



Background Ionizing Radiation and Health Risk of Selected Dumpsite in Owerri West Local Government Area, Imo State, Nigeria

*¹Nwii, A.A., ²Biibaloo, L.L., ¹Njoku, V., & ¹Nelson, S.K.

¹Department of Physics, Ignatius Ajuru University of Education Port Harcourt

²Department of Surgery (ENT Surgery), Rivers State University Nkoplum Port Harcourt

*Corresponding author email: abayiga.nwii@iaue.edu.ng

Abstract

Evaluation of background ionizing radiation and health risk of selected dumpsite in Owerri West Local Government Area, Imo State, Nigeria, has been carried out using a well calibrated radiation meter and global positioning system (GPS). The aim of the study was to evaluate the background ionizing radiation of the selected dumpsites. Three dumpsites were selected and ten (10) strategic sections of the dumpsites were considered for the measurement. The obtained result of background ionizing radiation varies from 0.013 to 0.020 mR/h, 0.010 to 0.017 mR/h and 0.014 to 0.017 mR/h with mean of 0.015 mR/h, 0.012 mR/h and 0.015 mR/h for Nokia house Dumpsite, Nokia house mechanic and Alaba Dumpsite respectively. The obtained mean of BIR are all higher than the recommended safe limit of 0.013 mR/h as stipulated by UNSCEAR (2002) except that of Nokia house mechanic which is within the tolerable limit. The absorbed dose varies 87.0 to 174 nGy/h, 78.0 to 121.8 nGy/h and 87 to 147.7 nGy/h with mean of 136.59 nGy/h, 102.66 nGy/h and 127.0 nGy/h they obtained reading are all higher than the stipulated safe limit of 84.0 nGy/h while the results of excess life cancer risk varies from 0.523 to 0.89, 0.336 to 0.81 and 0.523 to 0.77 with mean 0.67, 0.517 and 0.63 for Nokia house Dumpsite, Nokia house mechanic and Alaba Dumpsite respectively. The obtained result of the ELCR all exceeded the UNSCEAR (2000) recommended safe limit of 0.29×10^{-3} , indicating a potential long term radiological health risk. The result of radiation exposure to the different human body organs show that higher radiation was received by the human testes and lower radiation was obtained in the human liver and this higher radiation in the testes may be due to its sensitivity to radiation while that of the liver may be due to its protection with different body tissue. Though, there is no immediate health effects due to the exposure to background ionizing within the study area but there will be a long term health effects due to over exposure.

Keywords: Dumpsite, Background Radiation, Organ, ELCR, Health

Introduction

Environmental waste is on the increased and it is one of the major challenges cities are facing in the world in recent time. The rapid population growth, urbanization, industrial activities, and the current modern lifestyles has also contributed significantly to the increase of waste generated. Improper disposal of this waste can be harmful to the environment, human health, and natural ecosystems (Jambeck et al., 2015). Dumpsites are the strategies recognized or approved points or locations for the disposal of waste from either homes, hospitals, industries, and other sources of wastes. Some of the disposed wastes are non-hazardous while some of the disposed materials are capable of emitting ionizing radiation within the environment. The emitted radiation within dumpsites may lead to soil contamination, water contamination, and air contamination and in turns pose a serious health risks to both humans, animals, and plants (USPA, 2021). Waste (unwanted materials) is fully part of human environment and inappropriate dumping of waste within the environment may contribute to environment nuisance and other related health risk which will be dangerous to human health and the immediate environment. However, the radiation radiological health risks associated with the dumped waste within the dumpsites may emanate from the dumped materials which in turned generate unpleasant

smells and disease producing microorganisms within the immediate environment. Populace are exposed to background ionizing radiation of the dumpsite during daily activities and this radiation emanated from either the natural radiation sources, artificial radiation sources or from both sources. Improper disposal of unwanted (waste) such as medical waste, agricultural waste, industrial waste or medical waste also contributed to human exposure to background ionizing radiation within the immediate environment (Okevemeke et al.,2023). Some of the disposed building materials such as paint and other building material also contributed to the alteration of the natural background ionizing radiation within the environment and serve as path way through which radionuclide are transfer to human environment (Nwii et al.,2025). Populace are exposed daily to background ionizing radiation from a variety of sources, including scientific research, medical procedures, industrial activities, and diagnostic X-ray imaging. The potential health effects of this background radiation on people and the surrounding environment are therefore a matter of significant concern (UNSCEAR, 2000). The radiation originated from dumpsites within the environment is of great concern due to it health effect to human and the immediate environment, precisely within areas where there is a low level of waste management practices. The reaction from dumped waste may be lead to the alteration of radionuclide concentration within the environment and pose some health related effect to the populace. The waste within the dumpsites are made off household waste, industrial waste, medical waste, and electronic wastes, some of this waste emit greater percentage of radiation ionizing radiation. Over time, environmental contamination take place such as soil contamination, water contamination, air contamination, and more so becomes dangerous to living organisms and human health and. (UNSCEAR, 2019).

Radiological Health Risk Parameters

The following are some of the radiological health risk parameter considered for the evaluation of the background ionizing from dumpsite.

Absorbed Dose Rate

The amount of radiation absorbed by body is estimated in nGy/hr using the equation below:

$$\text{Absorbed Dose} = \text{Radiation Exposure dose Rate} \times 8.7 \text{ (nGy/hr)} \quad (1)$$

The Annual Effective Dose Equivalent (AEDE)

The obtained result absorbed dose rate is used to estimate the annual effective dose equivalent using the equation below.

$$\text{AEDE} = \text{Absorbed dose rate} \times 8760 \times 0.75 \times 0.25 \quad (2)$$

Excess Life Cancer Risk (ELCR)

The obtained value of the annual effective dose equivalent is used for calculating the excess lifetime cancer risk and the obtained result is use in predicting the probability of inhabitants within the environment of developing cancer as a result of over exposure to radiation. The life duration (LD) consider is seventy years (70) with a risk factor of 0.05.

$$\text{ELCR} = \text{AEDE} \times (\text{DL}) \times \text{RISK factor (RF)} \quad (3)$$

Effective Dose to Body Organs

Human body organ are exposed to radiation at different rate and the amount of radiation dose received by the different organs and its tissues is estimated using the value of annual effective dose equivalent and the conversion factor. The conversion factors of the different body organs, 0.58, 0.64, 0.69, are 0.82, 0.46, 0.62, and 0.68 for the, ovaries, lungs bone marrow, testes, liver, kidney and whole body respectively (Darwish et al., 2015).

$$\text{Dorgan (mSv/yr)} = \text{AEDE} \times \text{Conversion factor} \quad (4)$$

Study Area

The research work is carried out in Owerri West Local Government Area and this is one of the Twenty-seven (27) Local Government area in Imo state presently in the South-east geological zone of Nigeria. Owerri West headquarters is situated at Umuguma Town. Owerri West Local Government area was map out from the formal Owerri Local Government Area in the year 1996. It has an average land area of 295.0 km² with a population of 99,265. The Population made up of both rural and semi urban communities as recorded by 2006 census. Owerri West has an average temperature of 27°C and humid tropical climate with two season raining March to October and dry season November to February. The selected dumpsite for the purpose of the study is located within urban area of the Local Government Area and the Local Government Area is shown on the map with green.

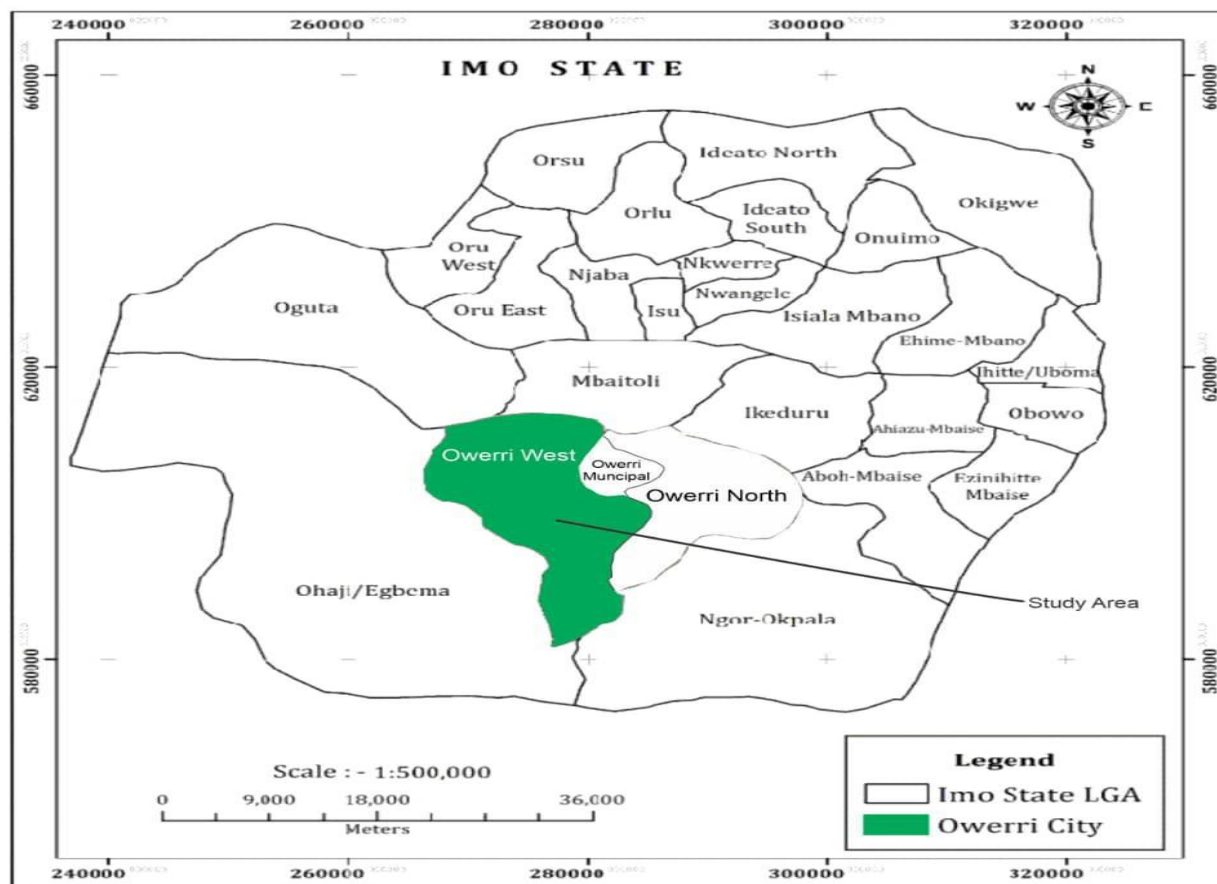


Fig.1. The Map of the Study Area

Materials and Methods

The evaluation background ionizing radiation of the selected dumpsites within Owerri West Local Government Area was carried out using *in-situ* measurement method. The radiation meter was well calibrated for the measurement of the background ionizing radiation level in order to obtain accuracy result. The radiation meter was able to detect the radiation level of the identified locations within the study area with the use of the Geiger-Muller tube found in the nuclear radiation monitoring meter. The Global Positioning System (GPS) was utilized in detecting the geographical coordinates of selected location within the study in order to identify the results of the sampling points. The radiological health risk was estimated using the radiation mathematical modelling equations based on the obtained results of background ionizing radiation. The *in-situ* measurement was carried out in Owerri West Local Government Area of Imo State and three selected dumpsites within the area were considered for the study such as Nokia house Dumpsite, Nokia House Mechanic Dumpsite and Alaba Dumpsite and ten (10) sampling points were considered within each of the selected Dumpsites. The radiation meter was placed one meter (1.0 m) above the earth surface when taking

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background ionizing radiation exposure and three different reading was recorded at each of the selected locations then the average reading was considered for accuracy of the result.

Results

The results of background ionizing radiation of the three selected dumpsites are presented in Table 1-3 and radiation to the different human organs are presented in Table 4-6. Figure 2-10 shows the comparison of the background ionizing radiation and its radiological health with standard and Figure 11-13 shows radiation dose exposure to different body organs.

Table 1: Background Ionizing Radiation Exposure of Nokia house Dumpsite

S/N	Sampling Points	GPS Reading	Exposure Dose Rate (mR/hr)	Absorbed Dose Rate (nGy/hr)	AEDE (mSv/y)	ELCR 10^{-3}
1	Edge	N04 ⁰²⁷ .560” E007 ⁰⁰² .455”	0.017	147.9	0.23	0.81
2	1m from Edge	N04 ⁰²⁷ .560” E007 ⁰⁰² .466”	0.017	147.9	0.23	0.81
3	Super market	N04 ⁰²⁷ .560” E007 ⁰⁰² .467”	0.014	121.8	0.15	0.52
4	Behind supermarket	N04 ⁰²⁷ .541” E007 ⁰⁰² .460”	0.010	87.0	0.14	0.49
5	Dump Side	N04 ⁰²⁷ .562” E007 ⁰⁰² .460”	0.017	147.9	0.23	0.81
6	Dump Top	N04 ⁰²⁷ .563” E007 ⁰⁰² .4564”	0.014	121.8	0.15	0.52
7	Dump mid-Point	N04 ⁰²⁷ .560” E007 ⁰⁰² .455”	0.020	174.0	0.33	0.89
8	Residential 2	N04 ⁰²⁷ .560” E007 ⁰⁰² .455”	0.014	121.8	0.15	0.52
9	Residential 1	N04 ⁰²⁷ .560” E007 ⁰⁰² .455”	0.014	121.8	0.15	0.52
10	New Dump	N04 ⁰²⁷ .560” E007 ⁰⁰² .455”	0.020	174.0	0.33	0.89
	Average		0.015	136.59	0.21	0.67
	UNSCEAR	(2008)	0.013	84.0	1.0	0.29x10⁻³

Table 2: Background Ionizing Radiation Exposure of Nokia House Mechanic Dumpsite

S/N	Sampling Points	GPS Reading	Exposure Dose Rate (mR/hr)	Absorbed Dose Rate (nGy/hr)	AEDE (mSv/y)	ELCR 10^{-3}
1	Gate	N04 ⁰²⁷ .612" E007 ⁰² '433"	0.014	121.8	0.149	0.523
2	1m from Gate	N04 ⁰²⁷ .621" E007 ⁰² '450"	0.014	121.8	0.149	0.523
3	Dum Top	N04 ⁰²⁷ .644" E007 ⁰² '444"	0.010	87.0	0.14	0.490
4	Workshop	N04 ⁰²⁷ .676" E007 ⁰² '456"	0.010	87.0	0.14	0.490
5	Sale Point 1	N04 ⁰²⁷ .687" E007 ⁰² '450"	0.017	147.9	0.23	0.81
6	Sale Point 2	N04 ⁰²⁷ .687" E007 ⁰² '456"	0.014	121.8	0.149	0.523
7	Center of Park	N04 ⁰²⁷ .679" E007 ⁰² '405"	0.010	87.0	0.14	0.490
8	Back of Park	N04 ⁰²⁷ .656" E007 ⁰² '453"	0.010	87.0	0.14	0.490
9	Park exit Gate	N04 ⁰²⁷ .654" E007 ⁰² '450"	0.009	78.3	0.096	0.336
10	Security office	N04 ⁰²⁷ .660" E007 ⁰² '450"	0.010	87.0	0.14	0.490
	Average		0.012	102.7	0.15	0.52
	UNSCEAR (2008)		0.013	84.0	1.0	0.29x10⁻³

Table 3: Background Ionizing Radiation Exposure of Alaba Dumpsite

S/n	Sampling Points	GPS Reading	Exposure Dose Rate (mR/hr)	Absorbed Dose Rate (nGy/hr)	AEDE (mSv/y)	ELCR 10^{-3}
1	Resident 1	N05 ⁰ 26'.357" E007 ⁰ 04'417"	0.014	121.8	0.149	0.523
2	Gutter	N05 ⁰ 26'.357" E007 ⁰ 04'418"	0.010	87.0	0.14	0.49
3	Edge one	N05 ⁰ 26'.350" E007 ⁰ 04'420"	0.014	121.8	0.149	0.523
4	Edge Two	N05 ⁰ 26'.358" E007 ⁰ 04'430"	0.016	139.2	0.22	0.77
5	Old dump	N05 ⁰ 26'.344" E007 ⁰ 04'428"	0.014	121.8	0.149	0.523
6	Dump Pathway	N05 ⁰ 26'.342" E007 ⁰ 04'428"	0.017	147.9	0.23	0.81
7	Behind dump	N05 ⁰ 26'.349" E007 ⁰ 04'422"	0.016	139.2	0.22	0.77
8	Back of dump	N05 ⁰ 26'.352" E007 ⁰ 04'436"	0.014	121.8	0.149	0.523
9	Resident 2	N05 ⁰ 26'.357" E007 ⁰ 04'440"	0.014	121.8	0.149	0.523
10	New dump	N05 ⁰ 26'.359" E007 ⁰ 04'446"	0.017	147.9	0.23	0.81
	Average UNSCEAR (2008)		0.015 0.013	127.0 84.0	0.12 1.0	0.63 0.29x10⁻³

Table 4:

Radiation to Different Body Organ for Nokia house Dumpsite

S/n	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
1	0.095	0.086	0.103	0.122	0.092	0.069	0.101
2	0.095	0.086	0.103	0.122	0.092	0.069	0.101
3	0.095	0.086	0.103	0.122	0.092	0.069	0.101
4	0.089	0.081	0.097	0.115	0.087	0.064	0.095
5	0.147	0.133	0.159	0.189	0.143	0.106	0.156
6	0.147	0.133	0.159	0.189	0.143	0.106	0.156
7	0.211	0.191	0.228	0.271	0.205	0.152	0.224
8	0.147	0.133	0.159	0.189	0.143	0.106	0.156
9	0.211	0.191	0.228	0.271	0.205	0.151	0.224
10	0.095	0.086	0.103	0.122	0.092	0.068	0.101
	0.134	0.121	0.144	0.171	0.129	0.096	0.142
Mean							

Table 5: Radiation to Different Body Organ for Nokia House Mechanic Dumpsite

S/n	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
1	0.095	0.086	0.103	0.122	0.092	0.069	0.101
2	0.095	0.086	0.103	0.122	0.092	0.069	0.101
3	0.089	0.081	0.097	0.115	0.087	0.064	0.095
4	0.089	0.081	0.097	0.115	0.087	0.064	0.095
5	0.147	0.133	0.159	0.189	0.143	0.106	0.156
6	0.095	0.086	0.103	0.122	0.092	0.069	0.101
7	0.089	0.081	0.097	0.115	0.087	0.064	0.095
8	0.089	0.081	0.097	0.115	0.087	0.064	0.095
9	0.061	0.056	0.067	0.079	0.059	0.044	0.0653
10	0.089	0.081	0.097	0.115	0.087	0.064	0.095
Mean	0.094	0.085	0.102	0.121	0.091	0.068	0.100

Table 6: Radiation to Different Body Organ for Alaba Dumpsite

S/n	Lungs	Ovaries	Bone Marrow	Testes	Kidney	Liver	Whole Body
1	0.095	0.086	0.103	0.122	0.092	0.069	0.101
2	0.147	0.133	0.159	0.189	0.143	0.106	0.156
3	0.095	0.086	0.103	0.122	0.092	0.069	0.101
4	0.141	0.128	0.152	0.180	0.136	0.101	0.150
5	0.095	0.086	0.103	0.122	0.092	0.069	0.101
6	0.147	0.133	0.159	0.189	0.143	0.106	0.156
7	0.141	0.128	0.152	0.180	0.136	0.101	0.150
8	0.095	0.086	0.103	0.122	0.092	0.069	0.101
9	0.095	0.086	0.103	0.122	0.092	0.069	0.101
10	0.090	0.081	0.097	0.115	0.087	0.064	0.095
10	0.090	0.081	0.097	0.115	0.087	0.064	0.095
Mean	0.114	0.104	0.123	0.146	0.111	0.082	0.121

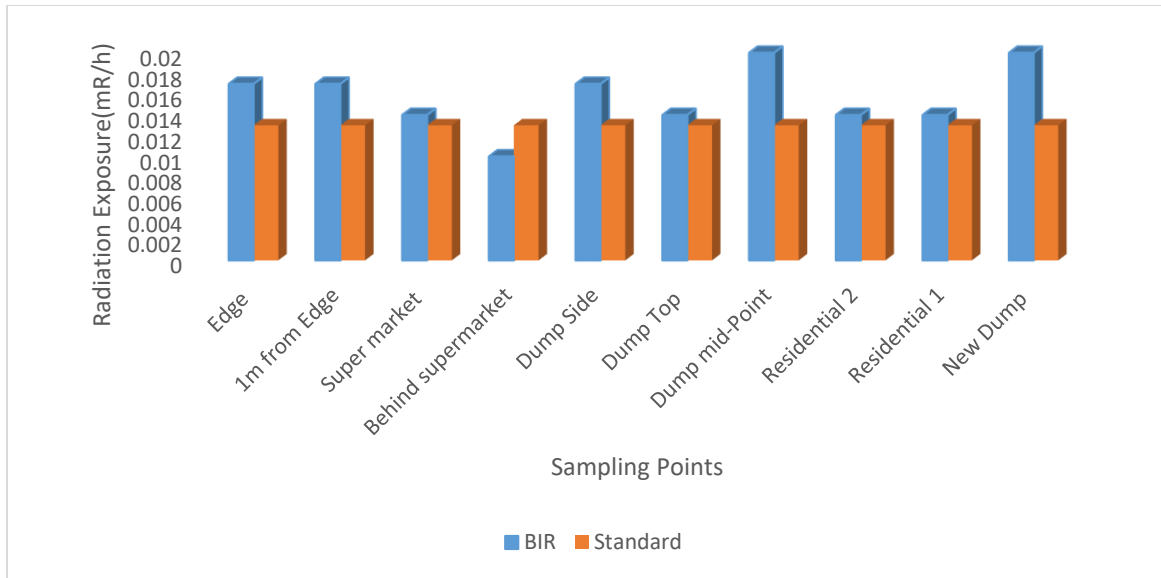


Fig.2: Comparison of Radiation Exposure of Nokia house Dumpsite with standard

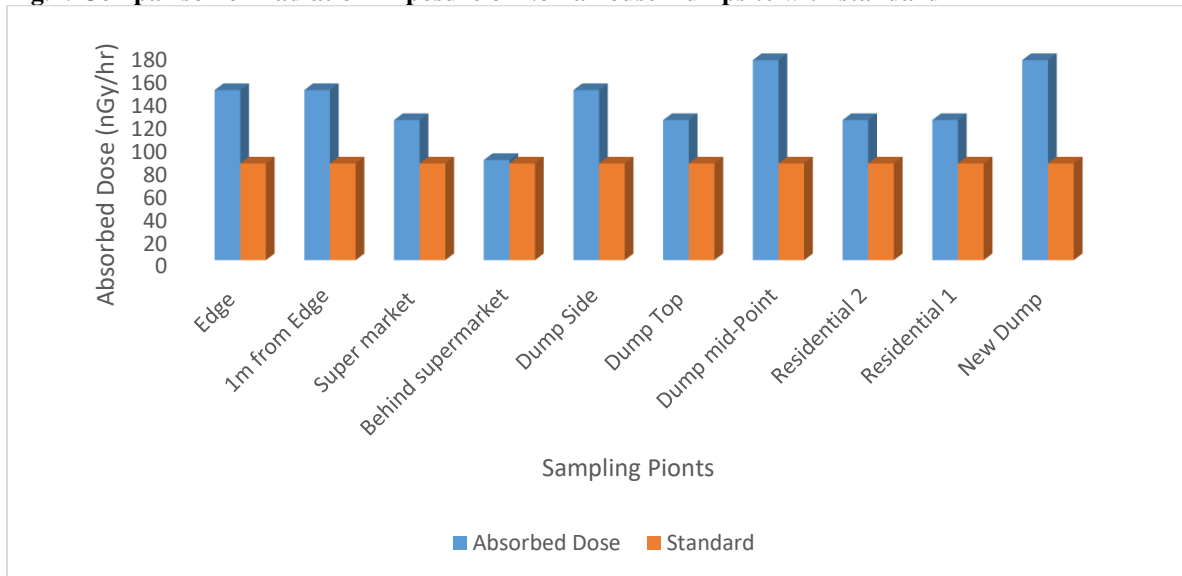


Fig.3: Comparison of Absorbed Dose of Nokia house Dumpsite with standard

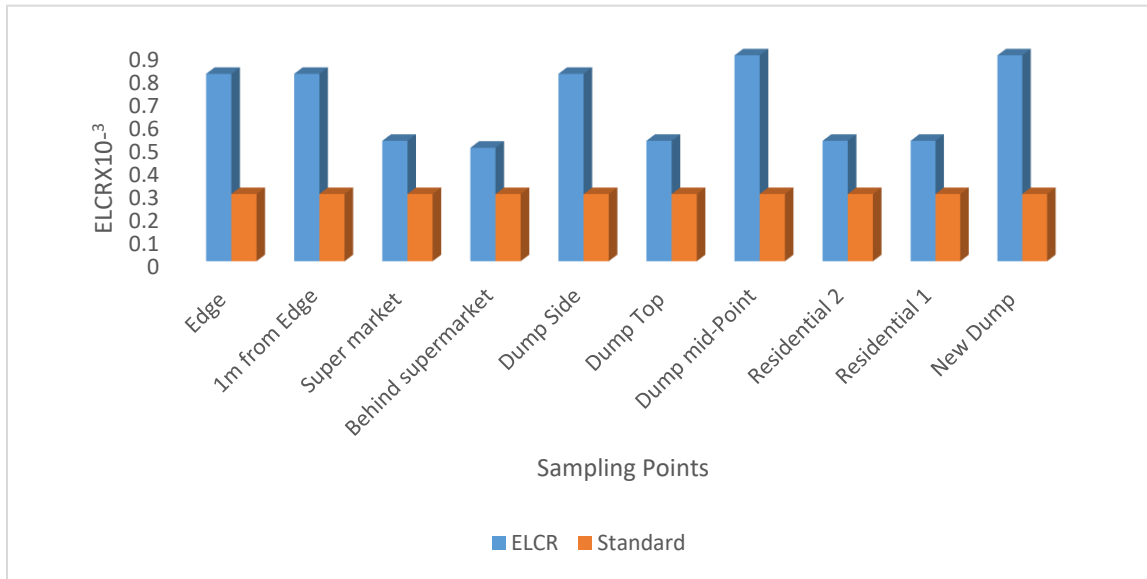


Fig.4: Comparison of ELCR of Nokia house Dumpsite with standard

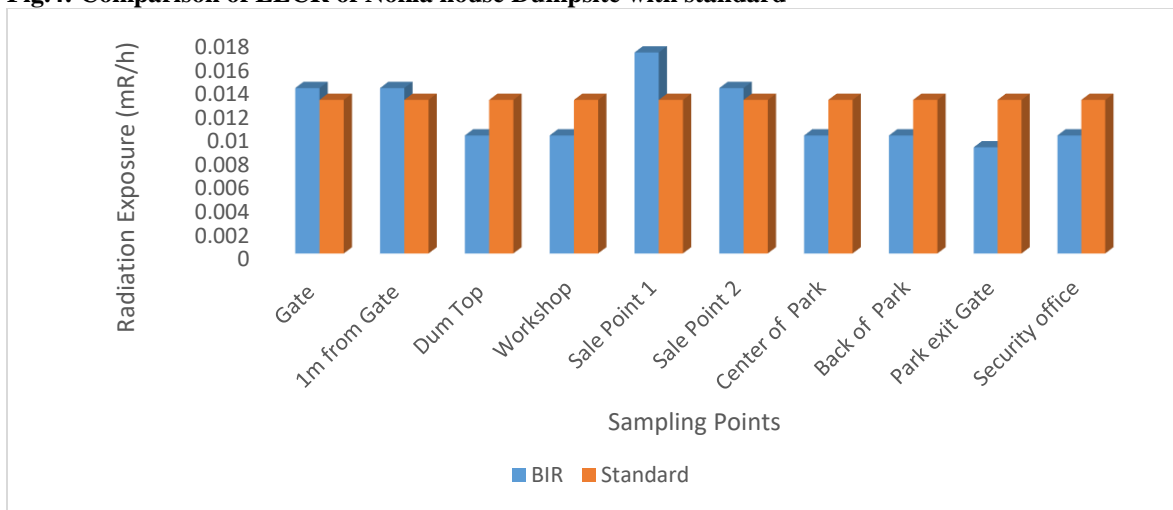


Fig.5: Comparison of BIR of Nokia House Mechanic Dumpsite with standard

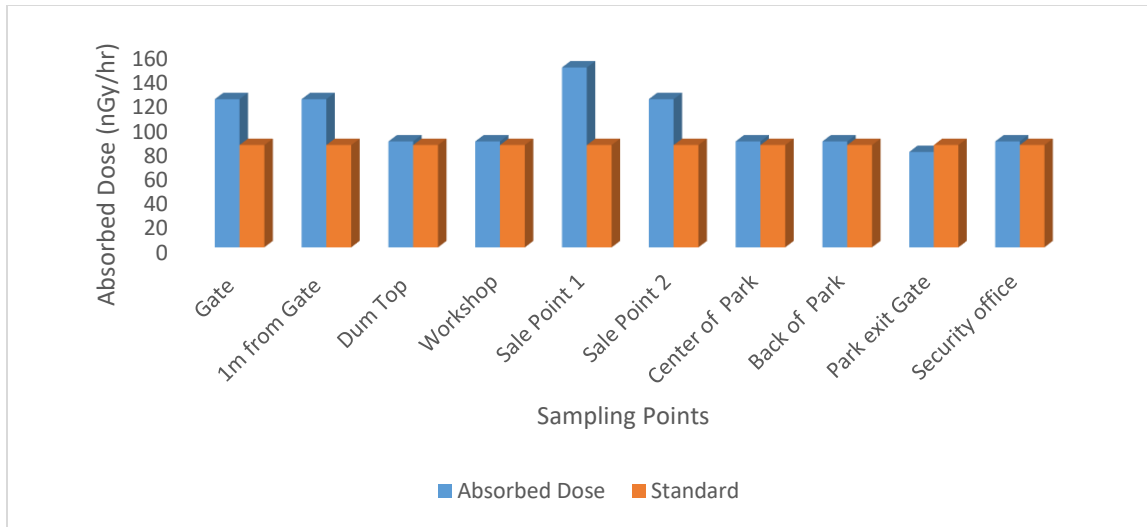


Fig.6: Comparison of Absorbed Dose of Nokia House Mechanic Dumpsite with standard

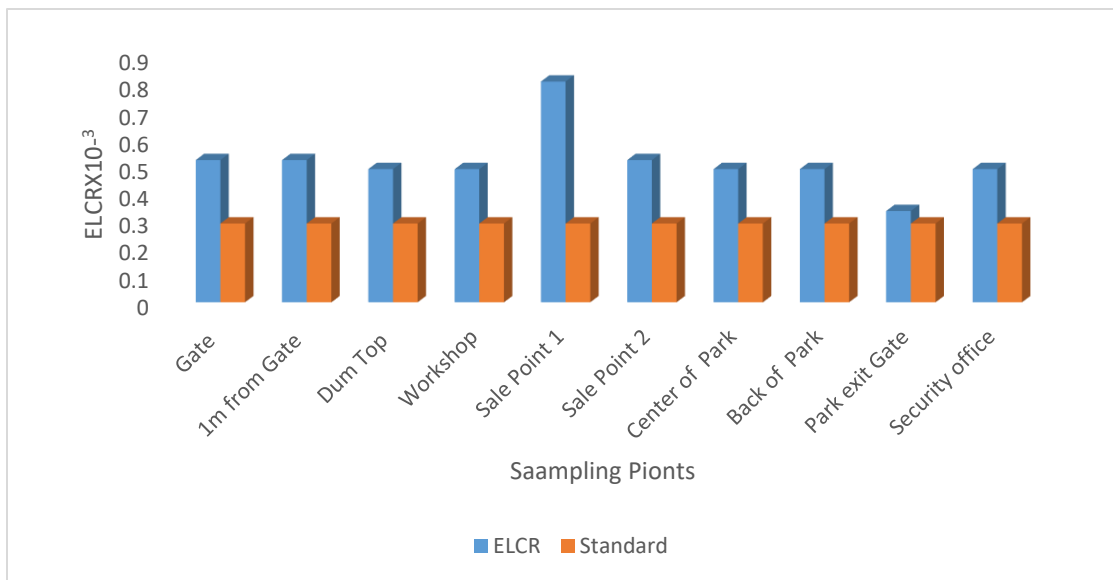


Fig.7: Comparison of ELCR of Nokia House Mechanic Dumpsite with standard

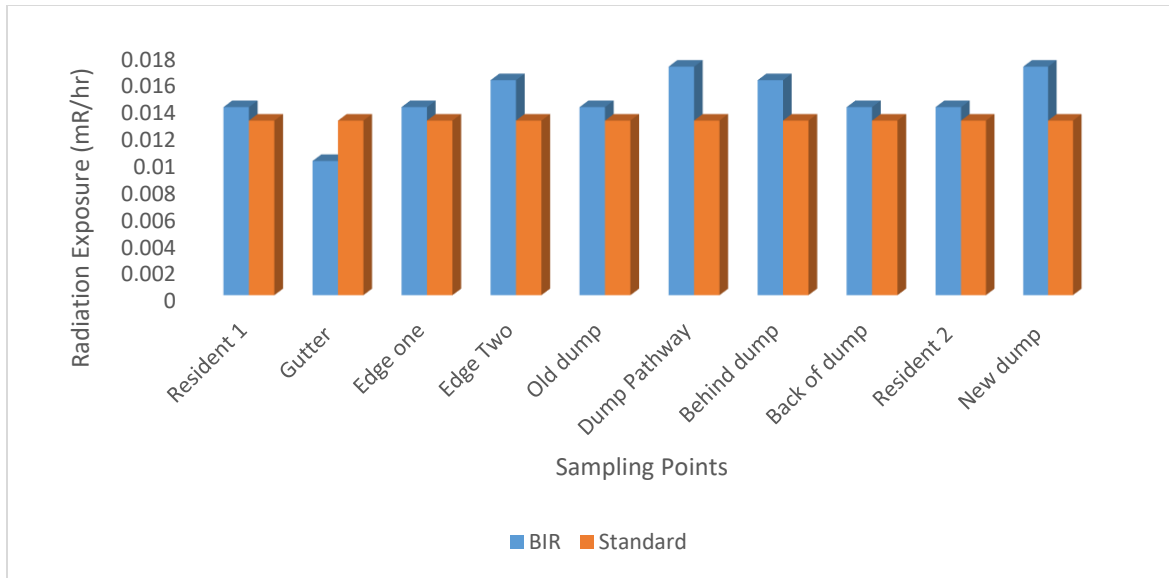


Fig.8: Comparison of BIR of Alaba Dumpsite with standard

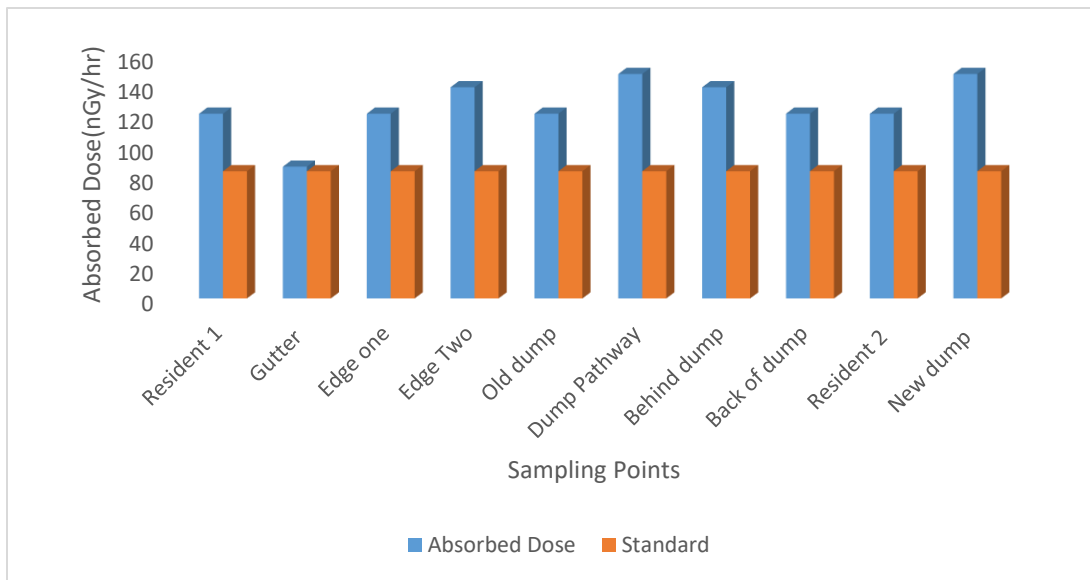


Fig.9: Comparison of Absorbed Dose of Alaba Dumpsite with standard

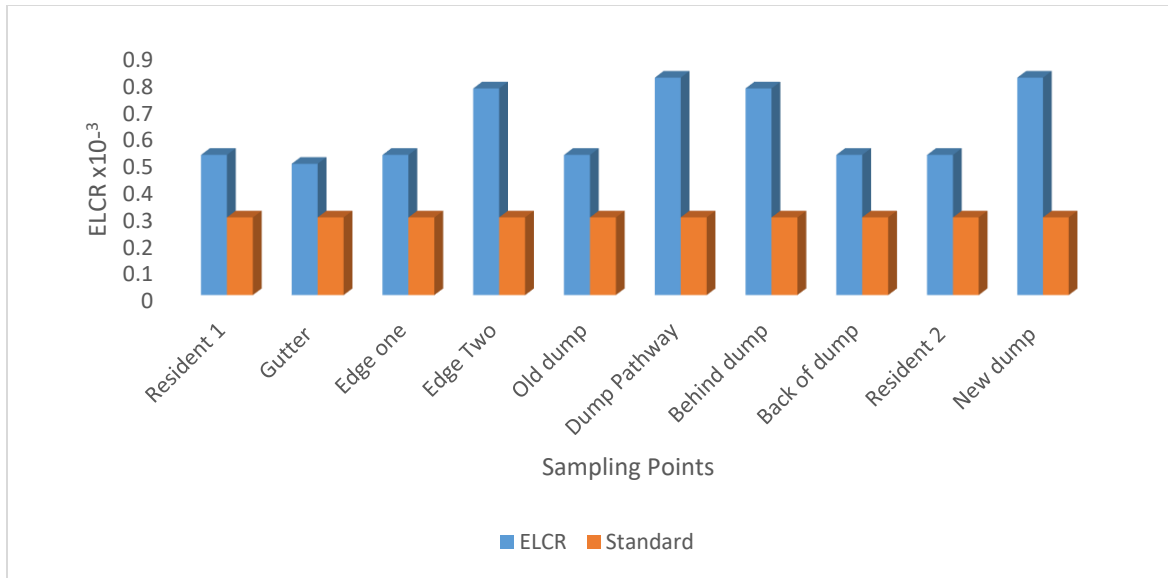


Fig.10: Comparison of ELCR of Alaba Dumpsite with standard

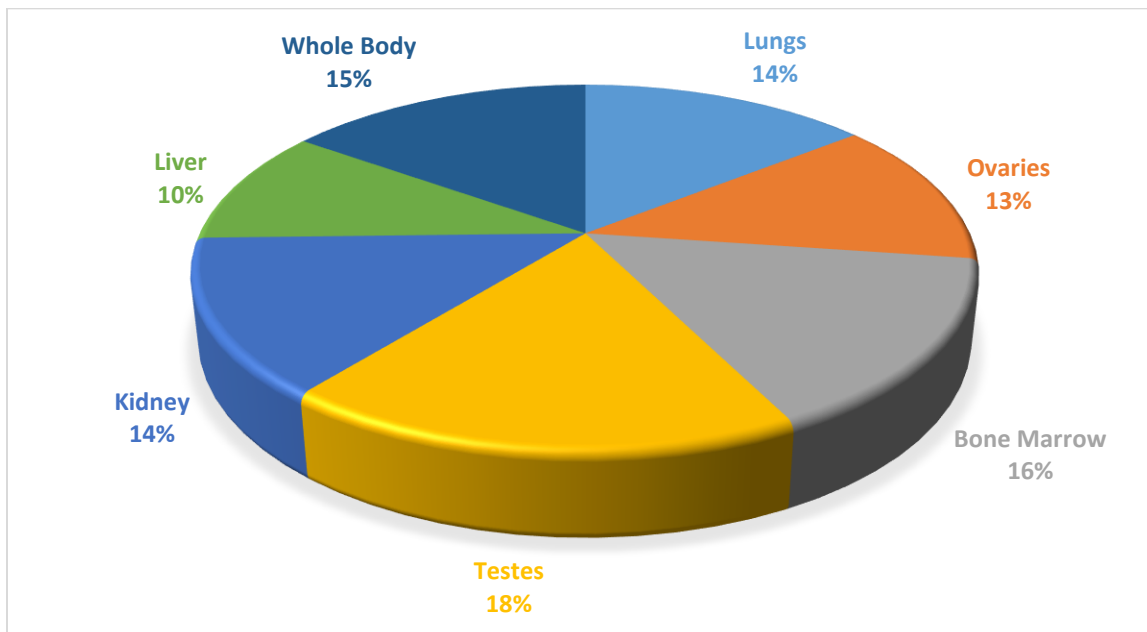


Fig.11: Percentage of Radiation to different Body Organ Dumpsite

Discussion

The results of the background ionizing radiation (BIR) of the selected dumpsites varies from 0.010 mR/h to 0.020mR/h, 0.009mR/h to 0.017mR/h and 0.010 mR/h to 0.017 mR/h with mean value of 0.015 mR/h, 0.012 mR/h and 0.015 mR/h for Nokia House Dumpsite, Nokia Mechanic Dumpsite and Alaba dumpsite respectively. The obtained mean value of Nokia Mechanic Dumpsite was within the recommended safe limit of 0.013 mR/h as stipulated by UNSCEAR (2008). While Nokia House Dumpsite and Alaba dumpsite was greater than the value reported by Agbalagba *et al.*, (2017). Though some of the sampling points within the selected Dumpsites were

higher than the recommended safe limits and these high value might be due to the chemical reaction between waste material dumped within the identified locations or due to the emission radionuclides from the disposed medical waste, building material or other material which are capable of emitting radiation within the environment. The results of absorbed varies from 87 nGy/h to 174,78.3 to 147.9 nGy/h and 87.0 to 147.9 nGy/h with mean of 136.6 nGy/h, 102.7nGy/h and 1127nGy/h for the three selected dumpsites respectively. The obtained absorbed dose mean value is higher than the (ICRP 2007) recommended standard of 84.0 nGy/hr and within the reported of work of Nwii et al., 2025. The result of Annual Effective Dose equivalent (AEDE) are all within recommended safe limit and higher than the reported work of Benson *et al.* (2018), and lower than the reported value of Agbalagba *et al.*, (2017). The obtained results of the excess life cancer risk (ELCR) varies from 0.49×10^{-3} to 0.89×10^{-3} , 0.34 to 0.81×10^{-3} 0.49 to 0.81×10^{-3} with mean 0.67×10^{-3} , 0.52×10^{-3} and 0.63×10^{-3} . the obtained mean value of the excess life cancer risk from the selected dumpsites all exceeded the recommended standard value as stipulated by UNSCEAR (2000) and within the reported value of Nwii et al. 2025. The variation in the ELCR within the study area might be due to the alteration in the radionuclide concentration through the consistence disposal of medical waste and related waste which altered the concentration of natural and artificial radiation within the study area. The result of radiation exposure dose to different body organs show that, testes and bone marrow received higher radiation while Liver received the least, and this may be due to the radiosensitive of these organs, and over exposure may lead to high risk of genetic effect and hematological disorder.

Conclusion

The *in-situ* measurement of the Dumpsite background ionizing radiation within the study has been area carried out. The result obtained for the Dumpsite within the selected Dumpsites are higher than the recommended tolerable limits except Nokia mechanic Dumpsite which is within tolerable value of 0.013 mR/h. Though some of the selected sampling points were higher than the stipulated standard value. This variation in the radiation level within the Dumpsites might be due to the alteration in the activity concentration of radionuclides emitting gamma rays within the study area or to the consistent disposal of medical waste and other related waste within the dumpsites. The mean value of the absorbed dose and the ELCR of the selected Dumpsites are higher than the recommended safe limit of 0.29×10^{-3} . This high value shows that the dumpsites are contaminated due to the presence of radionuclides emitting gamma rays within the immediate environment; however, the contamination does not constitute any immediate radiological effects on the residents within the study area, but there might be potential long-term effects in the near future, such as development of cancer, due to the high accumulated doses.

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