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EVALUATION OF BACKGROUND IONIZING RADIATION LEVELS IN HEALTH CARE WASTE IN SELECTED HEALTH CARE DUMPSITES IN AKWA IBOM STATE, NIGERIA

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ABSTRACT
This paper reports on the evaluation of background Ionization radiation level in some selected health care dumpsites in Akwa Ibom State, Nigeria. Background ionization radiation measurements were carried out in ten dumpsites in three hospitals. An *in- situ* measurement was done using a well factory calibrated radiation meter the (Radex) and a geographical positioning system. Readings were taken in ten different locations within each of the dumpsites. The mean background Ionization radiation values in the ten dumpsites ranges from 0.089±0.005 µSv/hr to 0.109 ± 0.003 µSv/h. All the background ionization radiation levels obtained values exceeded the normal world average BIR level of 0.013 µSv/h. The mean effective dose values range from 0.109 mSv/y to 0.134 mSv/y showing that all the dumpsites yearly effective dose were below the 1.0mSv/y maximum permissible limit recommended for the public and non-nuclear industrial environment by International Council on Radiological Protection. This research work indicated that the dumpsites environment may have contributed to an elevated radiation level which will pose some long-term health side effects on the workers and residents. Consequently regulatory actions are recommended.

Keywords: Radioactivity, health care waste, Background Radiation, Dumpsites.

1. INTRODUCTION
Health care institutions generate enormous waste due to their activities and the generated health care waste (HCW) can cause serious health risk to the personnel, managers and public who are responsible for the day to day running of the hospitals if not properly managed. The HCWs are categorized into two broad groups ; the health care general waste which are non hazardous and health care risk waste which are hazardous [1].The hazardous waste include medical waste composing of infectious waste, anatomic waste, sharps, pharmaceutical and radioactive waste [2] while infectious waste include contaminated blood from patients collected in or other containers. Sharp wastes are made up of needles, broken glass wares, ampoules, scalpels blades. The general wastes are not radioactive but similar to the municipal waste (MSW). It is reported that 80 % of HCW are general wastes while 20 % are hazardous materials which include radioactive waste [3]. Investigation shows that health care institutions (HCI) generate enormous HCW which varies in composition and quantity from institution to institution [4, 5]. Improper disposal of these waste poses a serious potential health hazards to the environment besides enhancing the radiation level of the environment [6,7,1]. Various studies show that the naturally occurring radionuclides materials (NORMS), which include, nuclides of uranium, radium, potassium and their progenies are also present in some municipal wastes [8], building materials such as, stones, sand, gravel, cement, concrete, brick, tiles, gypsum, granites etc [9, 10], soils, vegetables, fruits, vegetation , quarry materials and books [11, 12, 13, 14]. These NORM are also found in stable food stuffs [12] , timbers [15] and some metals like gold, silver, carbon steel, stainless steel, aluminum, nickel, copper products and their scrapes can contain sources of ionizing radiation with the associated emission causing environmental and health risks [14, 15. 16, 17]. Wastes from electronic devices (e-Wastes) are also known to produce ionizing radiations which find their way into the HCW dumpsites [18]. The elevated radiation level in the health care facilities could also come from other sources such as the exposure from X - ray unit without adequate shielding and quality control measures [19]. However, in this study, contribution to the background radiation at the waste dumpsite from X-ray exposures was not expected because the waste dumpsites were far away from the x-ray departments in hospitals. In addition, the X-ray facilities were properly shielded and no radiation leakage to the environment was expected. The gamma rays are known to be highly penetrating and the produced radon gas when inhaled or

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ingested attaches to the lung and poses a serious risk [20 , 21]. In view of the deleterious effect of the interaction of gamma rays with biological systems, it is pertinent to monitor the level of ionizing radiation in an environment at a given time in order to assess early the possibility of occupational radiological risk and the risk to the public within that environment [22]. The aim of this study is to assess the contribution of the HCW to the background ionizing radiation in health care environments.

Location of Dumpsites

Ten dumpsites in three hospitals were selected for this study. The hospitals were selected because they have a large number of patients daily as some are referral centers while one is a training institution. Dumpsites 1, 2 and 3are located in an eye specialist hospital which lies between latitude 4^0 28 and $4^0$53N and longitude 7^0 50 and 7^0 55E, dumpsites 4, 5 and 6 are located in a general hospital which lies between latitude 5^0 10 and 5^0 30 N and longitude 7^0 30 and 7^0 45 E and other dumpsites are located in a tertiary hospital lying between latitude 5^0 27 and 5^0 30 N and longitude 7^0 55 and 7^0 91E. The tertiary hospital does not undertake diagnostic or therapeutic care using radioisotopes hence such radioisotopes waste were not expected in their dumpsites.

2. MATERIALS AND METHOD

An *insitu* approach of measurement was employed according to [24] to measure the background ionizing radiation (BIR) level at the different dumpsites. This method was considered to enable the samples maintain their original environmental properties. The measurements were taken between 1000 hrs to 1700 hrs since the exposure meter is known to response maximally to radiation within these hours [15]

Measurement of background ionizing radiation (BIR) level was carried out using RADEX model (RD 1212 manufactured by Quart-Rad Inc, United States of America) radiation survey meter which is factory calibrated to measure radiation absorbed dose rate in micro Seviert per hour (µSv/h). The meter is a hand held digital radiation detector which detects gamma, beta and alpha radiations with a dose power range of 0.05 to 999 µSv/h and a linear response between 0.1 to 1.25 MeV.

The meter was switched on and allowed to absorb radiation for a few seconds and the meter read at the highest stable point. For effective monitoring, the radiation meter was placed at gonad level above the ground with the window of the meter directed towards the different directions within the measured environment and 10 readings taken in different directions and the mean recorded according to Essien et al [19]. Measurements were taken at points outside the hospital premises away from any building and recorded as controls. This was to enable us observed points of elevated radiation levels.

The measured effective dose σ (µSv/h) was converted to annual effective dose E (mSv/yr) using equation 1 [19]

$$E(mSv/yr) = \sigma(\mu Sv/h) \times \mu \times 24 \times 365 \times 0.7 \times 10^{-3} \qquad 1$$

Where µ is the outdoor occupancy of value 0.2, which implies that, the personnel staying around the waste dumpsites spend 20% of their time outdoors. The 0.7 is the conversion factor from absorbed dose in air to effective dose. Effective dose is a measure of the radiological effect of the radiation when the whole body is being irradiated.

3. RESULTS AND DISCUSSION

Table 1: The composition of the dumpsites

Dumpsite number	Composition of the dumpsite
1	Grasses, away from any building, not close to main road
2	Drug bottles, cotton wools, syringes, needles, bandages, plasters, polythene bags etc
3	Drug bottles, cotton wools, syringes, needles, contaminated gloves bandages, plasters etc
4	Drug bottles, cotton wools, syringes, needles, and contaminated gloves, bandages, plasters etc
5	Drug bottles, cotton wools, syringes, needles, pieces of paper, used drip bags, broken woods, wasted food, plastic containers, pieces of metals
6	Drug bottles, cotton wools, burnt syringes, needles, used drip bags, bandages, plasters etc

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7	Drug bottles, cotton wools, syringes, needles, wasted food, used drip bags, bandages, plasters etc
8	Drug bottles, cotton wools, burnt syringes, needles, pieces of papers, used drip bags, wasted foods, plastic containers, broken woods and blood bags
9	Drug bottles, cotton wools, syringes, needles, grasses, unused tiles, used drip bags, bandages, plasters etc
10	Drug bottles, cotton wools, syringes, needles, concrete blocks, blood bags, drip bags, pieces of paper, pieces of wood, wasted food, plastic containers, computer parts, contaminated gloves, water sachets, bandages, plasters etc

The composition of the dumpsites considered for this work were assessed and reported in Table 1. It was observed that their composition varies from dumpsites to dumpsites but all had similar hospital wastes while some of the dumpsites also contain municipal wastes.

The mean BIR at each dumpsite and the calculated effective doses are recorded in Table. The control measurements were taken at 6 meter away from each of the hospital premises [24] and the value varies between 0.068 ± 0.004 to 0.078 ± 0.002 µSv/h. Measurements at the dumpsites also show variations from hospital to hospital ranging from 0.089 ± 0.005µSv/h at dumpsite 4 to 0. 109 ± 0.003 µSv/h at dumpsite 10 located in a tertiary institution.

Table 2: Measured mean absorbed dose and mean calculated effective dose

Dumpsite no.	Mean absorbed dose (µSv/h)			E(mSv/yr)
	Control	At dumpsites	Difference (%)	
1	0.078 ± 0.002	0.090 ± 0.004	13	0.110
2	0.070 ± 0.002	0.094 ± 0.004	26	0.115
3	0.068 ± 0.004	0.095 ± 0.003	30	0.117
4	0.070 ± 0.002	0.089 ± 0.005	21	0.109
5	0.070 ± 0.002	0.098 ± 0.004	29	0.120
6	0.070 ± 0.004	0.095 ± 0.003	26	0.117
7	0.068 ± 0.004	0.094 ± 0.004	28	0.115
8	0.075 ± 0.002	0.098 ± 0.003	23	0.120
9	0.070 ± 0.002	0.094 ± 0.004	25	0.115
10	0.070 ± 0.004	0.109 ± 0.003	36	0.134

Comparing the exposures at the controls with the exposures at the dumpsites, the percentage differences ranged from 13 - 36 % from dumpsite to dumpsite. The corresponding annual effective dose ranging from 0.109 - 0.134 mSv/yr were also obtained from the different dumpsites. From the percentage differences between BIR measured at the control site and at the dumpsites as recorded in Table 2 it could be observed that there is an enhanced level of ionizing radiation due to the presence of the health care dumpsites in the hospitals. In addition, this observation shows that there is a high probability of increased radiation level at a long term period if proper waste management arrangement is not put in place. Figure 1 shows the variation in the annual effective dose from dumpsites to dumpsites and the control. Dumpsite 1 has the least percentage effective dose of 2 % while dumpsite 10 has the highest annual effective dose. This is because of the type of waste materials dumped into the dumpsites. Dumpsite 10 contains both municipal and medical wastes as seen in Table 1. The E-waste contained in dumpsite 10, metal and the broken timbers could emit additional radiation to the medical waste. The value of the annual effective dose (E) obtained for dumpsite 10 (University of Uyo teaching hospital) is comparable to that obtained by [1] from a similar environment.

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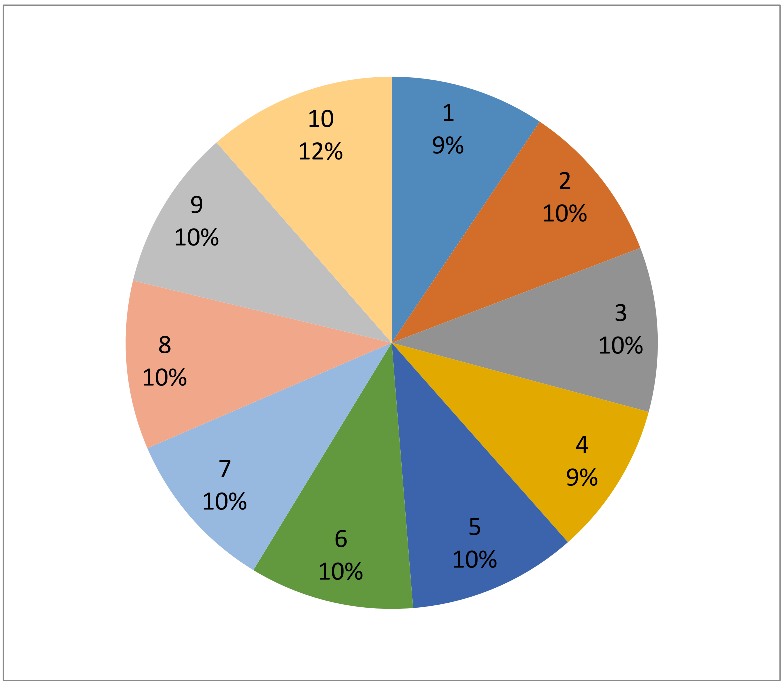

Fig.1. Percentage difference in annual effective dose per dumpsite

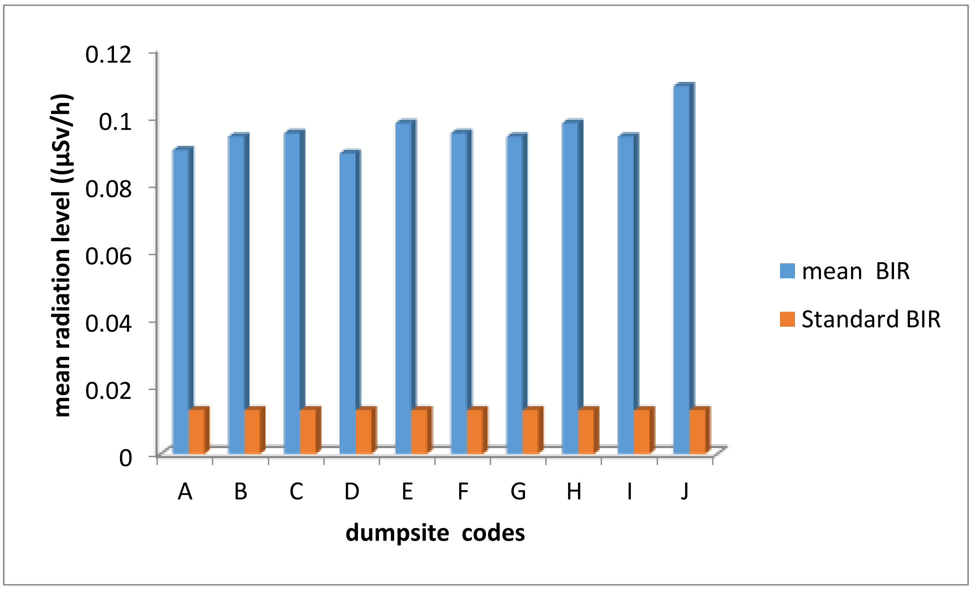

Fig. 2: Comparison of Mean BIR Levels with the Standard BIR Level

Figure 2 shows the comparison between the measured BIR at the dumpsites with the standard BIR level. it is observed that the BIR at all the dumpsites are higher than the global standard BIR confirming an elevated radiation level consequent upon the presence of the medical waste dumped in the dumpsites. Effective dose is the measures of the effect of the amount of energy (radionuclides) deposited by ionization radiation in the human body for a given period. Therefore for radiological safety ICRP, 1999 recommended and consequently set the maximum permissible limit for non–radionuclide industrial worker and the public as 1.0 mSvy^{-1} which is the maximum permissible limit for radiological safety. In this study the comparison of the mean annual effective dose from all the dumpsites and ICRP, 1999 maximum permissible limit is reported in fig. 3. The result shows that the mean annual effective dose obtained from all the dumpsites are far below the MPD showing no

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radiological concern on the safety of the hospital workers. However since there is no low dose of radiation at which there is no radiological safety concern [24] it is pertinent that some regulatory action be taken to avoid any somatic, epidemiological and radiological health side effect.

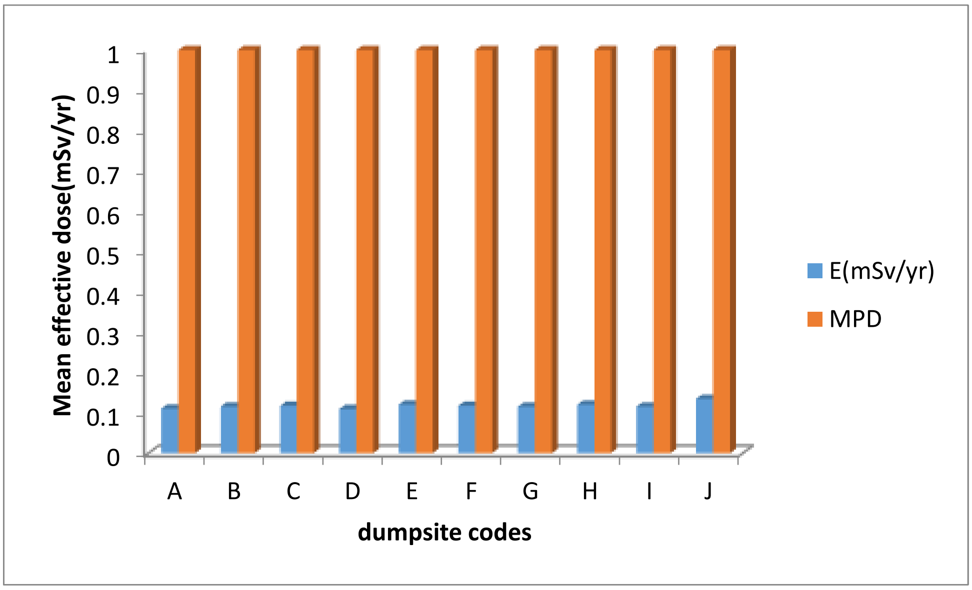

Fig. 3 Comparison of Mean effective dose Levels with the maximum permissible dose Level

4. CONCLUSION AND RECOMMENDATIONS

The evaluation of background ionization radiation level in ten dumpsites located in three health care facilities in Akwa Ibom State, Nigeria has been carried out. The results of statistical analysis showed that there is significant difference between the obtained and the control results and their standards. The mean background ionizing radiation values in the ten dumpsites ranges from 0.089±0.005µSv/hr to 0.109±0.003µSv/h. All the background ionization radiation level obtained values exceeded the normal world average BIR level of 0.013µSv/h. The mean annual effective dose values range from 0.109 mSv/y to 0.134 mSv/y were also obtained The results showed that all the dumpsites annual effective dose were below the 1.0 mSv/y maximum permissible limit recommended for the public and non-nuclear industrial environment by International Council on Radiological Protection.

These reported values may indicate no immediate health hazards, but may cause long-term health hazard to the hospital workers, visitors and residents of the host communities due to increase in wastes with longer period of operation. Consequently the following regulatory actions are recommended.

Hospitals dumpsites should be located far away from the medical, administrative and residential buildings. This complies with radiation protection principle of radiation dose obeying inverse square rule of physics, which implies that the farer the source of radiation from the target the lesser the radiological effect on the target. Secondly waste material must be adequately sorted out before disposing into the dumpsites.

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