

**KNOWLEDGE OF RADIATION SAFETY PROTOCOL AMONG
RADIOGRAPHY STUDENTS OF UNIVERSITY OF BENIN**

BY

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CERTIFICATION

This is to certify that this research project by **OKORO ESTHER OGECHI** with a Matriculation Number of BMS2001304 has been examined and approved for the award of Bachelors of Radiography in the department of Radiography; School of Basic Medical Science, University of Benin, Benin City.

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EXTERNAL EXAMINER.

Sign and date

DEDICATION

I dedicate this work to God Almighty, the giver of knowledge and for His grace and love upon me.

ACKNOWLEDGEMENT

My sincere appreciation goes to God, the giver of knowledge for His love upon my life. My profound appreciation and gratitude also goes to my supervisor **Dr. Kemisola Olasuyi** for her patience, concern, supportive and constructive idea which aided this project work. Special appreciation goes and to the Head of Department, Radiography, **Mrs Igbinedion F.O** and the entire Staff of the department for the support and the various part they played in my academic development.

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ABSTRACT

The radiography students in Benin and elsewhere must have the full knowledge and prerequisites to follow the best practices and reduce the risk of radiology. According to various researches in Nigeria, the area of protection practices has been identified to be lacking in the radiography field, which implies that the area required targeting in awareness and training. This was a descriptive cross-sectional study, which sought to determine the radiation safety awareness, knowledge and practices among radiography students in the University of Benin (UNIBEN). One Hundred and fifty-two [152] radiography students were recruited based on stratified random sampling technique that was used to ensure proportional representation of students. The stratification will be initially done into groups 300lv, 400lv and 500lv. Simple random sampling was used to select participants in each stratum and minimize the selection bias. The structured questionnaire and data collected will be the main tool of data collection and the statistical package of social scientist (SPSS) version 26.0 was used to analyze the data collected. The radiography students were aged and were the participants of the study. Most of the students (79.0%) were aged between 20-24 years, with the rest aged between 25-29 years (14.5%) and those under 20 years (5.3%). The least percentage of students (1.3%) was between 30 years and above. The gender distribution of radiography student who participated in this study. The results indicate that there were more female caregivers (61.2%) than male students (38.8%). Concerning the level of study of respondents, the result illustrates the level of study of radiography students. 500lv constituted the highest portion of radiography student in this study (51.3%), followed by 300lv (28.9%) and 400lv (19.7%). Those that have attended lectures, seminars and training on radiation protection. The majority of them (91.4%) had attended while 8.6% hasn't. With regard to radiography students awareness of the principle of radiography safety and protocol. A majority of the radiographers appear to be aware of the principles and radiation safety procedure well with 59.7% strongly agreeing and 18.5% agreeing. With regards to the perception toward radiation protection and safety measures among radiography students. The majority of radiographers appear to be optimistic about radiations and safety measures. In the case of the test of Hypothesis, the p value was found to be <0.017 indicating that there is statistically significant difference in radiation safety awareness among the students who have undergone previous radiation safety training and those who have not. Thereby, the null hypothesis that shows no statistically significant difference of radiation safety awareness among students that have had earlier radiation safety training and those that have not is rejected. This is why when the alternate hypothesis is accepted and it states that there is a statistically significant difference in radiation safety awareness between students who have undergone previous radiation safety training and students who have not is because the study offers some key recommendations on the same in order to foster the radiation safety awareness among radiography students.

KEYWORD: Knowledge, Radiation, Safety, Protocol, Students.

CHAPTER ONE

1.1 BACKGROUND OF STUDY

The widespread and frequent administration of ionizing radiation in clinical diagnostics procedure require strict radiation safety measures to safeguard the stakeholders who are the patients and medical workers. Radiography students in Benin and beyond Benin, need to be fully knowledgeable and practice the best so that risks of radiations are kept to the barest minimum. Various researches conducted on radiography protection practices in Nigeria have indicated gaps in the overall practice of radiography protection, which has necessitated the need to target the creation of awareness and training programs. Since Wilhelm Conrad Roentgen discovered X-ray in 1895, it has played a significant part in the contemporary world of medicine (Lecture et al., 2022). It is very essential in various fields of dentistry because of the capacity of the ionizing radiation to pass through the soft tissue and reflect a picture that cannot be viewed on a sensor with the naked human eye. It is used in the diagnosis of the minor carious lesions, periapical lesions of both the odontogenic and non-odontogenic origin and in the evaluation of the cases to improve the planning of the treatments (Iannucci & Howerton, 2012). The effect of ionizing radiation on living cells may be side effects, which may directly damage the DNA, or indirectly by the development of free radicals. These active and volatile molecules are prone to stabilizing through rebinding and, therefore, lead to the creation of new toxic components such as hydrogen peroxide that may cause cellular changes.

1.2 STATEMENT OF THE PROBLEM

Ionizing radiations have become important in medical diagnosis in the modern world, but they are very dangerous to the health of both patients and health workers when safety measures are

not strictly adhered to. Radiography students who regularly work with broadcasting devices are especially disposed to it when they have poor knowledge and practice of radiation protection (Eze et al., 2023).

Evidence from Nigeria shows that radiation safety practices among radiography students remain suboptimal. Eze et al. (2023) reported poor adherence to personal dosimeter use and inconsistent shielding among students in Lagos. Similarly, Adam and Eze (2017) identified major gaps in safety awareness and compliance among radiology personnel in Benin City, largely due to inadequate practical training and weak enforcement of protocols. Although radiography students receive theoretical instruction, their limited hands-on experience and insufficient supervision further compromise safe practice.

Exposure to ionizing radiation can lead to deterministic effects—such as skin injury and thyroiditis—when thresholds are exceeded, and stochastic effects—such as cancer—which increase in probability with cumulative exposure (Hamada & Fujimichi, 2020; López & Martín, 2018; Rehani et al., 2018; ICRP, 2017). Current literature indicates that even low-dose medical exposure may contribute to long-term health risks (Matityahu et al., 2017). Therefore, inadequate radiation safety knowledge and practices among radiography students present a serious concern that warrants urgent investigation.

1.3 RESEARCH QUESTIONS

1. What is the level of knowledge about radiation safety principles and protocols among radiography students of UNIBEN.
2. What are the attitudes of radiography students towards radiation protection and safety practices?

- 2 What is the extent of compliance with standard radiation protection measures (e.g., use of lead aprons, personal dosimeters, shielding) in clinical practice among radiography students?

1.4 HYPOTHESES

Null Hypotheses

1. There is no statistically significant difference in radiation safety awareness between students who have received prior radiation safety training and those who have not.

Alternate Hypotheses

1. There is a statistically significant difference in radiation safety awareness between students who have received prior radiation safety training and those who have not.

1.5 AIM OF STUDY

The primary aim of this study is to assess the level of radiation safety awareness, knowledge, and practices among radiography students in the University of Benin (UNIBEN).

The specific objectives of the study are;

1. To assess the level of knowledge about radiation safety principles and protocols among radiography students of UNIBEN.
2. To evaluate the attitudes of radiography students towards radiation protection and safety practices.

3. To determine the extent of compliance with standard radiation protection measures (e.g., use of lead aprons, personal dosimeters, shielding) in clinical practice among radiography students.

1.7 SIGNIFICANCE OF STUDY

This research will assist in establishing the weaknesses in radiation safety measures among students. The results will also indicate the weaknesses and strengths of the present radiation safety training to radiology students in the University of Benin. It will also make sure that they are fully knowledgeable and adhering to the standards of radiation protection that is essential in reducing the risks of radiation on both the healthcare professionals and patients.

1.8 SCOPE OF STUDY

The study was conducted in the University of Benin, Benin City, which is a subset of the population to be used, and the other subset of the population will consist of radiography student in the University of Benin. It will be concerned with the familiarity or the exposure to the amount of knowledge regarding the radiation safety principles and protocols among the radiography students at UNIBEN.

1.9 OPERATIONAL DEFINITION OF TERMS

Radiation Safety: The term radiation safety is used to refer to the practices and principles that are directed at shielding persons or mitigating the adverse impacts of ionizing radiation through limiting exposures by employing such protective factors as shielding, distance, and time restrictions.

Radiation Safety Awareness: The degree of understanding, knowledge and awareness of people concerning radiation hazards, the principles of protection, and the typical safety standards of radiological practices.

Radiography Students: Students are undergraduate students in Radiography program in the University of Benin (UNIBEN), who are on the way of completing their training in medical imaging and radiation protection of the body.

Radiation Protection Practices: The actual implementation of radiation safety concepts and precautions including the use of lead aprons, thyroid shields, personal dosimeters, beam collimation and the observance of the ALARA (As Low As Reasonably Achievable) principles.

Benin City: The capital of the Edo State in south Nigeria and the geographical location of the research, where the University of Benin and some of the diagnostic radiology centers are found.

Knowledge: Here, it means the degree of factual and idea-based insights on radiation hazards and safety precautions as measured by use of structured questionnaires..

CHAPTER TWO

LITERATURE REVIEW

2.1 CONCEPTUAL REVIEW

2.1.1. Introduction

The issue of radiation safety is of utmost importance in the field of contemporary medical imaging because the application of the ionizing radiation system is associated with certain risks, which are to be addressed. The stakeholders in the safe and effective use of diagnostic imaging equipment include radiographers and radiography students. Their awareness, knowledge and compliance to radiation protection principles are critical in occupational safety and protection of the patient. This theoretical review examines the pillars of the understanding of radiation safety awareness by covering some major themes of radiation hazards, radiation safety awareness, and knowledge, safety practices in radiation, education and training, and the legal framework of radiation awareness. The conceptions are the basis of comprehending the challenges and possible solutions to the improvement of the radiation safety culture among radiography professionals and trainees.

2.1.2. Radiation Safety

Radiation safety is an issue of concern to patients, physicians, and employees in most departments such as radiology, interventional cardiology, surgery among others. The radiation released during the procedure of fluoroscopic treatment is the source of the highest radiation dose to the medical staff. Diagnostic imaging modalities, including computed tomography,

mammography, and nuclear imaging are also minor contributors to cumulative dose exposures of healthcare personnel. Nevertheless, it is possible to get any radiation, and all these are potentially harmful to patients as well as healthcare workers (Mitchell and Furey, 2018).

Radiation protection seeks to minimize the unwarranted exposure to radiation with an objective of minimizing the toxic impact of ionizing radiation (Tsapaki et al., 2018). Ionizing radiation has become an inevitable instrument in the medical profession where it is employed in the diagnosis and treatment of various medical conditions. With its application, there have been cumulative lifetime radiation doses that the patient and the medical provider are exposed to. In the medical environment, majority of radiation contact is associated with fluoroscopic images, which are taken using x-rays in order to draw dynamic and cinematic functional images. Official radiation protection training assists in minimizing exposure of radiations among medical personnel and patients (ICRP, 2017). Nevertheless, implementation of radiation safety measures may be a tedious task and much interventionalist are not formally trained in residency or fellowship on radiation dose reduction. Specifically, there is low compliance to radiation safety rules by clinicians or medical personnel who are involved in fluoroscopic imaging practice which is not within specialized radiology or interventional departments. Fluoroscopy is applied in most specialties, including orthopedics, urology, interventional radiology, interventional cardiology, vascular surgery, and gastroenterology. The detailed knowledge of the risks of radiation exposure and methods of dose reduction will gain the highest significance as the number of radiation exposures increases.

Radiation protection has three fundamental principles namely justification, optimization and dose limitation. Justification entails the consideration of appreciating the advantages and risk of radiation use in procedures and treatments. Physicians, surgeons, and radiologic personnel are all

important in terms of informing patients about the possible negative consequences of radiation exposure. The medical community should be familiar with the benefits of exposure and should accept them. Many times, the procedures that involve exposing relatively more radiation to patients such as interventional vascular procedures are medically necessary, therefore, the benefits outweigh the harms. The code of federal regulations defines As Low as Reasonably Achievable (ALARA) principle as the concept of ensuring that all the steps to prevent radiation exposure have been made with the consideration that radiation is part of diagnosing and treating patients. Even minimal exposure to radiation will cause the risk of stochastic effects, or, in other words, probability to develop malignancy after being subjected to radiation. It is believed that these effects are linear in nature where there is no particular threshold that can be used to determine the likelihood or otherwise of malignancy developing. Because of such reasons, the radiologic community educates protection practices in terms of the ALARA principle.

2.1.3. Awareness and Knowledge of Radiation Hazards

The two types of radiations, such as ionizing and nonionizing, are widely applied in the medical field today. It is relevant in diagnostic and treatment modes. Ionizing radiation is however dangerous to the anesthesia staff and interventionists exposed to radiation at their working place.

The number of researches has proven that after exposure to medical radiations, there is a high risk of bone marrow suppression, cataract, infertility, birth defects, and various types of cancer, in particular, thyroid carcinoma (Sont et al., 2021). The threshold dose differs based on the radiation-related illnesses. As an example, 100-200 mGy is linked to teratogenicity and cancer, and 500 mGy is linked to cataracts (Chodick et al., 2018). Hence, education and health

information on radiation risks and protective precautions is significant in minimizing the radiation effect on healthcare personnel.

One of the general principles of radiation protection that have been suggested by the International Commission on Radiological Protection (ICRP) is that radiation protection is founded on three principles, i.e., justification, optimization (as low as reasonably achievable (ALARA)) and dose limitation (Park et al., 2017). Radiation protection strategies are based on this. The awareness of medical staff on radiation risks and precautions has received considerable research and yet, there have been disparate findings across various medical subspecialties. It has been established that Nigerian radiologists, radiotherapists, and dentists exhibit a satisfactory knowledge level on the topic of radiation hazards and personal protective devices use (Awosan et al., 2018). This may be compared with the results of the other study that was being carried out on the pediatric residents and fellows in Italy. To be specific, only a quarter of the participants answered the questions that evaluated the knowledge in radiation protection (ALARA), correctly (Salerno et al., 2021). These opposing results can be explained by the fact that there can be differences in the two study samples. That is, the majority of the participants of the Nigerian study worked in a radiology department, but the Italian research was performed in the pediatric residents and fellows.

The research studies have also focused on radiation safety awareness in Asia-Pacific countries in terms of health care professionals. To illustrate, in a particular study, in-depth interviews were carried out on the medical and dental professionals in India, and they showed poor knowledge on the radiation risks (Sukumar et al., 2023). In another study that was carried out on general practitioners, internists, and radiologists in Hong Kong, it was established that the level of knowledge and awareness regarding radiation protection was low among nonradiologists.

Nevertheless, the general education of radiologists was of a significantly lower quality than it should have been.

Most of the previous researches have been carried out on dissimilar subspecialties and particularly radiology. Nevertheless, few studies have been carried out on anesthesia staff, surgical subspecialists despite the fact that they are regularly exposed to radiation. Thus, the main aim of the research process was to investigate the knowledge and awareness regarding radiation hazards and knowledge regarding radiation protection in anesthesia providers and surgical subspecialists.

2.1.4. Compliance with Radiation Protection Practices

Radiation protection refers to that collection of facilities that are involved in the protection of individuals who are subjected to ionizing radiations. It gives grounds to the safety of the population and the environment without unjustifiably restricting positive practices that imply radiation exposure (Collection of IRSN scientific books, 2017). All these ways enable to identify some significant risks in terms of which some action can be taken by limiting the doses.

Failure to adopt all the steps necessary in the application of a standard is the cause of poor compliance with standard radiation protection processes. Ionizing radiation is a kind of energy emitted by atoms and transmitted by the electromagnetic waves or particles. There are two sources of rays which are; Natural sources which include cosmic rays and Artificial sources which include X-rays. The more people use the ionizing radiation, the more health risks they run in case it is not utilized or kept safely (World Health Organization, 2019). The list of diseases that can be caused by x-ray misuse includes Leukemias, connective tissue sarcomas and thyroid cancers (Collection of IRSN Scientific Books, 2017; Claude, 2022). These effects are aggravated

with increase in dose and dose rate. Indicatively, an acute radiation syndrome takes a threshold dose of approximately 1000 mSv. Prenatal exposure of the fetus to ionizing radiation may also cause brain damage when an acute dose of over 100 mSv is received at the age of between 8 and 15 weeks of gestation (Collection of IRSN scientific books, 2017).

Globally, over 3.6 billion diagnostic radiology tests are done each year, 37 million nuclear medicine tests are done each year and 7.5 million radiotherapy is done each year (World Health Organization, 2019). According to the guidelines of the International Labor Office on radiation protection, good radiation protection practices are another critical factor in reducing the exposure of workers hence a significant move towards ensuring the best radiation protection practices (Shengli, 2017). A report by the United Nations Scientific Committee on the Effects of Atomic Radiation (2018) reveals that 23 million laborers across the globe are exposed to ionizing radiation, of which 75% are in the medical industry (World Health Organization, 2019). This is primarily because of normal use of equipment but such workers can also be overexposed during an accident. They can be guarded by means of tangible solutions, such as surveillance, protective gear, or caution such as shielding. The International Atomic Energy Agency additionally claims that training, exchange of information and continuous health surveillance are also factors that contribute to an efficient occupational radiation protection regime (International Atomic Energy Agency, 2024).

All these duties must be well delegated to the workers, contractors or employers, or installations operators. These recommendations are used by national organizations in formulating or adopting laws, decrees and ministerial orders to be implemented in the countries to apply the radiation protection standards. In Benin, Article 20 of the Radiation Protection Act provides that any license holder, who engages in an activity with a risk of exposure, must protect the workers

against work-related exposures and comply with all regulations pertaining to worker protection against exposure to ionizing radiation especially concerning the exposure measurement, health monitoring and training (Republic of Benin, 2018).

In other countries particularly in Nigeria, despite the fact that majority of radiologist technician are well informed on the radioprotection strategies, most of the operational X-ray units have poor occupation practices on radiation protection and monitoring. The cost of the implementation makes it poor in following the advice of the medical physicists (Qutbi et al., 2021; Eze et al., 2017). Also in Benin, the position of the enforcement of radiation protection measures in medical imaging (MI) units is little known and there are few reports of internal or external observation of the adherence to standard radiation protection processes. Also, the related research has limited attention on radiation protection activities in MI units, and therefore, the lack of data and knowledge creates a substantial gap in evidence that can aid in the decision-making process. The aims of the current research were to survey the state of radiation protection in Benin and to suggest the options that will enable to improve the health of the users of the medical imaging services and the population in general.

2.1.5. Role of Education and Training (Burge, 2021)

Education and training on radiation protection are critical in ensuring that medical practitioners are abreast with safe applications of the latest technologies, and that is one of the motivators of a recent IAEA meeting. The IAEA virtually organized the Technical Meeting on Developing Effective Methods for Radiation Protection Education and Training of Health Professionals to determine the requirements and approaches of improving the qualification and competencies of health professionals working with radiation. The meeting was meant to be a forum where

effective methods of education were to be shared, strengths, weaknesses and opportunities in the existing education and training systems were to be identified that address the needs of particular groups of health professionals, as Jenia Vassileva, IAEA Radiation Protection Specialist.

Medical technologies based on ionizing radiation application still evolve rather fast. It means that health professionals must build their competencies and update them in parallel to use it effectively and safely in the diagnosis and treatment of patients.

Radiation protection in medical applications of ionizing radiation is the responsibility of three parties, namely radiologic medical practitioners, who implement procedures in diagnostic and interventional radiology, nuclear medicine or radiation oncology, medical radiation technologists, also referred to as radiographers, who implement the procedures and are the interface between patient and technology and clinically qualified medical physicists who are in charge of dosimetry, quality assurance and tend to organize radiation protection training.

According to Vassileva, radiation protection training will have to be specifically designed to correspond to the position and the risks it is related to. The online meeting took place between 8 and 10 March in the presence of over 200 participants representing 67 Member States and 24 international organizations, professional bodies and safety campaigns, and equipment manufacturers and regulatory bodies.

The meeting included seven panel discussions on medical applications of ionizing radiation and covered shortcomings of radiation protection training and potential solutions in the area of diagnostic radiology, such as dental radiology, fluoroscopy-guided interventional procedures, nuclear medicine and radiation oncology, and training of referring physicians and dentists.

Professional medical societies are on the forefront of ensuring and developing the competence of its members. This is however, based on a well-founded background of scholarly training and medical practice at medical and dental education, said Kimberly Applegate, Chair Committee 3 on Radiation in Medicine of the International Commission on Radiological Protection (ICRP). The second issue is the necessity to enhance behavioral skills like teamwork, communication with peers, as well as with patients, and adhere to ethical values and safety culture.

Education is also one of the pillars of safety culture. The students of radiography are shown the principles of radiation protection and radiation physics during the academic training. Nevertheless, this amount of knowledge can be shallow and lacking in practical significance due to the old-fashioned curricula and the loss of practical contact. Practicing radiographers should continue their professional growth because the latest technologies and rules are constantly changing.

2.1.6. Training closer to the point of care

The limitations to training are growing due to the busy work schedules and heavy clinical workloads. Adaptable training methods based on practical requirements that are at a closer vicinity to the point of care has been identified as a successful strategy to learn development.

One example of training strategies in practice-oriented learning in radiation protection to enhance knowledge, skills and competences is Case-based training, and pocket available quick view, videos and virtual simulators, said Graciano Paulo, a radiographer and full professor at Coimbra Health School (IPC-ESTeSC) in Portugal, and an organizer of the Euro safe imaging initiative and European Federation of Radiographer Societies.

2.1.7. IAEA learning resources and support

The scholars concurred that the IAEA General Safety Requirements No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standard and the supporting Safety Guide SSG-46, Radiation Protection and Safety in Medical Uses of Ionizing Radiation, form the basis of regulatory provisions on the education and training of health personnel. The implementation is influenced though by the difficulties created by varying levels of national minimum requirements of education and training, content and delivery.

The IAEA online literature is free of charge and is availed via the Radiation Protection of Patients site. Through the Human Health Campus, the IAEA also offers professional guidelines, informational and learning resources in every use of ionizing radiations in human health.

The respondents identified the necessity of international advice in the manner of executing the provisions of education, training, qualification and competence in radiation protection to health professionals.

2.1.8. Regulatory Framework and Institutional Responsibilities

In Nigeria, the main regulatory body that handles the regulation and monitoring of the radiation safety standards is the Nigeria Nuclear Regulatory Authority (NNRA). Every healthcare facility that utilizes ionizing radiation is supposed to adhere to the NNRA regulations comprising regularly checking the facility, training its staff, and ensuring the availability of appropriate equipment.

Nonetheless, it is being reported that there are weak enforcement mechanisms and institutional compliance in most centers (Lawani et al., 2023). Enhancing institutional responsibility and better regulation enforcement is an essential step towards enhancing the safety environment.

2.2 EMPIRICAL REVIEW

An empirical review often entails the study of past research studies which has been conducted in a bid to investigate similar research issues to give evidence-based information on the topic at hand. In this part, the review is based on the current studies on the level of radiation safety awareness, awareness, and practices among radiography students in the University of Benin (UNIBEN) and the practicing radiographers in Benin City. The findings highlighted in the review are in line with the goals of this study and in addition, these studies provide me with a platform through which to understand the contemporary challenges and gaps in practice.

Eze et al. (2023) used a cross-sectional study design and a descriptive design to evaluate the radiation protection practices of radiographers in Lagos State. Through the use of structured questionnaires given to 120 radiographers, the study equally discovered that despite the high percentage of moderate awareness of the radiation safety principles by 72% of the respondents, very few use personal dosimeters regularly. The research also indicated that there was a lack of institutional support of the radiation safety practices and that it strongly interfered with the effective implementation of the practices. This brings out a significant disconnect between the theory and the field.

In the same vein, Adams and Eze (2017) conducted a research in Benin City to determine the practice of radiation protection in both the public and privately owned radiological facilities. The researchers found that, most radiographers were conversant with the basic principles of safety,

but they did not exercise them consistently, especially in privately run centers. It is worth noting that 67 percent of the respondents had not got regular radiation safety training, and most of them had inadequately used available protective tool such as lead aprons because of a lax attitude towards such things. The present study is especially applicable to the existing study since it provides the reflection of the local conditions of Benin and proves the idea that institutional lapses have a significant role to play in non-compliance.

In a further related research by Briggs-Kamara, Okoye, and Omubo-Pepple (2023) in Port Harcourt, radiographers as well as the patients were surveyed. The findings showed that half of radiographers habitually used radiation protection devices and majority of patients had no proper information about the dangers of radiations. The paper found systemic issues like lack of training and equipment particularly in the state hospitals. This highlights the importance of better education and regulation in the government and the non-government sectors.

Ikubor et al. (2021) investigated the level of radiation safety knowledge and practices amongst medical doctors in a teaching hospital in the Niger Delta. Although the research involved doctors and not radiographers, it established that only one out of four had a formal training on radiation safety. The junior staff were particularly weak on the awareness of the ALARA (As Low As Reasonably Achievable) principle. This research strengthened the need to ensure that the standards of safety in all professions in healthcare are upheld with a consistent and ongoing training of professionals.

Olaopa, Adebayo, and Abdulraheem (2020) assessed the knowledge and practices regarding radiation safety among medical imaging employees in Ilorin, Nigeria. Among the surveyed participants, 81 percent of them showed theoretical awareness of radiation protection, but only

half of them followed some main safety measures, shielding equipment and wearing personal protective equipment. The researchers explained this discrepancy by the fact that there was no institutional support, ineffective availability of protective materials, and unsystematic supervision.

Additionally, Ogunlana et al. (2022) conducted a multicenter observational study across radiological facilities in Ogun State. Their findings revealed that 38% of radiographers had never used dosimeters, and more than 60% had not participated in any radiation protection workshop in the past two years. However, facilities that had active radiation safety officers recorded higher compliance with safety protocols, suggesting that institutional presence and culture play significant roles in shaping safety behavior.

In summary, these empirical studies reveal several recurring themes. Firstly, while awareness of radiation safety principles is generally moderate among radiographers, actual compliance with safety practices remains low. Secondly, there is a persistent gap between knowledge and implementation, often due to insufficient training, poor availability of protective resources, and lack of regulatory enforcement. Thirdly, the role of institutional support—through safety officers, routine audits, and provision of equipment—appears crucial in promoting best practices. Importantly, there is limited research focusing specifically on radiography students in Nigerian universities, including UNIBEN, creating a gap that this current study aims to address. By comparing students and practicing radiographers within the same geographic region, the study seeks to provide deeper insight into how educational exposure and field experience influence radiation safety awareness and behavior.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 RESEARCH SETTING

This study was conducted in Benin city. The background incorporates the department of radiography at the University of Benin (UNIBEN).

3.2 STUDY DESIGN

The research design used is descriptive cross-sectional survey research. The proposed design will be adequate to determine the amount of current awareness, knowledge, and practices on radiation safety among radiography Students at Uniben.

3.3 TARGET POPULATION

The research was centered on the entire student body of Radiography (300 -500 level) of the University of Benin.

3.4 SAMPLING TECHNIQUE

Proportional stratified random sampling by level of academic i.e. make each level of the departments (e.g., 300, 400 and 500) one stratum, and pick the participants of the stratum in proportionality of the stratum size in the population. Simple random sampling (or systematic random sampling) within each stratum then.

3.5 SAMPLE SIZE

The minimum sample size for this study was determined using the World Health Organization standard sample formula for calculation of sample size (Daniel *et al.*, 1999).

$$N = \frac{Z^2 pq}{d^2}$$

Where:

N= desired sample size

Z = standard normal deviation, usually set at 1.96 (for 95% confidence interval)

P = proportion in the target population estimated to have a particular characteristic.

q = 1.0-p

d = degree of accuracy desired, usually set at 0.05.

(P) of 10% = 10/100 = 0.1

This formula gives the sample size needed in an effectively infinite population.

$$N = \frac{(1.96)^2 \times 0.1 \times (1.0 - 0.1)}{0.05^2}$$

N = 138.3

The calculated minimum sample size is 138.3. To consider the non-response of the participants, the sample size was rounded off to 10 percent of the total population; this will provide a sample of 152.1. Nonetheless, this study recruited 152 participants as the maximum.

This sample was divided proportionally between the two groups:

300lv: 50

400lv: 50

500lv: 52

3.6 INSTRUMENT FOR DATA COLLECTION

The main tool of data collection was the structured self-administered questionnaire that was created to evaluate the radiation safety knowledge, practices and awareness.

3.7 VALIDITY OF THE INSTRUMENT

Validity is a term that is used to describe the degree of measuring what the instrument is supposed to measure. To achieve content validity, the questionnaire was face and content validated by the experts in radiography and my supervisor in this study.

3.8 RELIABILITY OF THE INSTRUMENT

The term reliability is used to define the consistency of the instrument, in other words, the results are consistent and can be replicated over time. The strategies that will follow is to make the questionnaire reliable:

Internal Consistency: Cronbachs Alpha was employed in evaluation of an internal consistency of the questionnaire and it is a statistical test that evaluates the relationship of the items under each section of a questionnaire.

A sample pilot study was done on a small group of radiography students in Uniben (around 10 percent of the chosen sample size). Another objective of the study was to find out how much time it took to respond to the questionnaire, whether there was a problem of time in collecting data and whether the questionnaire questions were appropriate. Such a process enabled the author to check and test the understandability and recognizability of the terms and phrases applied in the questionnaire as perceived by the participants. Based on their feedback, the items were considered to be understandable, all-inclusive, appropriate, and simple to fill.

3.9 METHOD OF DATA COLLECTION

A well-constructed questionnaire was used as a data collection tool in this study. Students of radiography in Uniben were given the questionnaire to complete on their own. This was carried out in a span of 3-4 weeks so that sufficient responses could be made.

3.10 METHOD OF DATA ANALYSIS

The data were analyzed with the help of the Statistical Package of Social Sciences version 28.0.

The demographic characteristics of the sample were reported using a descriptive statistic (frequencies, means, and standard deviates). Chi-square associations and Pearson correlations to test the relationship between the variables were used. A single logistic regression model was constructed with physically inactive and physically active qualities as dependent variables to come up with odds ratio (OR) with a 95 percent confidence interval. The average ranking was determined as the measure of the radiation safety awareness, knowledge, and the practices of radiography students in the University of Benin (UNIBEN). The p-value of the lowest level of statistical significance accepted was $p < 0.05$.

3.12 ETHICAL CONSIDERATIONS

At the Faculty of Basic Medical Sciences, University of Benin, Benin City, Edo State, the Ethics Committee of the study has given its approval. The respondents were encouraged to voluntarily take part in the study since their presence was solely voluntary and that there would be no adverse effects of dropping out of the study. Anonymity and confidentiality will also be explained to the participants in the form of a covering letter.

CHAPTER FOUR
RESULTS

4.1 Introduction

The chapter contains the results of the research on the subject radiography safety awareness among radiography students. A total of 152 respondents were sampled, and they are radiography student in the University of Benin. The sociodemographic profiles and aspects of radiography students, radiation safety level of awareness, knowledge and practices of radiology students in the University of Benin (UNIBEN) is analyzed.

4.2 Sociodemographic Characteristics of Respondents

4.2.1 Age Distribution of Radiography students

Table 4.1 shows the age distribution of Radiography Students who participated in the study.

Table 4.1: Age Distribution of Radiography Students (N=152)

Age Group (Years)	Frequency	Percentage
Below 20	8	5.3%
20-24	120	79.0%
25-29	22	14.5%
30 and above	2	1.3%
Total	152	100.0%

The age of radiography students that were involved in the study is presented in Table 4.1. Most of the students (79.0%), were aged 20-24 years, then secondly, 25-29 years old (14.5%), and

finally, under 20 (5.3%). The least percentage of students (1.3) was 30 years and above. This implies that the majority of the radiography students in this research were aged 20-24 years.

4.2.2 Gender Distribution

Table 4.2: Gender Distribution of Radiography students (N=152)

Gender	Frequency	Percentage
Female	93	61.2%
Male	59	38.8%
Total	152	100.0%

Table 4.2 presents the gender distribution of radiography student who participated in this study. The results indicate that there were more female caregivers (61.2%) than male students (38.8%).

4.2.3 Level of Study

Table 4.3: Level of study of radiography students (N=152)

Level of Study	Frequency	Percentage
300lv	44	28.9%
400lv	30	19.7%
500lv (Final year)	78	51.3%
Total	152	100.0%

Table 4.3 illustrates the level of study of radiography students. 500lv constituted the highest portion of radiography student in this study (51.3%), followed by 3000lv (28.9%) and 400lv (19.7%). This distribution suggests that the final year student was mostly recruited in this study.

4.2.4 Marital Status

Table 4.4: Marital Status of radiography students (N=152)

Marital Status	Frequency	Percentage
Single	152	100.0%
Married	0	0.0%
Others	0	0.0%
Total	152	100.0%

Table 4.4 depicts the marital status of radiography students recruited for this study. All radiography student recruited for this study are single occupying the entire proportion (100.0%).

4.2.5 Attended Lecture, Seminar, Training on radiation protection

Table 4.5: Attended Lecture, Seminar, Training on radiation protection (N=152)

Reponses	Frequency	Percentage
Yes	139	91.4%
No	13	8.6%
Total	152	100.0%

Table 4.5 indicates the ones who have attended lectures, seminars and training on radiation protection. Most of them (91.4) attended them and 8.6% have not. These results also show that the majority of the radiography students in this research have participated in seminars, radiation protection lecture, and training.

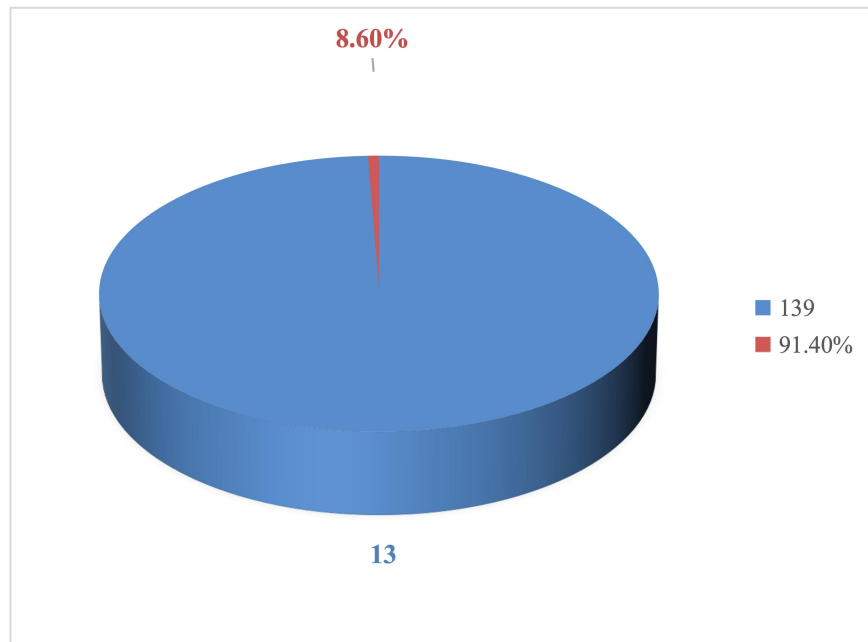


Fig 1.0: Showing the pie chart of the distribution of those that have attended lectures, seminars and training on Radiation Protection

4.3 Knowledge of Radiation safety principles and protocols

Table 4.6 Shows the Knowledge of Radiation safety principles and protocols among Radiography Students

(N=152)

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
I understand the concept of ALARA (As Low as Reasonably Achievable) principle.	30(19.7)	8(5.3)	12(7.9)	6(3.9)	96(63.2)
I am aware of the permissible dose limits for radiation workers.	22(14.5)	18(11.8)	4(2.6)	25(16.4)	83(54.6)
I know the importance of time, distance, and shielding in radiation protection.	12(7.9)	6(3.9)	0(0.0)	32(21.1)	102(67.1)
I can identify basic radiation warning signs and symbols.	0(0.0)	9(5.9)	10(6.6)	22(14.5)	111(73.0)
I am aware of radiation safety regulations as recommended by ICRP and NCRP.	13(8.6)	10(6.6)	3(2.0)	30(19.7)	96(63.2)
I understand the use and purpose of personal dosimeters.	6(3.9)	10(6.6)	5(3.3)	22(14.5)	109(71.7)
I know the potential biological effects of	12(8.0)	10(6.6)	13(8.6)	39(25.7)	78(51.3)

ionizing radiation exposure.					
I am familiar with procedures for reporting radiation overexposure incidents.	30(19.7)	31(20.4)	30(19.7)	27(17.8)	34(22.4)
I am knowledgeable about the function of lead aprons and thyroid shields.	5(3.3)	4(2.6)	2(1.3)	28(18.4)	113(74.3)

The insights on the knowledge of the radiography safety principles and protocol in the eyes of the radiography students are captured in Table 4.5. A majority of radiographers appear well acquainted with the radiation safety protocol and principle with approximately 59.7 rendering a strong agreement and 18.5 percent agreeing. This implies that students of radiography are well aware of the principle and protocols of radiation safety.

4.4 Attitude Towards Radiation Protection and Safety Practices

Table 4.7 showing the Attitude Towards Radiation Protection and Safety Practices (N=152)

Statement	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Radiation protection is essential for both patients and radiographers.	0(0.0)	0(0.0)	1(0.7)	30(19.7)	121(79.6)
I feel motivated to adhere strictly to radiation protection measures.	38(25.0)	2(1.3)	11(7.2)	33(21.7)	68(44.7)
I consider radiation protection	91(59.9)	48(31.6)	9(5.9)	4(2.6)	0(0.0)

procedures time-consuming and unnecessary.					
I believe that negligence in radiation safety can lead to serious health risks.	0(0.0)	0(0.0)	5(3.3)	48(31.5)	99(65.1)
I am willing to attend more training or workshops on radiation safety.	0(0.0)	0(0.0)	39(25.7)	38(25.0)	75(49.3)

The insights about the attitude to the radiation protection and safety practices among the radiography students are captured in Table 4.6. Majority of radiographers appear to be motivated about radiograph and radiation safety practices.

4.7 Test of Hypothesis

The researcher used the T-test statistics to test the hypothesis at a significance level of 0.05. The decision criterion was determined on the basis of the p-value that was associated with the T-test. Therefore, when the p-value is below 0.05 (significance level) the null hypothesis (H₀) is rejected and vice versa when the p-value exceeds 0.05, the null hypothesis is accepted.

The hypothesis that was proved and tested with the help of the T-test statistics was the following:

H₀; No statistically significant difference exists between radiation safety knowledge in students who have undergone previous radiations trainings and those students who have not undergone such trainings.

H₁; Radiation safety awareness level between the students who are and are not already trained in radiation safety is statistically significant.

Table 4.8 showing the One-Sample t-Test

Test Statistic	df	p-value	Mean Difference	95% Confidence Interval	Cohen's d
t(150) = 2.41	150	0.017	6.77	[1.22, 12.32]	0.54

Interpretation

An independent samples t-test showed that radiation safety awareness is statistically significant between the sample with and without a history of radiation safety training, $t(150) = 2.41$, $p = 0.017$, Cohen $d = 0.54$. Students who were previously trained demonstrated a high score on radiation safety awareness. The null hypothesis (H_0) is rejected as the p-value (0.017) is less than 0.05. The implication is that the difference in radiation safety awareness amongst students who receive radiation safety training and those that have not is statistically significant.

4.7 Discussion of Findings

The sociodemographic profile of participants showed clear patterns. Most radiography students were aged 20–24 years (79.0%), followed by 25–29 years (14.5%), with only 1.3% aged 30 and above. Females constituted the majority (61.2%) compared to males (38.8%). In terms of academic level, 500-level students formed the largest group (51.3%), followed by 300-level (28.9%) and 400-level (19.7%), indicating heavy representation of final-year students.

A large proportion of respondents (91.4%) had attended lectures, seminars, or training on radiation protection, suggesting strong exposure to radiation-safety education. This contrasts with findings by Ikubor et al. (2021), who reported that only 28% of medical doctors had formal radiation-safety training.

Overall, knowledge of radiation-safety principles was high among students, with 59.7% strongly agreeing and 18.5% agreeing that they understood key safety protocols, indicating generally good knowledge levels.

CHAPTER FIVE

CONCLUSION, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER STUDIES

5.1 Introduction

This chapter has a conclusion, recommendations that were made through the assessment of radiography students on radiation safety awareness in University of Benin.

5.2 Conclusion

The paper evaluated the awareness of radiation safety in Radiography students in the University of Benin with a specific focus on the influence of previous radiation safety training. The results indicated that the level of awareness on the principles and practices of radiation safety among the students was moderate to high. Nonetheless, a notable difference was also noted between those students who had prior training on radiation safety and those who had not. The independent samples t -test showed that students who were trained in radiation safety had much more heightened awareness scores than those who were not ($p = 0.017$). It states that before radiation protection education or workshop, previous exposure is crucial in enhancing the knowledge, attitudes, and adherence to the standards of safety among the students.

In general, the research reaches the conclusion that the radiation safety awareness of Radiography students is promising, however, it still can be improved, especially among the first-level students and those who did not receive training in radiation protection. Training and constant revision on radiation safety will be improved, which will result in a more safety-aware and well-equipped radiographer to work in a clinical setting.

5.3 Recommendations

1. Integrate radiation-safety modules into the 100- and 200-level curriculum, including dedicated lectures on ALARA principles, biological effects of radiation, and regulatory standards, so that students acquire safety competence before clinical postings.
2. Mandate at least one departmental radiation-safety workshop each semester, with attendance taken, certificates issued, and sessions facilitated by certified medical physicists or RRBN-accredited radiographers.
3. Include hands-on skill sessions in the clinical laboratory, where students practice correct use of lead aprons, gonad shielding, thyroid collars, personal dosimeters, and safe room positioning using actual imaging equipment.
4. Establish a formal partnership with the RRBN, enabling the department to host annual standardized radiation-safety certification exams for students and invite RRBN officials for guest lectures or compliance audits.
5. Expand radiation-safety awareness campaigns to other health-science departments (Medicine, Nursing, MLS, Physiotherapy), using posters, simulation exercises, and inter-departmental seminars to ensure multidisciplinary safety during imaging procedures.
6. Conduct biannual assessments of students' radiation-safety knowledge and clinical compliance, using structured tests, OSCE-style practical evaluations, and clinical supervisors' checklists to monitor adherence to protocols.
7. Create a student radiation-safety learning hub, where students are provided with links to RRBN guidelines, ICRP publications, online training modules (e.g., IAEA Radiation Protection Series), and are required to complete at least one accredited online course yearly.

5.4 Limitation of Study

1. Limited Study Population: The study is limited to Radiography students of the University of Benin, which limits the generalizability of the results to other institutions or regions that students of radiology attend.
2. Self-reported Data: Questionnaires are based upon the honesty and the ability to remember by the participants. There are chances of respondents overestimating or underestimating their knowledge thus causing bias when responding.
3. Small Sample size: The sample size can be statistically and yet be inadequate to reflect all the variability of the levels of knowledge at all levels of classes.
4. Time Limitations: The research is done in a small academic period and this can be a constraint to ensure that the data can be collected in depth as well as analyzed and validated.
5. Non-response or Partial Response Bias: Some students may fail to return questionnaires or skip key items, potentially affecting the representativeness and completeness of the dataset.
6. Lack of Practical Knowledge Assessment: The study primarily assesses theoretical knowledge and does not directly evaluate students' practical adherence to radiation safety protocols in clinical settings.
7. Environmental and Academic Factors: Differences in students' clinical exposure, level of training, and instructional quality across levels may influence their knowledge, making comparison difficult.

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APPENDIX I

QUESTIONNAIRE

RESEARCH TITLE: KNOWLEDGE OF RADIATION SAFETY PROTOCOL AMONG RADIOGRAPHY STUDENTS OF UNIVERSITY OF BENIN. This is a research paper that I conducted in the department of Radiography School of Basic Medical science at the university of Benin, Benin City in part fulfilment of awarding the Bachelor of Radiography degree. Will you mind taking some of your time to fill this questionnaire? Your support and help are much needed.

GENERAL INSTRUCTION FOR PARTICIPANTS:

- In case of emergency, the general instructions to be followed by the participants are as follows:
- Be candid as much as possible and do not include personal information that is not requested (phone number etc).
- Tick [✓] where appropriate Please answer all questions

SECTION 1: Demographic Information

(Tick (✓) the appropriate response or fill in where necessary.)

1. Age: Below 20 []; 20–24 []; 25–29 []; 30 and above [].

2. Gender: Male []; Female [].

3. Level of study: 300 Level []; 400 Level []; 500 Level [].

4. Marital status: Single []; Married []; Others (specify) _____

5. Have you attended any lecture, seminar, or training on radiation protection? Yes []; No [].

SECTION B: KNOWLEDGE OF RADIATION SAFETY PRINCIPLES AND PROTOCOLS

(Please indicate your level of agreement using the scale below for each item.)

Scale: 1 – Strongly Disagree 2 – Disagree 3 – Neutral 4 – Agree 5 – Strongly Agree

S/N	Statement	1	2	3	4	5
1	I understand the concept of ALARA (As Low As Reasonably Achievable) principle.	[]	[]	[]	[]	[]
2	I am aware of the permissible dose limits for radiation workers.	[]	[]	[]	[]	[]
3	I know the importance of time, distance, and shielding in radiation protection.	[]	[]	[]	[]	[]
4	I can identify basic radiation warning signs and symbols.	[]	[]	[]	[]	[]
5	I am aware of radiation safety regulations as recommended by ICRP and NCRP.	[]	[]	[]	[]	[]
6	I understand the use and purpose of personal dosimeters.	[]	[]	[]	[]	[]
7	I know the potential biological effects of ionizing radiation exposure.	[]	[]	[]	[]	[]
8	I am familiar with procedures for reporting radiation overexposure incidents.	[]	[]	[]	[]	[]
9	I am knowledgeable about the function of lead aprons and thyroid shields.	[]	[]	[]	[]	[]

SECTION C: ATTITUDE TOWARDS RADIATION PROTECTION AND SAFETY PRACTICES

(Use the same scale as above.)

S/N	Statement	1	2	3	4	5
6	Radiation protection is	[]	[]	[]	[]	[]

S/N	Statement	1	2	3	4	5
	essential for both patients and radiographers.					
7	I feel motivated to adhere strictly to radiation protection measures.	[]	[]	[]	[]	[]
8	I consider radiation protection procedures time-consuming and unnecessary.	[]	[]	[]	[]	[]
9	I believe that negligence in radiation safety can lead to serious health risks.	[]	[]	[]	[]	[]
10	I am willing to attend more training or workshops on radiation safety.	[]	[]	[]	[]	[]

SECTION D: GENERAL FEEDBACK

1. **What challenges do you face in adhering to radiation safety protocols?**

2. **What recommendations can you make to improve radiation safety compliance among radiography students?**

Thank you for your participation in this questionnaire. Your input is essential to the success of this research project. Your responses will be kept confidential, and your involvement is greatly appreciated.

APPENDIX II: ETHICAL APPROVAL



RESEARCH ETHICS COMMITTEE
COLLEGE OF MEDICAL SCIENCES
UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.



Chairman: Prof. F. A Imarhiagbe
MBChb, FMCP
Cert Clin Res and ethics (NIH), MD.
0803449092

P.M.B 1154, BENIN CITY
Email: researchethics.cms@gmail.com

Our Ref: CMS/REC/01/VOL.2/840

Date: 3rd November, 2025

Re: KNOWLEDGE OF RADIATION SAFETY PROTOCOL AMONG RADIOGRAPHY STUDENTS OF UNIVERSITY OF BENIN

Name of Principal Investigator: OKORO ESTHER OGECHI
Department of Radiography
School of Basic Medical Sciences
College of Medical Sciences,
University of Benin

REC Approval No: CMS/REC/2025/840

This is to inform you that the research described in the submitted proposal, the Informed Consent Forms and other participant information materials have been reviewed and approved by the College Research Ethics Committee, University of Benin.

This approval dates from **3rd November, 2025 to 2nd November, 2026**. In multi-year research, Endeavour to submit your annual report to the REC early in order to obtain renewal of your approval and avoid disruption of your research.


The National Code of Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the code including ensuring that all adverse events are reported promptly to the REC. No, changes are permitted in the research without prior approval by REC except in circumstances outlined in the code. REC reserves the right to conduct compliance visit to your research site without prior notice. Thank you.

PROF. F.A IMARHIAGBE
Chairman, REC

Promoting best ethical & scientific standard for research in Nigeria

APPENDIX III: PLAGIARISM CLEARANCE CERTIFICATE

INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER OFFICE (IPTTO)
Vice Chancellor's Office
University of Benin
PMB1154, Benin City, Nigeria



CLEARANCE FORM

DATE: 18-12-2025

NAME: OKORO ESTHER OGECHI

MATRIC NO: BMS 200 1304

DEPARTMENT: RADIOGRAPHY

FACULTY: RASTC MEDICAL SCIENCES

SESSION OF GRADUATION: 2024 / 2025

DIRECTOR
DATE: [Signature]
IPTTO (VCO)
Head Of Unit (IPTTO)