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ESTIMATION OF RADIATION EXPOSURE RATE AND EVALUATION OF LIFETIME CANCER RISK IN TWO WASTE DUMPSITES IN YENEGOA METROPOLIS IN BAYELSA STATE, NIGERIA.

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ABSTRACT

The study of background ionizing radiation exposure close rate and calculated radiological indices in selected waste site in Yenogoa metropolis, Bayelsa State has been carried out using Radalert 100X^{TM}, nuclear Radiation monitor. The two selected sites were partitioned into ten (10) locations respectively. Obtained results showed that at the integrated waste dump (IWD) site, locations IWD7 and IWD8 had the same highest values. Exposure dose rate (ER) 0.030mR/h (1.596msv/h) Absorbed dose rate (ADR) 261.00 nGy/h (0.21msv/h) Annual effective dose equivalent (AEDE), 0.370mSvy^{-1} and excess life cancer rate (ELCR) of 1.120x10^{-3} determined Do (mSvly) for lungs and taste were 0.41mSvy^{-1} and 0.053mSvy^{-1}respectively. At the characterized metal waste (CMW) site, CMW4 location point had the highest value of ER 0.04mR/h, (2.128mSv/h), ADR 348nGy/h (0.348mSv/h), AEDE 0.427mSvy^{-1} and ELCR 1.500X 10^{-3}, DO (mSvy^{-1}) for Lung and testes were 0.055mSvy^{-1}and 0.070mSvy^{-1} respectively. The results were discussed and compared with those reported in similar studies and internationally recommended values. The calculated mean obtained for the parameters in both sites were above world average values (WAV) of ER 0.013mR/h(0.692mSv/h), ADR 59.00nGy/h(0.059mSv/h), AEDE 0.070mSly and ELCR 0.290X10^{-3} according to UNSCEAR.

KEYWORDS: **Radiation Exposure, lifetime Cancer risk, waste dump**

INTRODUCTION

The practice of waste generation and disposal in Yenagoa metropolis is devoid of any form of management, so instead of landfill what exists is dumpsite. In dumpsite, waste of all kind and class are lumped integratedly making it a hazardous site, the engaged practice pose environmental and public health nuisance in the given ecosystem. One of its hazards is the issue of radiation emanating from some components in the waste since the waste has domestic, commercial and industrial characteristics. Those who transfer the waste into an open truck from the point of initial dumping to the site of final dumping are not usually protected with personal protective equipment (PPE), so also are the site scavengers that are involved in economic activities at the dumpsite.

Radiation refers to the transmission of energy (as waves or particles) in a medium. It could be electromagnetic radiation (visible light, x-rays) particle radiation (, , neutron) or acoustic radiation (sound, ultrasound) IAEA. A major effect of radiation when it is ionizable is the health implication inform of cancer. It is in appreciation of this effect that international organizations such as, international commission on radiological protection (ICRP), International Atomic Energy Agency (IAEA) and United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) have worked extensively in area of principles and protection of radiation against cancer, to prevent its effects of genetic mutation and subsequent fatal cell death. UNSCEAR caption her report "Effects of radiation sources and effects of Ironizing Radiation in her 2000 report to United Nations General Assembly. ICRP in its publication 60 report, 103 of 2007 presented her contribution as "General recommendation of radiation protection" and IAEA submitted" safety standards; for protecting people and the environment, radiation protection and safety of radiation sources published in General Safety requirements part 3 No. GSR part 3 2014, in consideration of non-compliance by Governments and operators and the large level in short falls, researchers have been up and doing in carrying out studies in furtherance to radiation and environmental protection. Kerinya et al (2020) assessed radiation exposure level from some scrap metal dumpsites in Nassarawa State, Nigeria using interceptor spectroscopic personal radiation detector (SPRD), examining selected sixteen (16) dumpsites, the work showed that the ELCR in some locations exceeded 0.29 x 10^{-3}. The authors recommended that scavengers and workers at the scrap dumpsites should minimize the periods of their stay at the sites. This means that reducing the time of exposure can reduce the dose.

Seo et al (2010) used an integrated approach to risk-based post closure safety to evaluate complex radiation exposure situations in radioactive waste disposal. The paper's approach deals with important exposure scenarios from a view point of receptor to estimate the resulting risk. Finally, Linsley (1989) worked on protection of natural ecosystem; impact of radiation from waste disposal practices. In line with the works presented, this current study estimates the radiation exposure rate and evaluates the lifetime cancer risk in selected waste dumpsites in Yenagoa metropolis in Bayelsa State Nigeria.

MATERIALS AND METHODS

This study was carried out in Yenagoa in Bayelsa State, Nigeria at two dumpsites located at 4°59ⁱ30.012ⁱⁱN, 6°19ⁱ43.821ⁱⁱE and 459 ⁱ30.0ⁱⁱN, 6°19 ⁱ458ⁱⁱE respectively. A scrap metal dumpsite and an integrated waste dumpsite. A radiation exposure rate in mR/h was monitored using Radalert 100 x™, a nuclear radiation monitor. The two sites were divided into Ten (10) locations each, the locations were uniformly chosen to cover the area under study. At each measurement point, the monitoring device was positioned at 1m above the ground level with the Alpha window of the monitor facing the point or area under study, enabling the area to maintain its original environmental quality. Three measurements of exposure rate in mR/h were taken at each point within interval of three (3) minutes and the values averaged to a single value as average exposure rate. The results were tabulated and radiological indices determined using established conversion factors and formulas. Finally, results were compared with those reported in other studies and discussed.

RESULTS

Table 1: Showing measured BIR exposure rate and associated radiological indices located at 4°59ⁱ30.012ⁱⁱN, 6°19ⁱ43821ⁱⁱE the location of characterized metal waste (CMW) dump.

Location Code	Exposure Rate (mR/h)	Absorbed dose rate (nGy/h)	AEDE (mSv/y)	ELCR x 10^{-3}	Do ($mSvy^{-1}$) Lung	Do ($mSvy^{-1}$) Testes
CMW_1	0.020 0.00	174.00	0.213	0.746	0.027	0.035
CMW_2	0.020 0.00	174.00	0.213	0.746	0.027	0.035
CMW_3	0.030 0.00	261.00	0.320	1.120	0.041	0.053
CMW_4	0.040 0.02	348.00	0.427	1.500	0.055	0.070
CMW_5	0.038 0.00	330.60	0.405	1.420	0.052	0.066
CMW_6	0.026 0.04	226.20	0.277	0.970	0.036	0.045
CMW_7	0.015 0.01	130.50	0.160	0.560	0.021	0.026
CMW_8	0.010 0.00	87.00	0.107	0.375	0.014	0.018
CMW_9	0.020 0.00	174.00	0.213	0.746	0.027	0.035
CMW_{10}	0.030± 0.00	261.00	0.320	1.120	0.041	0.053
MEAN SEM	0.02 0.01	216.63 79.97	0.27 0.1	0.93 0.34	0.03 0.01	0.04 0.02

Table II: showing measured BIR exposure rate and associated radiological indices located at 459ⁱ30.0ⁱⁱN, 619ⁱ458ⁱⁱE the location IWD.
Where IWD = Integrated waste dump.

Location Code	Exposure Rate (mR/h)	Absorbed Dose rate (nGy/h)	AEDE (mSv/y)	ELCR x 10^{-3}	Do ($mSvy^{-1}$) Lung	Do ($mSvy^{-1}$) Testes
IWD_2	0.020 0.00	174.00	0.213	0.746	0.027	0.035
IWD_2	0.010 0.00	87.00	0.107	0.375	0.014	0.018
IWD_3	0.014 0.02	121.00	0.149	0.522	0.019	0.024
IWD_4	0.020 0.00	174.00	0.213	0.746	0.027	0.035
IWD_5	0.020 0.00	174.00	0.213	0.746	0.027	0.035
IWD_6	0.020 0.00	174.00	0.213	0.746	0.027	0.035
IWD_7	0.030 0.01	261.00	0.320	1.120	0.041	0.053
IWD_8	0.030 0.00	261.00	0.320	1.120	0.041	0.053
IWD_9	0.011 0.02	95.70	0.117	0.410	0.015	0.019
IWD_{10}	0.020 0.00	174.00	0.213	0.746	0.027	0.035
MEAN SEM	0.020± 0.01	168.65 54.44	0.210 0.07	0.730 0.24	0.030 0.01	0.03 0.01

Table 3- showing world average value and mean values for ER, ADR, AEDE, ELCR, DO

LOCATION CODE	MEAN EXPOSURE RATE (mR/h)	MEAN ABSORBED DOSE RATE (nGy/h)	MEAN AEDE (mSv/Y)	Mean Elcrx10^{-3}	Mean Do (Msvy^{-1}) For Lungs	Mean Do (mSv/Y) For Testes
IWD	0.020±0.01	168.65±54.44	0.210±0.1	0.730±0.24	0.030±0.01	0.030±0.01
CMW	0.020±0.01	216.63±79.97	0.270±0.1	0.930±0.34	0.030±0.01	0.040±0.02
WorldAverage Value WAV	0.013	59.000	0.070	0.290		

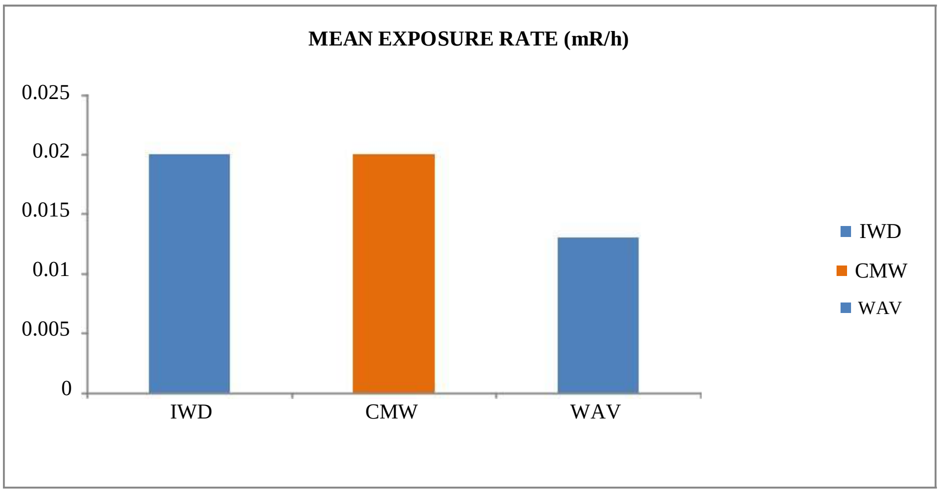

Figure 1: Mean Exposure Rate (mR/h)

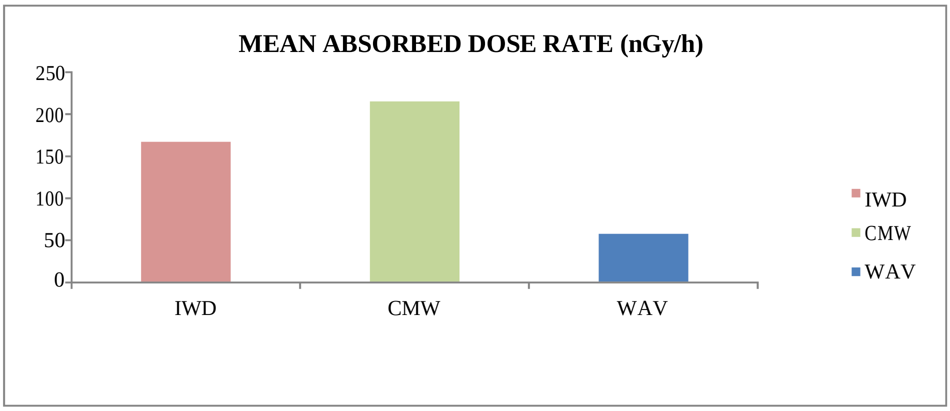

Figure 2: Mean Absorbed Dose Rate (nGy/h)

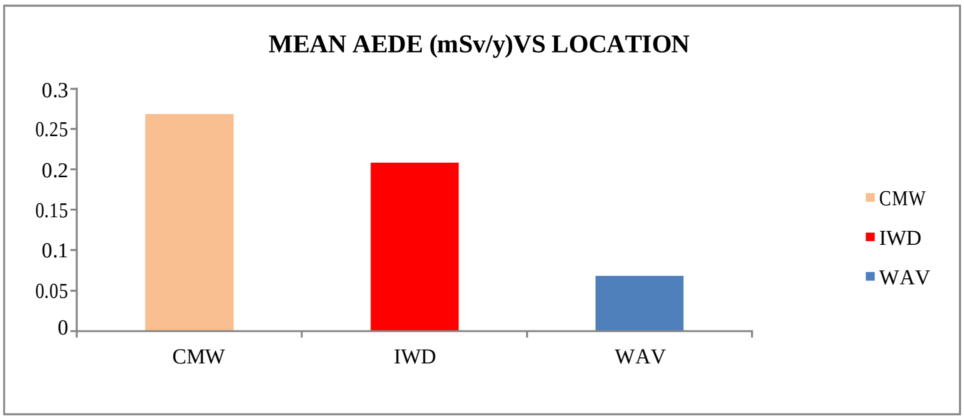

Figure 3: Mean Aede (mSv/y) vs Location

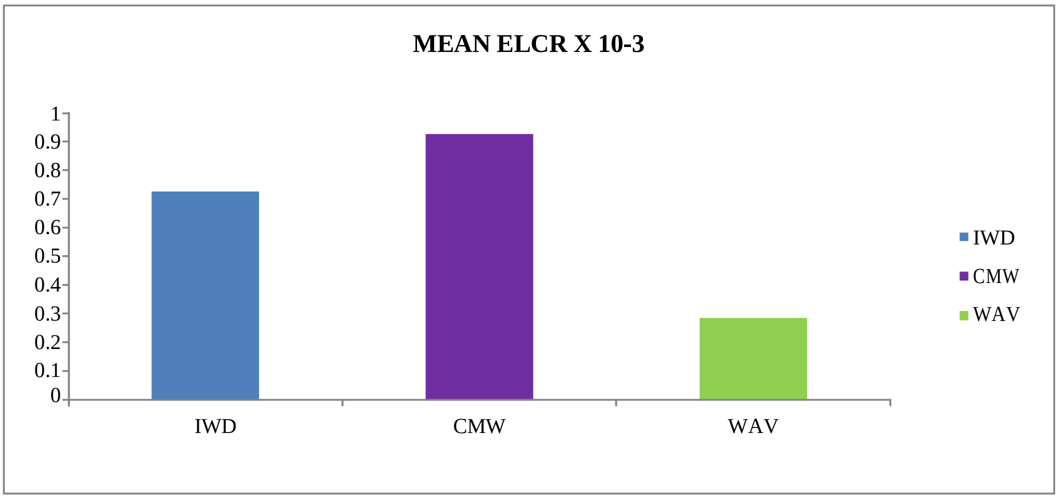

Figure 4: Mean ELCR X 10^{-3}

DISCUSSION

Principles of protection and safety including protection from harmful effects of ionizing radiation are abridged in words as; justification, optimization and dose limit. The research which the results are hereby presented was carried out in response to them. The results of the findings of this research presented in tables 1,2 and 3 and figures 1,2,3 and 4 shows that at integrated waste dumpsite (IWD) locations 7 and 8, the exposure rates (ER) were 0.03 mR/h (1.596 mSv/h) respectively. The IWD locations 7 and 8 had same values of absorbed dose rate (ADR) of 261nGy/h (0.261 Sv/h) each, Annual effective Dose Equivalent (AEDE) of 0.320 mSv/y and Excess lifetime cancer risk (ELCR) of 1.120 x 10^{-3}. At the dumpsite tagged characterized metal waste (CMW), Location 4 code named CMW4, Exposure rate (ER) was 0.04 mR/h (2.128mSvy-1), ADR was 348nGy/h, (0.348 Sv/h), estimated AEDE was 0.427mSvy^{-1} and ELCR of 1.500x 10^{-3}. These established figures are higher than those reported by Kerinya et al (2020) where highest AEDE was 0.2167 mSvyr^{-1}, ELCR of 0.7585 x 10^{-3} and mean ADR of 0.18 mSv/h (0.00018 mSv/h) reported by Akpan et al (2018) while this study reported mean ADR(s) of 168.65 nGy/h (0.16865 mSv/h) and 216.63 nGy/h (0.21663 mSv/h) respectively. The values are also higher than world average value (WAV) of 0.013 mR/h (0.692 mSv/y) for ER, 59 nGy/h (0.059 Sv/h) for ADR, AEDE value Of 0.70mSy^{-1} and ELCR of 0.290x10^{-3} against reported IWD of 0.730x10^{-3} and CMW, 0.930x10 $^{-3}$. However, the AEDE values were lower than the ICRP recommended figure of 1 mSv/y. It is necessary to ensure that no practice like waste management or its “dumping” is undertaken unless it is justified by which protection and safety are optimized, leading to compliance with relevant rules, so as to ensure that the emanating radiation emission is kept as-low-as-reasonably-achievable, the ALARA Principle. The results on organ impact shows that the testes were most impacted on, such that the male scavenger and worker must be put on focus.

CONCLUSION:

The study involving evaluation of lifetime cancer risk in two waste dumpsites in Yenagoa has been untaken. The results showed evaluated mean of excess lifetime cancer risk of 0.930x10^{-3} and 0.730x10 $^{-3}$ for characterized mental waste (CMW) and integrated waste dumpsite (IWD) respective which are all greater than the world average value (WAV) of 0.29x10^{-3}. Given this development the work is recommending that: time of exposure should be reduced, which is expected to directly reduce radiation dose. The distance between the source of the radiation (the waste point) and the workers or scavengers resting place should be increased. This is expected to reduce exposure by the square of the distance. Shielding should be put in place in any form. Irrespective of the poor practice of waste management, the use of proper personal protective equipment (PPE) must be made compulsory and good personal hygiene emphasized by the state Government and operators. Finally, Government and operators, through her ministry of Environment must interface with experts for regular training of operators and field workers.

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