation values were recorded within the Residents point, plastic point two and road opposite the dump Gate. This higher radiation values might be due to the concentration of radionuclide emitting gamma rays within the dump spot as a result of waste material from different part of the city or residential area and also due to the present of the medical waste materials which emit radiation within the dump spot. The absorbed dose varies from 87.0 to147.9 nGy/hr with mean of 121.8 nGy/hr which was higher than the (ICRP 2007). Annual effective dose equivalent (AEDE) varies from 0.14 to 0.27 mSv/yr with mean of 0.21 mSv/yr which is lower than the (ICRP 2007) standard and also lower than the reported work of (Ugbede et al., 2018). The Excess life time cancer risk (ELCR) varies from 0.49 to 0.91x10^{-3} with mean of 0.74x10^{-3} which is higher than the reported value of (Taskin et al., 2009). The calculated dose of the different body organ show that the testes have the highest organ dose of 0.162mSy^{-1} with eighteen percentages (18%) and ovary have the lowest of 0.115mSy^{-1} with thirteen percentages (13%) as shown in figure 5, the organ dose value were below the recommended safe limit of 1.0 mSy^{-1}. The result of organ dose agreed with the work of (Ugbede et al., 2018). The ELCR values of the dumpsite exceeded the (UNSCEAR 2000) value of 0.29x10^{-3}, this implied that the residential area within the dump spot may developed cancer in future due to the high the values of radiation within the study.

Conclusion

The *in-situ-* measurement of outdoor background ionizing radiation of the Dump site was high in some of the selected sampling points and low in some of the selected sampling point when compared with the recommended safe limit of 0.013 mR/hr. The alteration in the background ionizing radiation within the Dump site might be due to the present of radionuclide within waste materials dumped within the dumping site and also due to accumulated concentration of radionuclide emitting gamma rays within the old dump site. The Excess life time cancer risk (ELCR) obtained was greater than the (UNSCEAR 2000) standard of $0.29x10^{-3}$. The ELCR values of the study area is greater the worldwide average value of 0.29×10^{-3} this implied that the residential area and workers within the Dump site may developed cancer in future due to the high values of radiation within the dumpsite.

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