# Assessment of radiation dose on occupational health workers of some selected hospitals in Jigawa state, Nigeria

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**Abstract**

Medical Occupational Health workers under Radiology and Dental departments are generally exposed to chronic low dose and long-term doses of ionizing radiations in their bodies. The research was carried out to evaluate the harmful effects of ionizing radiation on the occupational health workers for some selected hospitals in Dutse Emirate of Jigawa State, Nigeria. The trends and distribution of dose from occupational radiation exposure to radiation health workers from five selected hospitals in Jigawa State were assessed and evaluated using renowned techniques. The collected data to monitor and compute the total doses by workers was from a period of eight months (from January 2023 to August 2023). Total of 79 medical occupational health workers were monitored from two different departments (Radiology and Dental Department) comprising 60% in radiology department and 40% from Dental Department. The results Show that the average estimated dose for all departments ranged from 0.39 to 3.92 mSv. The study revealed that workers in radiology department had the highest dose compared to personnel in Dental Department. Moreover, there are no such risks of radiation dose to occupational health workers, patients and people visiting the two departments. Based on this research, all departments working with ionizing radiation are within the International Standard of 20mSv as stated by ICRP, UNCEAR and they should ensure a strict obedience to such radiation safety practices to protect the occupational health workers, while people living in a vicinity and patients have to be enlightened about harmful effects of radiation to the humankind.

***Keywords*:** Radiation Dose, Occupational Health workers, Exposure, Medical Imaging, TLD

## Introduction

X-rays are commonly used today mostly in medical imaging, be it a single image or diagnostic examination such as image of X-ray to a skull, shoulders, legs and lungs, a tooth at the dentist, or CT scanning (Joseph, 2020) (AWOSAN1, 2016). But the three dimensional imaging with X-rays are made in a CT (or CAT) scanner, like 160 slides reconstructing a volume by Computed Tomography or X-rays are used in many applications other than clinical (Chinangwa1, 2017) such as scientific applications, security reader in the airports, and some industries (Nadia, 2017), and dose measurements radiology workers are superficially exposed from unsealed radiation sources/radiopharmaceuticals when managing them in the homework and administration phase of the RD procedure (Al-Masker, 2021). As such internal irradiation is likely due to gulp of air or intake of radionuclide or their penetration through skin and wound (Nayereh khalil, 2022). Similarly, dose estimations for medical radiation workers are essential factors to assess the radiation risks so that they can set up protective procedures (Oglat, 2019). Occupational health exposure is a result of radiation exposure at working area whereby health workers can be affected to such radiations while managing radioactive substance or dealing with ionizing radiation (Naema, 2021). Majority of people leaving in Jigawa including the elites have a little experience pertaining the harmful effect of ionizing radiation, this has contributed immensely in making the lives of people in Jigawa and Nigerian unsecured (Adliene, 2020). Therefore, People dealing with X-ray radiation and those living in vicinity need to be reminded and enlightened on the effects of ionizing radiation to their lives, and how good they should handle the situation (Kinsara, 2017). In this present situation people live in a world of radiation, in recent years' people have educated to panic the effects of radiations. People don't like to stay close to nuclear reaction (Nabil, 2005). They are scared by report of any links between surplus exposed by skin cancer and sunlight in which afraid of the leakage from the radiation produced by their telephone sets or microwave ovens (Alnahhal1, 2017). Many factors governed to heighten the public anxiety about both the short-range and long-range effect of radiation (KENDALL, 2006). fear in this regard is a radiation that can be detected by the average person (Owusu, 2018). Furthermore, the effect of exposure of radiation might not appear for month or year decades to understand the difference between ionizing and non-ionizing radiation (karan, 2011). The primary focus of this research is to assess the effect of radiation hazard in medical imaging to workers and relate the result to international accepted level 20mSv (Quico, 2011). While the target of International Commission on Radiological Protection (ICRP) is to initiate a systematic outcome to overcome the calamity, as such, meaningful standard solution for radiation protection that involve medical, environmental, occupational, and exposures controls against radiological misfortunes without excessively limiting the valuable Practices giving rise to radiation exposure (Ashiru Garba Abdullahi, 2018). In this regard “occupational exposures” implies the exposure to the workers in the working environment and the exposure controls beside radiological accidents without greatly limiting practices produces to the radiation exposure (ICRP, 2010). It can be the exposure to people at working nearest area to ionizing radiation from human made and natural sources, as a result of using some equipment dealing with radiation in a working place (Harrison, 2007). Some factors such as general health, sex, age, inherited traits, as well as exposure to other cancers causing agents such as cigarette smoke can possibly affect vulnerability to the cancer which can cause the effect of radiation (Dalianis, 2015). A lot of diseases are caused by the interaction of some factors, and these interactions appeared to increase the vulnerability to cancer (Erkan, 2019).

## MATERIALS AND METHOD

The research has used the quantitative method in collecting data from X-ray and Dental departments in five different health facilities in Dutse Emirate of Jigawa State. The data were collectively analyzed using graphs and charts to find out the absorb dose from each of the above departments which deal with radiation. The doses were from occupational health radiation exposure among radiation health workers in the five selected hospitals from Dutse emirate in Jigawa state Nigeria. Three-month measurements of dose were used for a period of eight months from (January to August 2023), using a transportable environment radiation monitor (TLD) to work out the total radiation in places of work in the two departments. A total of 79 medical occupational health workers were monitored, consisting of 53 personnel from department of Radiology, 26 personnel in Dental Department as shown in table 1.

### Study Area

The study area is Jigawa State, which is one of the 36 State in Nigeria. The State is located in north western part of the country. It comprised of five Emirates namely Dutse, Hadejia, Ringim, Gumel and Kazaure with twenty-seven local Government Councils and the land area of 22,410, square kilometers; the State is bordered on the west by Kano state, on the east by Bauchi and Yobe, on the north by Katsina, Yobe and Republic of Niger. And it’s a topography state which contains some mountains that can absorb Radiation. Area of the study covers occupational health workers in five selected hospitals at Dutse Emirate of the state, and the locations were strategically selected in the study to measure the radiation levels on occupational health workers working in such health facility (James, 2014).

***Table 1:*** *Number of Radiation health Workers Monitored for both the occupations*

| ***workers in the Departments*** | ***absorb radiation by workers*** | ***Staffs monitored*** | ***Total*** |
|---|---|---|---|
| | *Visiting consultant* | *4* | |
| | *Radiologist* | *7* | |
| ***Radiology Dept*** | *Chief Technician* | *1* | |
| | *X-ray Technician* | *12* | *52* |
| | *X-ray Assistance* | *9* | |
| | *Cleaners* | *4* | |
| | *Radiographers* | *10* | |
| | *Radiology Nurse* | *5* | |
| | *Dental Doctors* | *5* | |
| ***Dental Dept*** | *Dental technician* | *13* | *26* |
| | *Dental Assistance* | *5* | |
| | *Cleaners* | *3* | |
| ***TOTAL*** | | | *79* |

**Sample Analysis**

The total annual dose was calculated using the relation,

$$A = \frac{365 \text{ days x total dose}}{\text{Total days}}$$

Thus, A, the estimated dose exposed to the personnel per annum is equal to total days in the year multiplied by total dose received in TLD and divided by the total days taken for the dose.

**RESULT AND DISCUSSION**

The dose distributions of radiation health workers are used to determine the minimum level of radiation exposure in the medical health field (yousif, 2011)(Ahmadl, 2019). In these four health facilities in Dutse Emirate in Jigawa state, approximately 79 occupational health radiation workers were monitored, the percentage distribution is as follows: Visiting Consultant (5%), Radiologist (8%), Chief Technician (1%), X-ray Technician (15%), X-ray assistant (11%) Cleaners (5%) Radiographers (12%), Radiology Nurse (6%), Dental Doctors (6%), Dental Technician (16%), Dental Assistant (6%), Cleaners (3%). To the best of the researchers' knowledge, this study is the first to explore the awareness level of radiation risks among occupational health working in the aforementioned health facilities in dutse emirate of jigawa state. This implies that nearly all of the radiology workers did not attend any radiation protection courses (alYamad, 2022). This explains why nearly all of the Dental department workers were not familiar with the ALARA principle (Alashban, 2019).It can be assumed that the information provided to these radiology and dental departments about the effects of radiation and the protective measures were needed (AHMAD, 2020), meanwhile doses to radiology technologists and radiology assistants were established to be highest over the years. Though their annual effective doses which have never exceeded actual dose limit of 20 mSv and were followed the same declining tendency as the doses of other workers (Nassef, 2017). There was no augment of doses to radiology department staff observed after installation of two new PET/CT 160 slides machines in one of the health facility at Rashid Shekoni hospital, representing the increased radiation protection culture and application of applicable technical and protective measures by the health workers (Andreana, 2012). Hence, this could form the basis of future records on the hurtful effects of the radiation feature of health workers in the medical field, because the ionizing radiation has hazardous health effects upon human exposure. The dose spreading of radiation health workers is used to fine the minimum level of exposure in the medical field given by ALARA (Kazerooni, 2009) principles. Table 1 explained the total number of radiation health workers monitored for all the occupational health workers in medical departments as well as their place during 2021 exercise. Also, Fig. 1 gives the percentage input yields for each type of medical radiation worker to the total monitored worker. The value of doses for this research is a sign of the improve practice of radiation protection as compared to some countries in previous years. This development was due to many factors, such as: using high efficiency dental radiography machines, and raising and keeping the dental clinics up to date with new radiation protection policies (Al ashban, 2021).

Table 2 represents the period of dose record with TLD as shown below. TABLE 3 describes the dose and the estimated dose per annum by radiology department worker. Chart 1 is the overall level of the exposed dose rate by two departments which vary by the use of series. Table 4 gives total estimated dose in mSv from the departments and doses calculated. Figures 1,2 and 3 show the data in graphical forms.

**TABLE 2** The period of data collected from the hospitals with TLD

| | | **Period 1 (in days)** | | **Period 2 (in days)** | | **Period 3 (in days)** | |
|---|---|---|---|---|---|---|---|
| Staff | TLD code | Issued | Returned | Issued | Returned | Issued | Returned |
| code | | 1/1/23 | 20/3/23 | 22/3/23 | 11/5/23 | 12/5/14 | 31/8/21 |
| 001 | 83004721 | 80 | | 80 | | 80 | |
| 002 | 83004722 | 80 | | 80 | | 80 | |
| 003 | 83004723 | 80 | | 80 | | 80 | |
| 004 | 83004724 | 80 | | 80 | | 80 | |

| | | | | |
|---|---|---|---|---|
| 005 | 83004725 | 80 | 80 | 80 |
| 006 | 83004726 | 80 | 80 | 80 |
| 007 | 83004727 | 80 | 80 | 80 |
| 008 | 83004728 | 80 | 80 | 80 |
| 009 | 83004729 | 80 | 80 | 80 |
| 010 | 83004730 | 80 | 80 | 80 |
| 011 | 83004731 | 80 | 80 | 80 |
| 012 | 83004732 | 80 | 80 | 80 |
| 013 | 83004733 | 80 | 80 | 80 |
| 014 | 83004734 | 80 | 80 | 80 |
| 015 | 83004735 | 80 | 80 | 80 |
| 016 | 83004736 | 80 | 80 | 80 |
| 017 | 83004737 | 80 | 80 | 80 |
| 018 | 83004738 | 80 | 80 | 80 |

**TABLE 3.** Description of the dose and the estimated dose per annum by radiology department worker

| | **D1** | **D2** | **D3** | | |
|---|---|---|---|---|---|
| Total days | Dose mSV | Dose mSV | Dose Msv | Total dose mSV | Annual Estimated dose mSV |
| 240 | 0.23 | 0.28 | 0.42 | 0.93 | 1.41 |
| 240 | 0.19 | 0.26 | 0.28 | 0.73 | 1.11 |
| 240 | 0.23 | 0.44 | 0.40 | 1.07 | 1.62 |
| 240 | 0.20 | 0.33 | 0.32 | 0.85 | 1.29 |
| 240 | 0.15 | 0.39 | 0.49 | 1.03 | 1.56 |
| 240 | 0.21 | 0.32 | 0.38 | 0.84 | 1.27 |
| 240 | 0.20 | 0.34 | 0.43 | 0.91 | 1.33 |
| 240 | 0.35 | 0.54 | 0.56 | 1.45 | 2.20 |
| 240 | 0.13 | 0.19 | 0.46 | 0.78 | 1.18 |
| 240 | 0.11 | 0.19 | 0.31 | 0.64 | 0.91 |
| 240 | 0.18 | 0.22 | 0.42 | 0.82 | 1.24 |
| 240 | 0.24 | 0.39 | 0.62 | 1.25 | 1.90 |

| | | | | | |
|---|---|---|---|---|---|
| 240 | 0.79 | 0.32 | 0.23 | 1.34 | 2.03 |
| 240 | 0.24 | 0.21 | 0.43 | 0.89 | 1.35 |
| 240 | 0.32 | 0.48 | 0.36 | 1.16 | 1.76 |
| 240 | 0.19 | 0.28 | 0.37 | 0.84 | 2.79 |
| 240 | 0.69 | 0.61 | 1.28 | 2.58 | 3.92 |
| 240 | 0.38 | 0.23 | 0.74 | 1.35 | 2.05 |
| 240 | 0.28 | 0.27 | 0.63 | 1.18 | 1.79 |

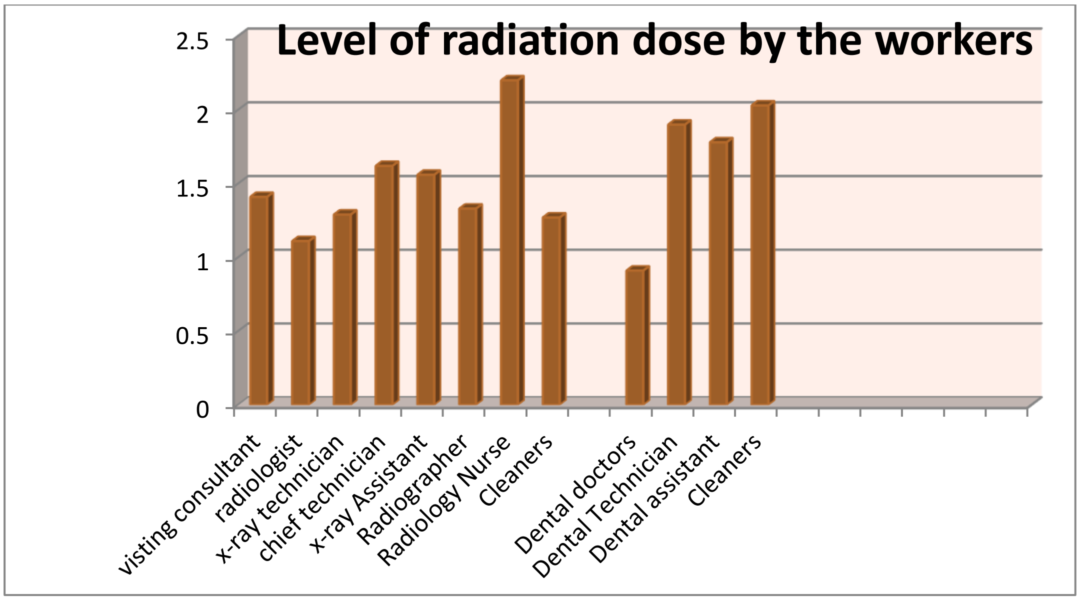


**Chart 1.** Overall level of the exposed dose rate by two departments which vary by the use of series

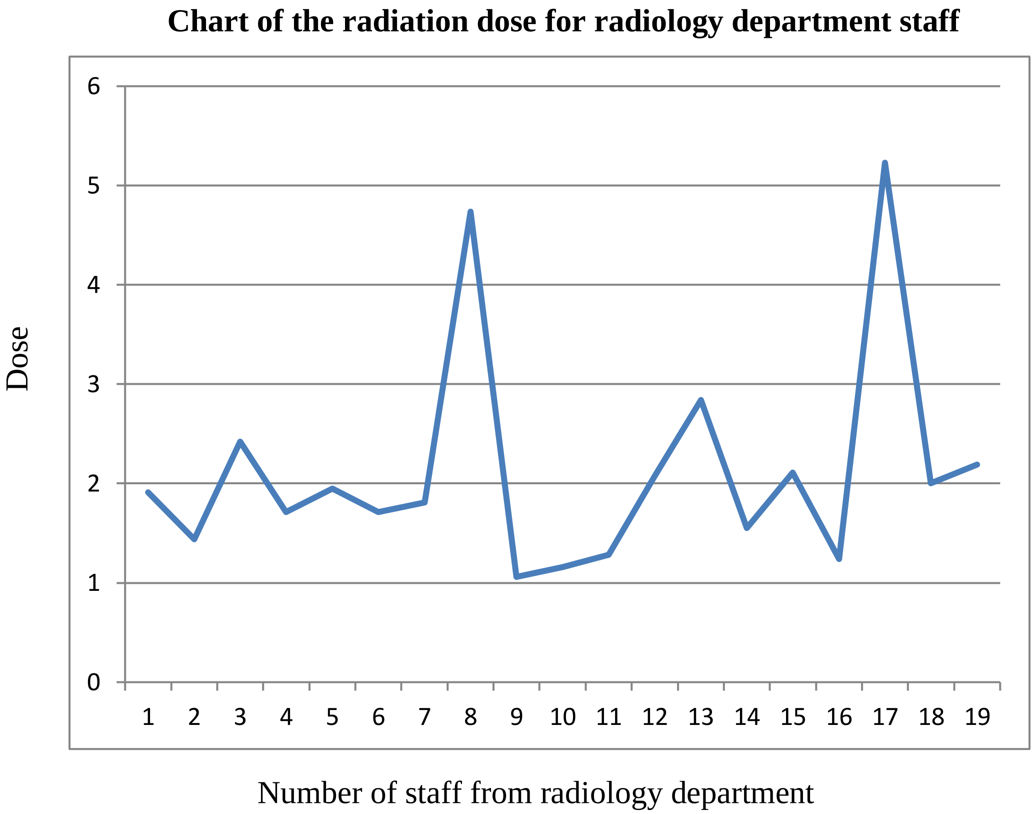


**Fig 1 Data of the exposed dose from Radiology Department**

**Table 4** Total estimated dose in mSv from the above departments and doses calculated

| **Total days** | **Dose in mSV** | **Dose in mSV** | **Dose in mSV** | **Total dose in mSV** | **Estimate dose/ yr** |
|---|---|---|---|---|---|
| 240 | 0.08 | 0.06 | 0.07 | 0.21 | 0.40 |
| 240 | 0.12 | 0.22 | 0.24 | 0.58 | 0.94 |
| 240 | 0.13 | 0.27 | 0.21 | 0.61 | 0.94 |
| 240 | 0.15 | 0.14 | 0.15 | 0.43 | 0.72 |
| 240 | 0.22 | 0.30 | 0.35 | 0.87 | 1.23 |
| 240 | 0.49 | 0.56 | 0.67 | 1.72 | 1.68 |
| 240 | 1.01 | 1.03 | 0.82 | 2.86 | 4.35 |
| 240 | 0.69 | 0.45 | 0.63 | 1.77 | 2.13 |
| 240 | 0.73 | 1.20 | 1.12 | 3.05 | 2.03 |
| 240 | 0.24 | 0.60 | 0.50 | 1.34 | 1.82 |

| | | | | | |
|---|---|---|---|---|---|
| 240 | 0.12 | 0.32 | 0.24 | 0.68 | 1.25 |
| 240 | 0.22 | 0.25 | 0.25 | 0.72 | 0.85 |
| 240 | 0.08 | 0.06 | 0.13 | 0.27 | 2.19 |
| 240 | 0.41 | 0.27 | 0.63 | 1.31 | 1.62 |
| 240 | 0.09 | 0.08 | 0.17 | 0.34 | 0.39 |
| 240 | 0.13 | 0.35 | 0.26 | 0.74 | 0.74 |
| 240 | 0.29 | 0.54 | 0.48 | 1.31 | 1.51 |

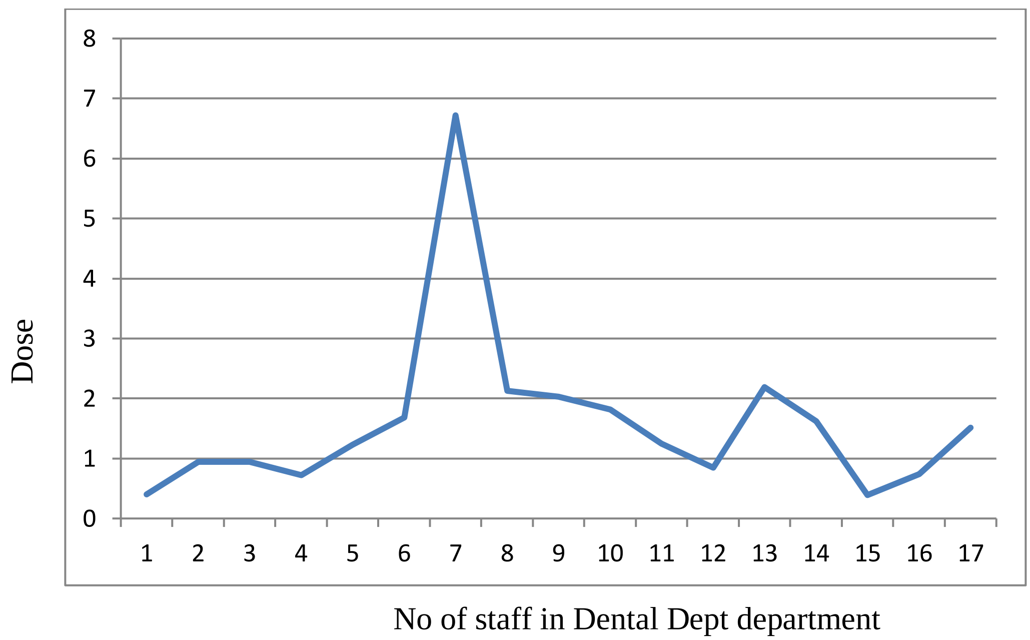


**Fig 2 Dental Department exposed dose for staff**

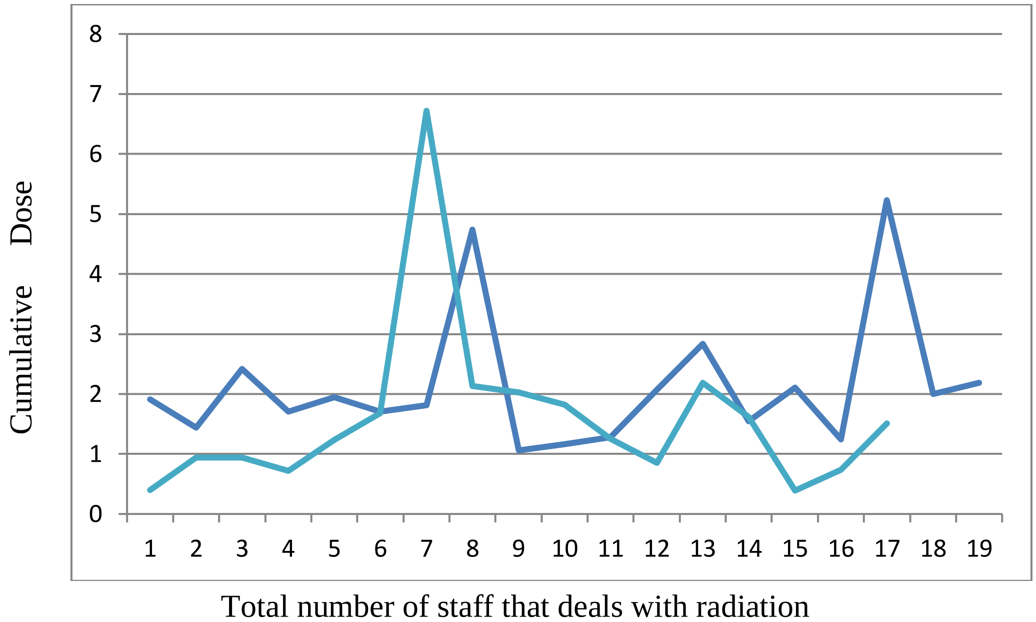


**Fig 3. The data above shows the cumulative exposed dose for Staffs**

## PERCENTAGE

The maximum permissible exposure limit for an occupational health worker allowed by the international commission for radiological protection (ICRP) is 20mSv. For the workers in the radiation environment from the estimated dose of exposure per annum indicated in the tables above, the maximum estimated exposure dose per annum among all the health workers in the departments is 4.35mSv, which means the maximum percentage is given as;

$$\text{Max} = \frac{4.35 \text{ mSv}}{20\text{mSv}} \times 100\% = 21.75\%$$

while annual minimum estimated dose exposure is 0.39mSv. So, minimum percentage is given as;

$$\text{Min} = \frac{0.39 \text{ mSv}}{20\text{mVs}} \times 100\% = 1.95\%$$

The annual estimated average dose exposure is:

$$\text{Ave} = \frac{(4.35 + 0.39) \text{ mSv}}{2} = 2.74\text{mSv}$$

The percentage average is given as;

$$\text{Ave} = \frac{2.74 \text{ mSv}}{20\text{mSv}} \times 100\% = 11.85\%$$

## CONCLUSSION

Based on the fact the research has not been conducted before in jigawa state, meanwhile this is the exact percentage of the occupational health workers working with radiation in some selected hospitals. From this analysis, the occupational health staffs in the hospitals within dutse emirate in Jigawa state have not yet exceeded the estimated dose level approved by international commission on radiological protection (ICRP) to the occupational health workers. Because for the staff monitored, the exposure have not exceeded the dose rate of 20mSV, the staffs under those departments based on the above result will continue to maintain safety measures regularly for living in radiation area. This study has revealed that the Radiation Dose received by x-ray technicians and their Assistants in hospitals surveyed in Nigeria are a bit high in comparison to other workers dealing with radiation. Based on this, the awareness and the precautionary motives will be maintained. Moreover, according to this research, there were no radiation dose risks to patients, staff and people visiting the x-ray departments. The result points out that within the radiology department of the hospital, all the selected locations were safe to patients, workers and the general public which could be recognized to adequate shielding in the health facility. The implication of that is that most of radiology department workers are exposed to some health risks which are not sufficiently supposed by the health authorities.

## RECOMMENDATIONS

1. The departments working with ionizing radiation should ensure maintaining all the safety measures related to radiation safety practices that protect their staff such as X-ray technicians and patients from effects of ionizing radiation.
2. Quality assurance tests should be done necessarily in all departments dealing with radiation.
3. Radiographers should make concerted efforts to follow existing radiation protection protocols in their daily work routine and they should always update their knowledge especially the current trends in radiation protection.

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