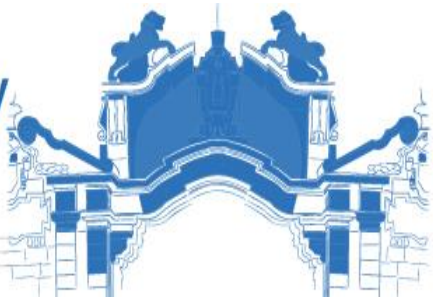


Addis Ababa University
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College of Health Sciences

School of Medicine

Department of Internal medicine

Nuclear Medicine unit

A Research Thesis on Assessment of Knowledge, Attitude and Practice on Radiation Safety among nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued, Algiers, Algeria

Addis Ababa, Ethiopia
April, 2025.

A Research Thesis Submitted to the School of Graduate Studies of the Addis Ababa University in Partial Fulfillment for the Requirements of Specialty Certificate in Clinical Nuclear Medicine.

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Approved by the Examining Board

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Title of the project: Assessment of Knowledge, Attitude and Practice on Radiation Safety among nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued, Algiers, Algeria,2024.

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List of Abbreviations/Acronyms

AAU- Addis Ababa University

ALARA- As Low As Reasonably Achievable

CHU- Center Hospital University

CT- Computed Tomography

IAEA-International Atomic Energy Agency

KAP- Knowledge, Attitude and Practice

MRI- Magnetic Resonance Imaging

NCRP - National Council on Radiation Protection and Measurements

PET- Positron Emission Tomography

PPE- Personal Protective Equipment

RIA - Radioimmunoassay

RP- Radiation Protection

RSO- Radiation Safety Officer

SPECT- Single Photon Emission Computed Tomography

UNSCEAR - United Nations Scientific Committee on the Effects of Atomic Radiation

Abstract

Background: Nuclear medicine staff members who involved in this study typically include a variety of professionals who work together to perform diagnostic imaging and therapeutic procedures using radiopharmaceuticals. Radiation safety is a critical aspect of the nuclear medicine practice. It encompasses practices and protocols designed to protect patients, healthcare workers, and the general public from the harmful effects of radiation exposure.

Objective: To Assess Knowledge, Attitude and Practice on radiation safety among nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued Algiers, Algeria,2024.

Methods and Materials: The survey was conducted as institution based cross sectional study, using a structured questionnaire on nuclear medicine staff members in Service de medicine nuclear-CHU de-Bab El Oued Algiers, Algeria. The study was conducted from August 2024 – February 2025.

Result: In this study, a total of 48 participants were included in the analysis, resulting in a response rate of 96%. While staff members generally possess a solid understanding and knowledge of fundamental radiation safety principles but certain concerning findings emerged regarding their attitudes and practices. Specifically, it was found that staff members with less than one year of experience demonstrated a lower attitude score towards radiation safety with the level of significance 0.010 ($p<0.05$). Additionally, study participants holding doctorate degrees shows admirable knowledge levels and a positive attitude towards radiation safety; but, their practical application was inadequate p-value of 0.016 ($p<0.05$***).***

Recommendations and Conclusion: This study discloses certain concerning trends regarding their attitudes and practices. To address these, it's recommended that nuclear medicine centers implement ongoing professional training programs, particularly targeting newer staff members. These short-term training sessions should deliver basic knowledges with emphasize on building good attitude and believes on the importance of radiation safety. Interventions are also needed to bridge the gap between theoretical understanding and practical implementation.

Key words: Knowledge, Attitude, Practice, KAP, Radiation Safety, Nuclear medicine staff members.

1. Introduction

1.1 Background

Nuclear medicine is a specialized discipline employing radioactive substances for both diagnostic imaging and targeted therapies. Utilizing radionuclides, it enables visualization of physiological processes at the molecular level, early disease detection across different part of the body like oncology, cardiology, and neurology. This modality enhances diagnostic accuracy and permits precise therapeutic interventions, ultimately improving patient outcomes. Key imaging modalities include gamma cameras for SPECT imaging, PET scanners for metabolic activity assessment, and hybrid PET/CT or PET/MRI systems, which synergize functional and anatomical data for enhanced diagnostic precision. (Cherry,S. R.,et al. 2012 & Duan, Y.,et al 2018) .

Radiation plays a crucial role in both diagnostic and therapeutic medical procedures. In diagnostics, modalities such as X-rays, computed tomography (CT), and nuclear medicine utilize ionizing radiation to produce detailed images of the body, aiding in the identification of various conditions and guiding treatment plans. Therapeutically, radiation is employed in techniques like radiation therapy to target and destroy malignant cells, thereby facilitating the management of cancer. The precision of targeted radiation minimizes damage to surrounding healthy tissues, enhancing patient outcomes while underscoring the importance of risk assessment and safety protocols in its application. (*American Association of Physicists in Medicine, 2019)*

Annually, thirty-five million nuclear medicine procedures are carried out globally (Volterrani et al.,2019). Exposure to ionizing radiation can cause acute radiation syndrome, cancer, genetically induced mutation, developmental abnormalities and degenerative diseases (Migliore. and Coppedè, .2002). Unwanted harms and complications can be prevented by good policies and regulations. So, all nuclear medicine professionals working in the nuclear medicine department must be well-educated and skilled to attain this aim (Mettler and Guiberteau, 2011).

Nuclear medicine staff member typically includes a variety of professionals who work together to perform diagnostic imaging and therapeutic procedures using radioactive materials. In a nuclear medicine department, the collaboration of various specialized staff members is imperative for

optimal patient care and safety. Nuclear medicine physicians including nuclear medicine specializing residents, imaging technologists, radio pharmacists, RIA laboratory technologists, radiation safety officers, nurses and medical physicists, each fulfil distinct yet critical roles. (Radiological Society of North America, RSNA,2023).

Radiation safety is a critical aspect of nuclear medicine and other fields that involve the use of ionizing radiation. It encompasses practices and protocols designed to protect patients, healthcare workers, and the general public from the harmful effects of radiation exposure (International Atomic Energy Agency, IAEA ,1998).

Radiation safety is a critical aspect of ensuring safety in medical environments where radioactive materials are utilized, especially in nuclear medicine. The fundamental principles guiding radiation protection include justification, optimization, and limitation (ALARA), thereby ensuring that personnel are protected during their work. (International Atomic Energy Agency, IAEA ,1998)

Overseeing these protocols is the Radiation Safety Officer (RSO) task, whose responsibilities include managing radiation safety programs, ensuring compliance with regulatory standards, conducting training sessions, and monitoring the radiation exposure of employees (Frane,and Bitterman,2023).

To uphold safety during procedures involving radioactive materials, personal protective equipment (PPE) significantly reducing exposure risks. Furthermore, monitoring and surveillance are integral components of radiation protection; utilizing personal dosimeters allows for the continuous measurement of staff members exposure, while regular area monitoring ensures that radiation levels in workspaces remain within safe parameters. Effective handling and storage of radioactive materials are equally crucial, requiring strict protocols to minimize risks during disposal and restrict access to designated areas where these materials are utilized (World Health Organization, WHO, 2008).

Active emergency procedures must also be developed, detailing response plans for spills or accidental exposures, coupled with comprehensive training for staff members to respond effectively to radiation emergencies. (International Atomic Energy Agency, IAEA ,1998).

1.2 Statement of the problem

The use of ionizing radiation in nuclear medicine is essential for diagnostic and therapeutic procedures. However; it poses potential risks to both healthcare workers and patients if not managed properly. Despite the critical importance of radiation safety, there is evidence that KAP regarding radiation safety among nuclear medicine staff members can vary significantly. Inadequate understanding of radiation safety protocols can lead to unsafe practices, increased exposure to radiation, and potential health risks for both staff members and patients. Additionally, the rapid advancements in technology and treatment modalities in nuclear medicine necessitate continuous education and assessment of staff members competencies in radiation safety. (Goula, et al. 2021)

National Council on Radiation Protection and Measurements reports that approximately 30,000 radiation injuries occur annually in medical settings, with a substantial portion attributed to nuclear medicine practices. Furthermore, improper dose calculations can lead to a 50% increase in unnecessary radiation exposure, raising the potential for long-term health consequences, including cancer. Such figures underscore the critical importance of strict radiation safety protocols in safeguarding both patients and healthcare professionals. (Matthew King 2022),

Regulatory frameworks governing radiation safety in medical settings are essential to ensure the protection of patients, healthcare workers, and the environment. Prominent among these regulations are the guidelines established by the IAEA and WHO, which emphasize the principles of justification, optimization, and limitation of radiation exposure. Furthermore, national regulatory bodies, enforce compliance with safety standards pertaining to equipment use, training of personnel, and emergency procedures. (International Atomic Energy Agency, IAEA ,1998)

Previous studies on radiation safety KAP in different nuclear medicine centres in different part of the world had revealed notable gaps in knowledge and inconsistencies in attitudes and practices among healthcare professionals.These inconsistencies underscore the necessity for standardized training programs and the dissemination of updated information to ensure uniformity in radiation safety practices within the field. Therefore, there is a pressing need to assess the current level of knowledge, attitudes, and practices related to radiation safety among nuclear medicine personnel to identify gaps and areas for improvement. (Goula, et al. 2021).

1.3 Significance of the study

Enhancing safety standards within nuclear medicine necessitates a comprehensive approach that underlines the importance of evaluating KAP of personnel in this essential sector a thorough assessment of staff members KAP is crucial for identifying gaps in understanding and adherence to safety protocols. By systematically addressing these areas, nuclear medicine institutions can implement targeted training and educational initiatives, ultimately developing a culture of safety that protects both healthcare providers and patients. (Danial.et.al.2019).

Regular assessments of KAP not only support compliance with local and international radiation safety regulations but also play a crucial role in maintaining authorization and mitigating potential legal liabilities that could arise from non-compliance. Conducting these assessments encourage a culture of safety within the institution, emphasizing the importance of shared responsibility and ongoing learning among staff members. (Yunus et al ,2014).

In summary, assessing the knowledge, attitudes, and practices regarding radiation safety among nuclear medicine staff members is vital for enhancing safety standards, improving patient care, ensuring regulatory compliance, and promote a culture of continuous improvement in healthcare settings.

2. Literature Review

Radiation safety is a critical concern in nuclear medicine due to the inherent risks associated with ionizing radiation (United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR, 2018). The effectiveness of safety protocols largely depends on the KAP of the personnel involved (Danial.et al. 2019).

The assessment of KAP on radiation safety among nuclear medicine staff members is crucial for ensuring the well-being of both healthcare workers and patients. Studies have shown concerning gaps in awareness and training among medical professionals regarding radiation safety protocols. Researches indicate that a significant portion of healthcare professionals lack adequate knowledge and training in radiation safety, leading to poor utilization of safety equipment and posing health hazards to both staff members and patients (Danial et al. 2019).

This literature review examines various studies assessing KAP related to radiation safety among health care professionals in nuclear medicine and radiology staff members. Several studies have highlighted gaps in the knowledge of radiation safety among healthcare professionals, including nuclear medicine staff members. For instance:

The research article by Danial Seifi, et al. 2019 concludes that were statistically significant differences in the level of nuclear medicine staff members KAP radiation protection with gender ($p<0.05$), the average knowledge level was 63.5 (SD=18.3) and 55.5 (SD=20.3) for males and female nuclear medicine staff members, respectively. There was statistically significant difference in the percentage of nuclear medicine staff members radiation protection practice ($p<0.05$).Statistically significant difference was detected between clusters in the percentage of staff radiation protection practice with working experience ($\leq$15 years and >15 years) ($p<0.05$).The statistical difference observed in the percentage of staff radiation protection knowledge, attitude and practice with gender, practice age and the participant's working locality ,geographical region ($p<0.05$). These findings have shown that radiation protection KAP level of nuclear medicine staff members was inadequate in some regions. This is due to the lack of continuous training and absence of adequate safety knowledge about ionizing radiation. It seems that awareness about

radiation protection rules and regulations, along with continuous training and preparations has a direct effect on radiation practice leading to enhanced KAP of staff members in nuclear medicine centres. (Danial.et al. 2019).

Another pilot study by N. A Yunus *et al.* 2014, findings showed that the range of total scores obtained by the nuclear medicine nurses before and after the training were 6-14 (with a mean score of 11.19) and 13-16 marks (with a mean score of 14.85), respectively. Findings also revealed that the mean score for the area of general radiation knowledge (7.59) was higher than that of the radiation safety practice (7.26). Currently, the knowledge and awareness on radiation safety among the nuclear medicine nurses are at the moderate level. It is recommended that a national study be conducted to assess and increase the level of knowledge and awareness among all nuclear medicine nurses in Malaysia (Yunus *et al.* 2014).

A study by Hadi Hasanzadeh et al. 2018 conclude that Significant differences exist in RP, KAP mean scores based on educational age ($p < 0.05$). There was no significant difference in RP KAP mean scores when looking at sex, practice age, and hospital type ($p > 0.05$). Significant difference between RP KAP mean scores and different regions ($p < 0.05$). Educational and practice age, sex, type of hospital, and geographical region affect the KAP of interventional radiology staff members regarding RP. Since many of the subjective radiation harms for both medical team and patients, this can be easily controlled and prevented; a checkup for personnel of interventional radiology departments, considering samples from different parts of the country with different levels of education, continuous training, and practical courses may help map the status of KAP. The results of this study may also help authorized health physics officers design strategic plans to enhance the quality of such services in radiation departments (Hasanzadeh et al. 2018).

A study by Samson Dauda Yusuf et al., 2019 findings have revealed that even though most of the protective equipment's such as Lead Aprons, Gonad shields, waist Apron, and Lead gloves are readily availability which can provide protection to an extent they are still deficient in the availability and use of thyroid shields which could expose them to thyroid cancer. Since majority of the workers do not have monitoring devices, they may be over exposing themselves to radiation

which is not a good safety measure. This finding is similar with the findings of Doolan et al. 2004 where availability and use of gonad shielding were inadequate in a hospital in Dublin and also to the findings of Dewey et al. 2005 where lead gloves and thyroid collars were often omitted and orthopedic surgeons developed thyroid cancer due to exposure to radiation (Doolan et al. 2004, Dewey et al. 2005).

Though based on the radiation principles in use, findings on compliance and noncompliance to safety standard in certain elements of the Radiation Safety standards in the hospital have shown high rate of literacy and compliance of personnel to radiation safety standards as stipulated by the Nigerian Nuclear Regulatory Authority and International Atomic Energy Agency (Yusuf,et al :2020) . However, it was noticed that the total number of exposures given during radiography is usually not recorded; The hospital has also failed to implement the quality assurance program (Yusuf,et al :2020).

A study by Abdellah, et al 2015 the overall knowledge score ranged from 40% - 60% (mean; 56.5 ± 15.2), with a low score among surgeons and orthopaedics. Adherence to safe radiation practices was violated by most of participants, especially surgeons and orthopaedics, but they attributed it to the poor applicability of the protective measures during performing the procedures. This study concluded that physicians at the Suez Canal University Hospital had deficient knowledge, unsafe practices and negative attitude towards radiation safety policies & precautions (Abdellah, et al 2015).

Numerous studies have highlighted the lack of knowledge and proper radiation safety practices among healthcare personnel, including nurses and radiologic technologists (Alshamrani, 2022, Thambura et al., 2019). A study conducted in South Africa with title of Nurses' knowledge of ionizing radiation in Northern Gauteng state hospitals found that more than 50% of nurses lacked basic knowledge on the principles of radiation safety, and 63% had never received any formal training on the subject (Thambura et al., 2019).

In a study by Kumar,et al 2023 majority of participants experience medical radiation exposure less than once per week (42.1%), with a significant portion having exposure more than three times per week (40.8%). 90.8% of participants have never undergone a radiation protection course, despite

73.7% expressing willingness to participate in such a course if provided by their institution. 52.7% strongly disagreed that radiation significantly affects reproduction, while 39.5% believe they are safe within 1 meter of radiation exposure. On a positive note, 86.8% of participants correctly identified the ALARA principle for radiation protection. Regarding the implementation of safety protocols, only 28.9% were more likely to wear a lead apron, and 22.4% never wore it. The study Concludes that health care professionals lacks adequate knowledge, training and attitude regarding radiation safety protocols. Lack of adequate knowledge and training leads to poor utilization of radiation safety equipment and it is a source of health hazard for both medical professionals and the patients (Kumar,et al 2023).

In general research findings have shown that radiation protection KAP level of nuclear medicine staff members was inadequate in some regions. This might be due to the lack of continuous training and absence of adequate safety knowledge about ionizing radiation. It seems that awareness about radiation protection rules and regulations, along with continuous training and preparations has a direct effect on radiation practice leading to enhanced KAP of staff members in nuclear medicine centres (Danial. et al. 2019).

3. Objectives

3.1 General Objective

To Assess Knowledge, Attitude and Practice on radiation safety among nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued Algiers, Algeria. from August 2024 –February 2025 G.C.

3.2 Specific objectives:

- To assess knowledge on radiation safety among nuclear medicine staff members.
- To assess the attitude towards radiation safety among nuclear medicine staff members.
- To assess the practice of on radiation safety among nuclear medicine staff members.

4. Methods and Materials

4.1 Study Area and Period

The study was conducted among nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued Algiers, Algeria. This nuclear medicine institution gives nuclear medicine service for more than 30 years and according to my investigation no research has been done regarding assessment of staff members KAP on radiation safety. Consequently, doing this study is very important for this esteemed nuclear medicine institution.

The Research was conducted from August 2024 –February 2025 G.C

Data was collected from October 2024 -- November 2024 G.C

4.2 Study Design

The study was conducted as institution based cross sectional survey on current nuclear medicine staff members in Service de medicine nuclear-CHU de-Bab El Oued Algiers, Algeria.

4.3 Source population

The source population are all staff members in nuclear medicine center in Bab El Oued Algiers, Algeria.

4.4 Study population

The study population are staff members in nuclear medicine centre in Bab El Oued Algiers, Algeria with direct involvement in clinical services which includes, Nuclear Medicine Physicians and specializing residents, Nuclear Medicine imaging Technologists, RIA laboratory technologists, Radio pharmacists, Radiation Safety Officers, Medical Physicists, Nuclear Medicine Nurses.

4.5 Inclusion and exclusion criteria

4.5.1 Inclusion criteria

- Nuclear medicine staff members in Service de medicine nuclear-CHU de-Bab El Oued, with direct involvement in clinical services, willing to participate, available and provide consent.

4.5.2 Exclusion criteria

- Nuclear medicine staff members in Service de medicine nuclear-CHU de-Bab El Oued who weren't available due to various reasons during this study period.

- Nuclear medicine staff members in Service de medicine nuclear-CHU de-Bab El Oued not willing to participate in the study.

- Nuclear medicine personnel who do not engage directly in clinical services encompass roles such as administrative staff, cleaners, porters, security personnel, and transport assistants.

4.6 Sampling technique and sample size

Using the single proportion formula with a 95% CI, 5% margin of error; p- 50%.

Cochran formula ***(*** Cochran, W.G. 1977)

$n = [z^2 \times \hat{p}\,(1 - \hat{p})/]e^2$ n= [1.96² * 0.5(1-0.5)]/0.05² = 384.16

In our case N is 54 so sample size can be calculated by using this formula

ñ= n / 1+(z² * $\hat{p}$(1-$\hat{p}$))/e²N

ñ = 384/1+(384/54)

ñ ≈ 47 , add 5% for non respondant sample and the final sample size ñ ≈ 50

where

Z is z score

e is the margin of error

N is the population size

P is population proportion

50 participants randemly selected from the source population.

For ,N=54 sample size ñ =50

4.7 Data collection instruments and techniques

Staff members in the Nuclear Medicine department at CHU de Bab El Oued in Algiers, Algeria, were randomly selected and given a consent form to participate in the study and was requested to complete a structured online questionnaire using Google Forms, allowing respondents to choose their preferred language. Following data collection, the information was organized with Microsoft Excel and subsequently exported to IBM SPSS Statistics 25.0 for comprehensive analysis. Initial descriptive analysis was done by performing simple frequency distributions on demographic data, which were then visually represented in chart format to provide a clear overview of the participant characteristics. Subsequently, a series of separate analyses were conducted for each dependent variable under investigation, encompassing knowledge, attitude, and practice. Staff members' responses to the questionnaires related to these areas were recorded and analyzed in distinct tables, enabling the calculation of a total score for each variable individually. To explore the relationships between these key dependent variables, correlational analysis was performed, examining the correlation between the mean scores of knowledge, attitude, and practice assessments and various independent variables. Separate tables were generated for each of the three dependent variables, displaying the levels of significance and detailed explanations of the results observed in the table. Finally, the findings of this study were carefully compared with those reported in similar investigations conducted elsewhere, allowing for a broader contextualization and interpretation of the results within the existing body of literature on the subject.

4.8 Variables

The dependent variables

The dependent variables in this study refer to the outcomes or responses that are being evaluated or measured, which include:

- **Knowledge of Radiation Safety:**

✓ The level of understanding nuclear medicine staff members have regarding radiation safety principles, procedures, and regulations.

- **Attitudes towards Radiation Safety:**

✓ The perceptions, beliefs, and attitudes of staff members regarding the importance of radiation safety and their commitment to following safety protocols.

- **Practices Related to Radiation Safety:**

✓ The actual behaviors and adherence to safety protocols by the staff members, including use of protective equipment, handling of radioactive materials, and compliance with safety procedures.

The independent variables in this study are:

These are the factors that might influence or affect the dependent variables. In this research context, independent variables could include:

- ***Demographic information;***

✓ Demographics information's like Age and sex can affect dependent variables.

- **Educational Background:**

✓ The level of formal education or specific training in radiation safety that staff members have received.

- **Years of Experience:**
  - ✓ The number of years staff have worked in nuclear medicine, which might affect their knowledge and practices.
- **Type of Training Received:**
  - ✓ The nature and frequency of radiation safety training programs attended by the staff, such as initial training, refresher courses, or specialized training sessions.

  .
- **Source of information regarding radiation safety:**
  - ✓ Primary Knowledge and information source and methods of staying update on radiation safety.
- **Role or Position:**
  - ✓ The specific job role or position within the nuclear medicine department, which may influence the level of responsibility and exposure to radiation.

4.9 Data analysis

Collected data were organized by using Microsoft Excel 2019 and will be exported to SPSS version 25.0 statistical package for analysis after being checked for missing values.

4.10 Operational Definition

Here are potential operational definitions for the key concepts in the study:

1. Knowledge

Knowledge refers to the understanding and awareness of nuclear medicine principles, protocols regarding radiation safety measures. It can be assessed using a structured questionnaire in the form of multiple-choice questions. The knowledge score will be calculated based on the number of correct responses, with higher scores indicating greater knowledge. (Zakavi, 2004).

2. Attitude

Attitude encompasses the beliefs, feelings, and predispositions of nuclear medicine staff members towards their work regarding radiation safety protocols. This can be measured using questionnaire where participants express their level of agreement or disagreement with various statements related to nuclear medicine safety practices. The attitude score will be derived from the sum of responses, with higher scores indicating a more positive attitude. (Aspasia,2021)

3. Practice

Practice refers to the actual behaviors and actions taken by nuclear medicine staff members in their daily work routines, particularly regarding the implementation of safety protocols and adherence to best practices. This can be assessed through self-reported surveys that inquire about specific practices related to patient handling, equipment usage, and safety measures. (Hsieh. and Shannon., 2005).

4. Nuclear Medicine Staff Members

Nuclear medicine staff members include all healthcare professionals working in the field of nuclear medicine, such as Nuclear Medicine Physicians and specializing residents, Nuclear Medicine imaging Technologists, RIA laboratory technologists, Radio pharmacists, Radiation Safety Officers, Medical Physicists, Nuclear Medicine Nurses. Participants will be defined as individuals currently employed in a nuclear medicine department or facility (Frane, . and Bitterman., 2023)

i. **Nuclear Medicine Physicians and specializing residents:** These are medical doctors who specialize in nuclear medicine and specializing residents. They interpret imaging studies, diagnose diseases, and may also administer therapeutic treatments.

ii. **Nuclear Medicine imaging Technologists:** These are trained professionals who handle and, operate the nuclear medicine imaging instruments like SPECT, PET SPECT/CT, PET/CT etc. And prepare patients to carry out the imaging procedures.

iii. **Radiopharmacists:** These are radio pharmacy specialists who synthesize, produce, formulate (prepare) and dispense radiopharmaceuticals for patients used in nuclear medicine for diagnostic and therapeutic purposes. They also ensure the quality and safety of the radioactive materials (radiopharmaceuticals/radionuclides) before they are used for patients.

iv. **Radiation Safety Officers:** These Professionals are Responsible for ensuring that all the safety protocols related to radiation use are followed. In this connection the RSOs, help protect, patients, staff members, and the environment from unnecessary exposure to radiations.

v. **Nurses**: Nurses in nuclear medicine may assist in patient care, monitor patients during procedures, and provide education about the procedures and any necessary follow-up care.

vi. **Medical Physicists:** These professionals ensure that the equipment used in nuclear medicine is functioning properly and safely. They may also be involved in the calibration of imaging devices. (Frane. and Bitterman., 2023).

vii. ***RIA laboratory technologists***; Medical laboratory technologists conduct medical laboratory tests using radioactive agents, to analyses samples and assist in the diagnosis.

5. Assessment

Assessment refers to the systematic evaluation of knowledge, attitude, and practice among nuclear medicine staff members. This includes the administration of surveys/questionnaires, data collection, analysis of results, and interpretation of findings to draw conclusions about the overall competency and readiness of staff members in their roles (Hsieh. and Shannon, 2005).

5. Data collection, data processing and Data Quality Control Method

- Prior to the data collection, the data collection format was cross-checked with available information, then the study questionnaires were organized and distributed to the participants online in google forms. Completeness of the data assessed and incomplete data rejected and finally statistical analysis of data were done.

6. Ethical Considerations

- Ethical clearance was obtained from Service de medicine nuclear-CHU de Bab El Oued Algiers, Algeria and Addis Ababa University CHS Department of Internal Medicine.

7. Plans of disseminating the findings of the study

- Results of the study was be submitted to the nuclear medicine unit department of Internal Medicine, School of Medicine College of Health Sciences at Addis Ababa University and Service de medicine nuclear-CHU de Bab El Oued Algiers, Algeria for the postgraduate certificate program in clinical nuclear medicine and presented for all staff members and residents in the unit.

- It will also be submitted to medical journals for possible publication.

8. Results

8.1 Socio-demographic characteristics of the study participants

In the current study, a total of 48 participants were included in the analysis, resulting in a response rate of 96%. Among these participants majority comprising 66.7% (32 individuals), were female. The age distribution revealed that 62.5% of the participants fell within the 25 to 34 age range. Additionally, approximately 50% of the participants reported having 1 to 3 years of experience in a nuclear medicine institution. And also, nuclear medicine residents and physicians constituted the majority of the sample, accounting for 56.3% (27 individuals). Additionally, most participants possessed a bachelor's degree. With respect to training in radiation safety majority, approximately 72.9%, indicated that they had undergone both basic and extensive training courses in this area. Detailed demographic data can be found from Figure 1 to 7 below.

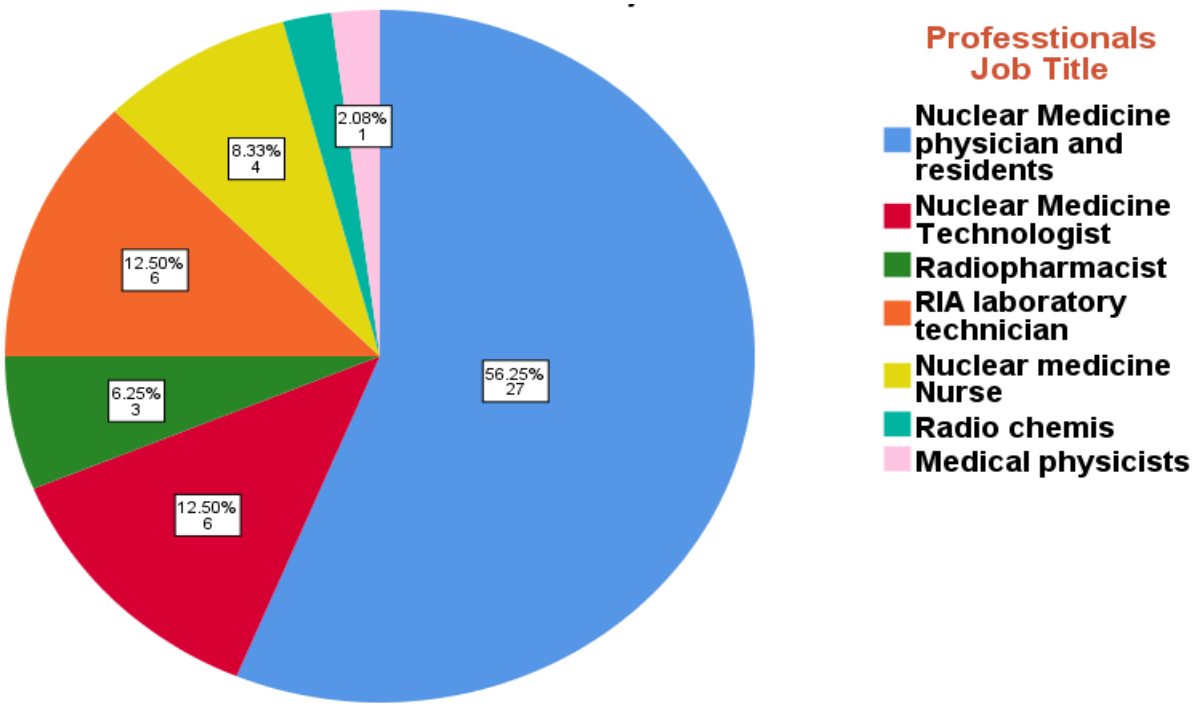


Figure 1. Nuclear medicine staff members Professionals Job Title in CHU de Bab El Oued, Algiers, Algeria, 2024

Figure 1. presented above illustrates the study participants job titles, revealing that a significant majority, comprising 56.25%, are nuclear medicine physicians and residents. Following this group, nuclear medicine technologists and Radioimmunoassay (RIA) laboratory technicians occupy the second and third positions, respectively, in terms of their representation within the study.

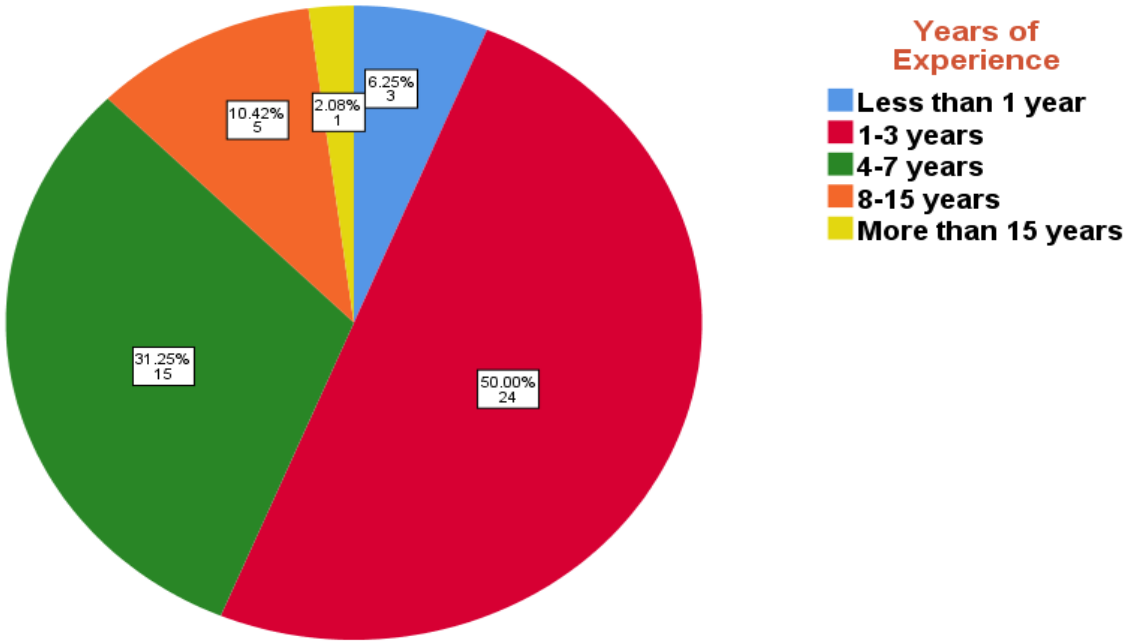


Figure 2, Nuclear medicine staff members Years of Experience in CHU de Bab El Oued, Algiers, Algeria, 2024

Figure 2. presented above, illustrates the years of experience of study participants within nuclear medicine institutions. The data reveals that a significant proportion, comprising 50%, possess between 1 to 3 years of experience. Additionally, approximately 31.25% of participants have 4 to 7 years of experience, while 12.5% are categorized as highly experienced, holding over 8 years in the field.

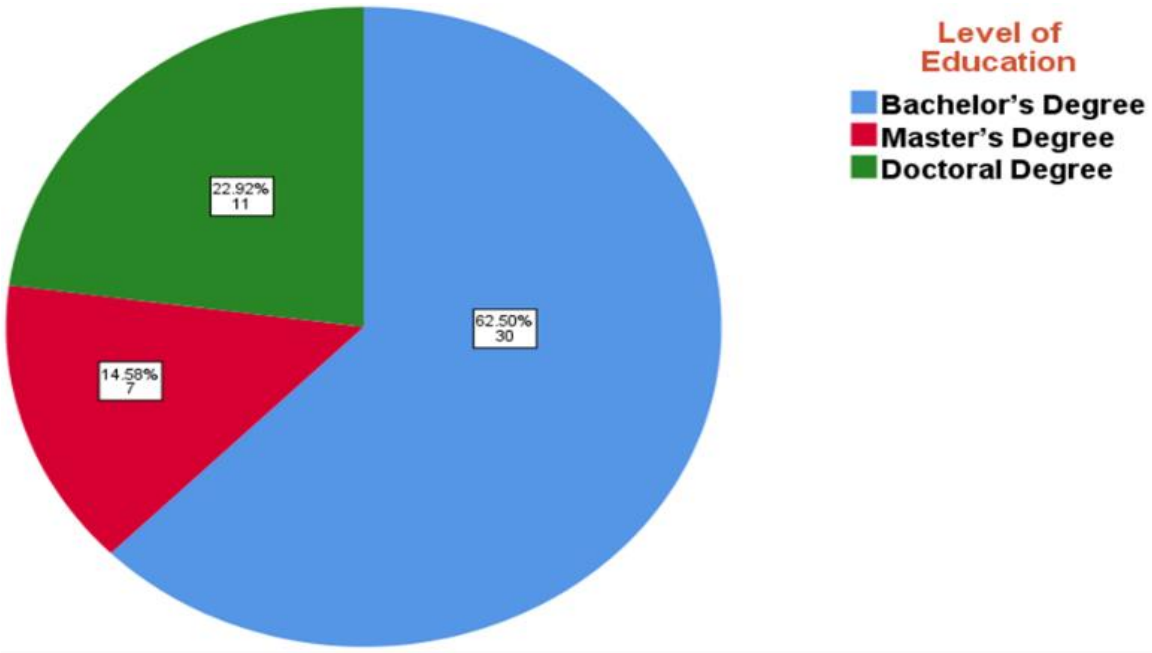


Figure 3. Nuclear medicine staff members Level of Education in CHU de Bab El Oued, Algiers, Algeria, 2024

Figure 3. presents a pie chart illustrating the educational attainment of the survey participants. Notably, a significant majority, comprising 62.50%, holds a bachelor's degree. Additionally, approximately 22.92% possess a doctoral degree, while the remaining 14.58% have a master's degree.

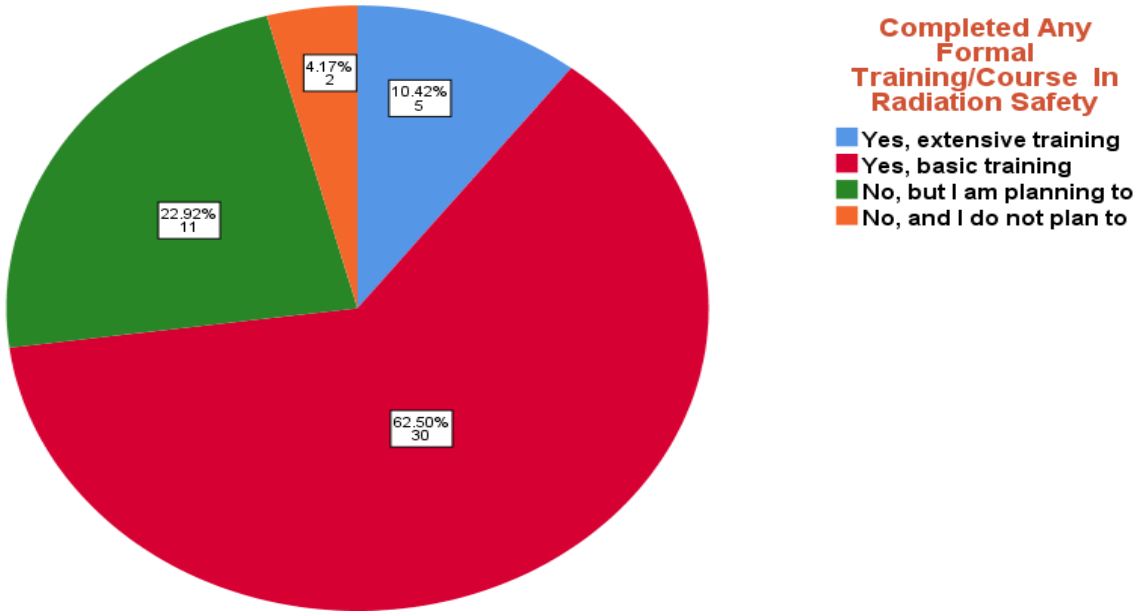


Figure 4. Nuclear medicine staff members status on Completion of any formal training/courses in radiation safety in CHU de Bab El Oued, Algiers, Algeria, 2024.

Figure 4. above illustrates the survey participants' completion status of formal training or courses related to radiation safety. A significant majority, comprising 72.92% (35), reported having undergone comprehensive to basic training courses in radiation safety. Conversely, a minority of participants indicated that they had not completed any formal training on radiation safety.

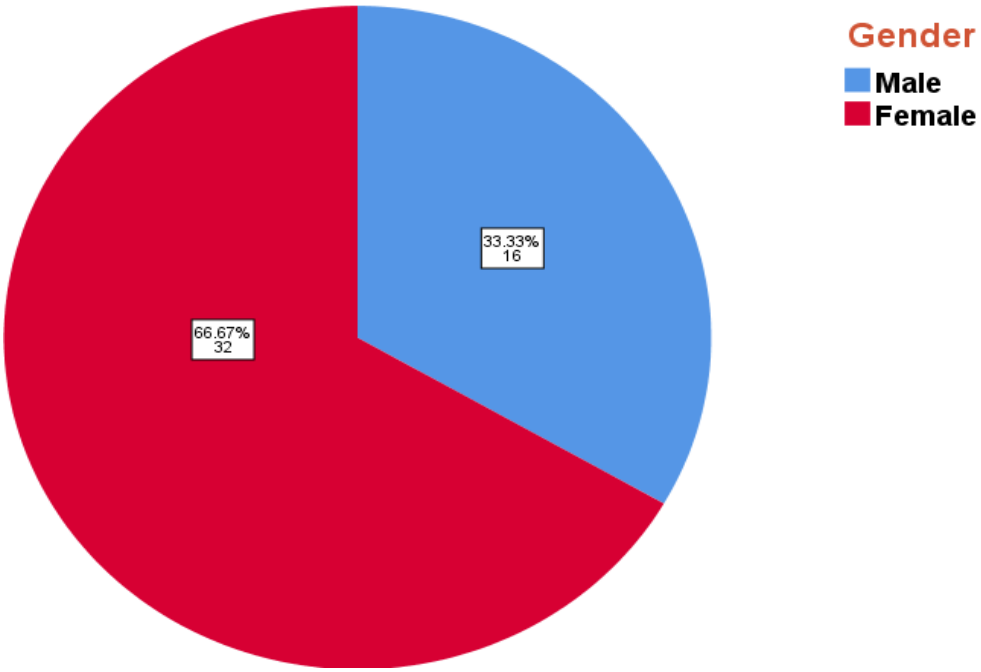


Figure 5. Nuclear medicine staff members Gender distribution in CHU de Bab El Oued, Algiers, Algeria, 2024

Figure 5. illustrated above shows the gender distribution among the research participant staff members, revealing that a predominant majority, comprising 66.67% (32 individuals), are female. Males constitute the remaining 33.33% (16 individuals) of the study.

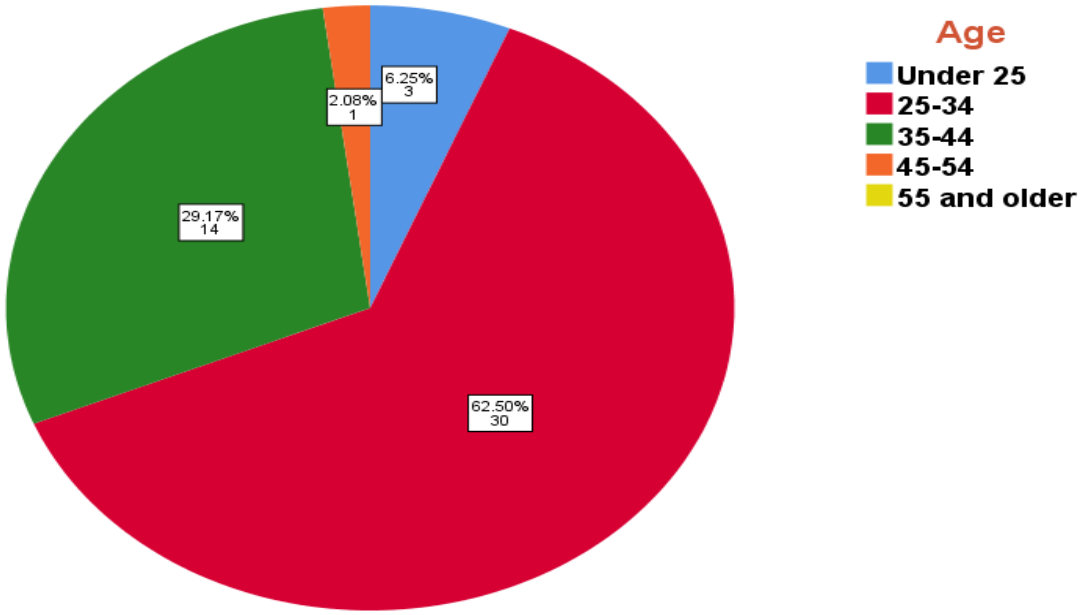


Figure 6. Nuclear medicine staff members Age Distribution in CHU de Bab El Oued, Algiers, Algeria, 2024

The above pie chart illustrates the age distribution of participants in the study. Notably, a predominant segment, comprising 62.50%, falls within the age range of 25 to 34 years. In contrast, 31.25% of participants are aged above 35 years, while a smaller fraction, accounting for 6.25%, is aged under 25. This data highlights a significant concentration of younger adults among the participants.

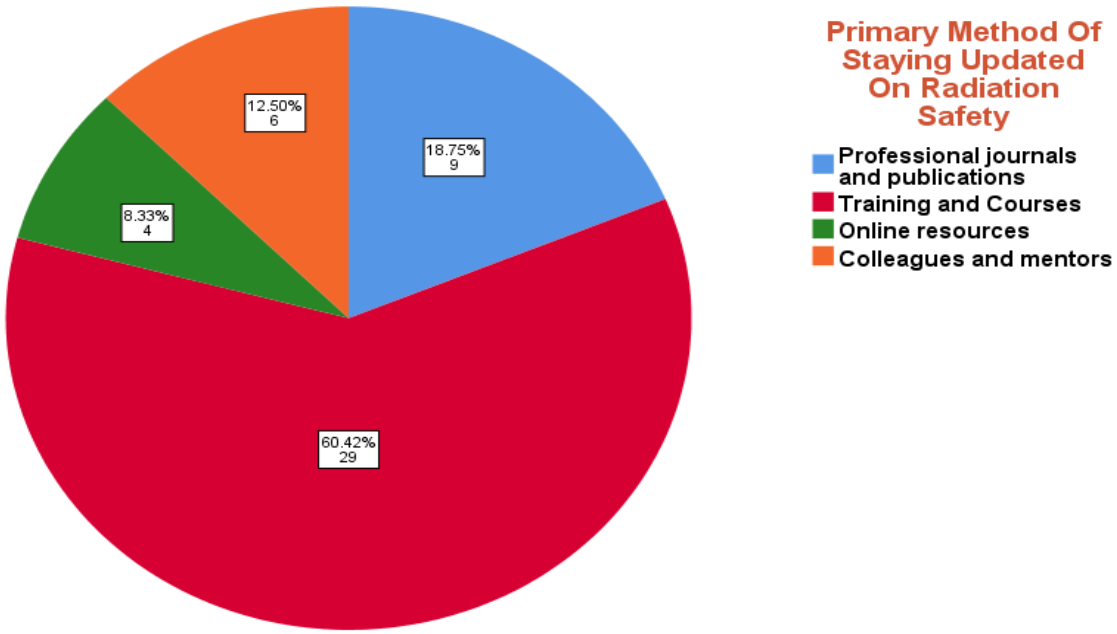


Figure 7. Nuclear medicine staff members Primary Method of source of information on Radiation Safety in CHU de Bab El Oued, Algiers, Algeria, 2024.

The figure 7. above illustrates the primary methods through which study participants acquire information on radiation safety. Notably, training courses emerged as the predominant source, utilized by approximately 60.42% of participants. Professional journals and publications were referenced by 18.75% of individuals, while online resources and information from colleagues /mentors accounted for 8.33% and 12.50%, respectively. The result of this statics shows that most of the staff members use training courses as their main source of information in radiation safety.

8.2 Knowledge Assessment

Nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued, Algiers, Algeria were assessed their knowledge by asking them basic questions regarding Radiation Safety. The result is displayed below,

Table 1. Summary of knowledge assessment regarding Radiation Safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Knowledge testing questions	Correct Response	Incorrect Response
1.Unit of measurement for radiation dose?	48(100%)	0
2.Purpose of radiation shielding	34(70.8%)	14(29.2%)
3.Source of radiation exposure in nuclear medicine?	48(100%)	0
4.Maximum annual dose limit	39(81.3%)	9(18.7%)
5. Radiation used in nuclear medicine	47(97.9%)	1(2.1%)
6. How often should radiation surveys be conducted	42(87.5%)	6(12.5%)
7. Primary role of a dosimeter	40(83.3%)	8(16.7%)
8. Which principle is most effective in minimizing radiation exposure?	48(100%)	0
9. What is the purpose of a radiation safety officer (RSO) in a nuclear medicine facility?	47(97.9%)	1(2.1%)
10. What should be done if a spill of radioactive material occurs?	46(95.8)	2(4.2%)
Total cumulative percent	***91.45 %***	***8.55 %***

The analysis displayed above in, Table 1, illustrates the general knowledge assessment on radiation safety conducted within the Service de Médecine Nucléaire at the CHU de Bab El Oued in Algiers, Algeria, showed an overall score of 91.45% (Table 1) correct understanding concerning general knowledge in Radiation Safety among the nuclear medicine staff members. And the remaining 8.55% of them responded incorrectly.

8.3 Attitude Assessment

Nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued, Algiers, were asked their Opinion and Attitude regarding Radiation Safety. Result is displayed below,

Table 2. Summary of Attitude assessment regarding Radiation Safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Attitudinal Testing Questions	Positive Response	Negative Response	Neutral Response
1. How important do you think radiation safety is in your daily work?	48(100%)	0	.0
2. Do you feel adequately trained to handle radiation safety issues?	44(91.7%)	4(8.3%)	0
3. How confident are you in identifying potential radiation hazards in your work environment?	43(89.6)	5(10.4%)	0
4. Do you believe that radiation safety procedures are 1 followed in your facility?	43(89.6)	5(10.4%)	0
5. How would you rate the importance of regular refresher training on radiation safety?	48(100%)	0	0
6. Do you think your colleagues take radiation safety seriously?	47(97.9%)	1(2.1%)	0
7. How do you feel about the adequacy of personal protective equipment (PPE) provided for radiation protection?	43(89.6)	5(10.4%)	0
8. Do you believe that proper radiation safety practices can significantly reduce health risks for staff?	48(100%)	0	0
9. How satisfied are you with the level of support from management regarding radiation safety?	38(79.2%)	1(2.1%)	9(18.7%)
10. Do you feel that there is a culture of safety in your workplace regarding radiation exposure?	46(95.8%)	1(2.1%)	1(2.1%)
Total Cumulative Percent	***93.34%***	***4.58%***	***2.08%***

The questionnaire responses have indicated that 93.34% (Table 2) of nuclear medicine staff members at the Service de Médecine Nucléaire of CHU de Bab El Oued possess a positive attitude towards radiation safety. And 4.58% of the participants had negative attitude regarding radiation

safety and the remaining 2.08% of them had neutral response refers to a response option that indicates neither a positive nor a negative attitude toward the specific attitude assessing question.

8.4 Practice Assessment

Nuclear medicine staff members in Service de medicine nuclear-CHU de Bab El Oued, Algiers, Algeria were asked questions to assess their actual practice regarding Radiation Safety. The result displayed below.

Table 3. Summary of Practice assessment regarding Radiation Safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Questions associated with professional's safety habits implementations	Acceptable practical Response	Non-Acceptable practical Response
1. How frequently do you wear your dosimeter during work?	48(100%)	0
2. Do you regularly check your dosimeter readings?	40(83.3%)	8(16.7%)
3. How often do you perform radiation safety checks in your work area?	39(81.3%)	9(18.7%)
4. Do you follow established protocols for patient handling and positioning during procedures?	46(95.8)	2(4.2%)
5. How do you ensure that radioactive waste is properly disposed of?	43(89.6)	5(10.4%)
6. Do you report unsafe conditions or practices related to radiation safety?	47(97.9%)	1(2.1%)
7. Do you document and report any incidents of radiation overexposure or contamination?	44(91.7%)	4(8.3%)
8. How often do you clean and maintain your radiation protection equipment?	44(91.7%)	4(8.3%)
9. How often do you review radiation safety policies and procedures?	41(85.4%)	7(14.6%)
10. Do you use protective barriers or lead shields during procedures with radioactive materials?	43(89.6%)	5(10.4%)
11. How do you handle and store radioactive materials safely?	47(97.9%)	1(2.1%)
12. How do you ensure that patient doses are kept as low as reasonably achievable (ALARA)?	25(52.1%)	23(47.9%)

13. Do you actively seek feedback on your radiation safety practices from supervisors or peers?	45(93.7%)	3(6.3%)
Total Cumulative Percent (Average Result)	***88.46%***	***11.54%***

The data reflects an acceptable practice response rate of 88.46% (Table 3) towards Radiation Safety among the nuclear medicine staff members at the Service de Médecine Nucléaire at CHU de Bab El Oued. Participants with non-acceptable practical response accounts for 11.54%. Furthermore, practical assessment revealed interesting result regarding there dosimeter usage, 100% of survey participants reported wearing dosimeters daily while performing their duties.

8.5 Additional Analysis

Upon further analysis, we try to establish correlations between the participants' knowledge scores and various independent variables. The findings are summarized in Table 4 below.

Table 4. Additional Analysis on knowledge assessments regarding radiation safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Characteristic		*Mean*	*Frequency*	*Std. Deviation*	*P-value*
1.job title	Nuclear Medicine Technologist	88.32%	6	9.83	0.072
	Nuclear Medicine physician and residents	95.21%	27	7.00	
	Radio pharmacist	90.00%	3	-	
	RIA laboratory technician	86.72%	6	12.11	
	Nuclear medicine Nurse	77.53%	4	22.17	
	Radio chemist	100.00%	1	-	
	Medical physicists	90.00%	1	-	
2.years of experience	Less than 1 year	100.00%	3	-	0.919
	1-3 years	91.23%	24	9.47	
	4-7 years	88.00%	15	13.73	
	8-15 years	96.02%	5	5.48	
	More than 15 years	100.00%	1	-.	
3.level of education					
	Bachelor’s Degree	90.32%	30	12.45	0.358
	Master’s Degree	92.91%	7	4.88	
	Doctoral Degree	93.65%	11	8.09	
4.completed any formal training or certification in radiation safety?	Yes, extensive training	92.00%	5	8.37	0.497
	Yes, basic training	91.74%	30	11.47	
	No, but I am planning to	91.73%	11	10.09	
	No, and I do not plan to	80.05%	2	00.00	
5.gender	Male	93.81%	16	7.19	0.300
	Female	90.35%	32	12.04	
6.Age	Under 25	93.34%	3	11.55	0.259
	25-34	89.74%	30	11.89	

	35-44	94.36%	14	7.56	
	45-54	100.00%	1	-.	
7.primary method of staying updated on radiation safety practices?	Professional journals and publications	93.36%	9	8.66	0.997
	Training courses and workshops	90.76%	29	11.93	
	Online resources and forums	90.00%	4	11.55	
	Colleagues and mentors	93.38%	6	8.16	

The study conducted to assess knowledge levels among various professionals in the field of nuclear medicine as the result displayed in Table 4, revealed findings particularly concerning the relationship between level of the staff members knowledge with different independent variables the first one is job titles and knowledge scores. Notably, the analysis found no statistically significant differences ($p > 0.05$) in knowledge based on profession. Among the diverse professional groups evaluated, nurses exhibited the lowest average knowledge score when compared with other professionals, with a mean of 77.53% (Table 4) and a standard deviation of 22.17. The difference in mean scores among the professions was not statistically significant p value of 0.072 ($p > 0.05$).

Furthermore, when examining the participants' years of experience in nuclear medicine. Both staff members with more than 15 years of experience and those with less than one year demonstrated admirable knowledge levels, achieving scores categorized as good to excellent. Newer staff, who may be more recently trained in current practices, and experienced professionals, who might possess extensive practical knowledge gained over years, have a solid grasp of fundamental radiation safety principles knowledges with no statically significant difference found with p value of 0.919 ($p > 0.05$).

Knowledge analysis in terms of the level of education of the study participants, bachelor's degrees holders scored marginally lower than their counterparts holding master's and doctorate degrees. This observed difference was considered statistically insignificant with p value of 0.358 ($p > 0.05$).

A correlational analysis was also conducted to assess the mean knowledge scores of participants regarding basic radiation safety understanding in relation to their status on formal training course in this area. The results indicated that participants who had neither undertaken any formal training in radiation safety nor had plans to do so scored a mean knowledge percentage of 80.05%. This score was notably lower than that of participants who had completed formal courses or training in radiation safety 92.00%. However, difference in knowledge scores between the two groups was not statistically significant, with a p-value of 0.497 ($p > 0.05$).

In a study assessing radiation safety knowledge, male participants demonstrated a marginally higher score compared to their female counterparts. Specifically, the analysis focused on participants' understanding of fundamental principles associated with radiation safety. However, the observed difference in scores was not statistically significant with p value of 0.300 ($p > 0.05$).

An analysis of knowledge scores across different age groups reveals that all participants demonstrated a solid understanding of the subject matter. Notably, individuals aged 35 and above achieved an impressive average knowledge score of over 94.36%, indicating a strong grasp of the content compared to younger participants. However, despite this apparent advantage, the difference in knowledge scores between age groups did not reach statistical significance, with a p-value of 0.259 ($p > 0.05$).

Generally, the study's analysis revealed that there were no statistically significant relationships ($p>0.05$) between the outcome variables related to knowledge and the independent variables observed. Indicating that their basic knowledge of radiation protection is quite satisfactory.

The findings showed below in **Table 5** illustrate the correlation between the average levels of radiation safety attitudes and various independent variables.

Table 5. Additional Analysis on Attitude assessments regarding radiation safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Characteristic		*Mean*	*Frequency*	*Std. Deviation*	*P-value*
1.job title	Nuclear Medicine Technologist	95.00%	6	5.477	0.339
	Nuclear Medicine physician and residents	95.19%	27	9.755	
	Radio pharmacist	93.33%	3	5.774	
	RIA laboratory technician	90.00%	6	12.649	
	Nuclear medicine Nurse	90.00%	4	14.142	
	Radio chemist	90.00%	1	.	
	Medical physicists	100.00%	1	.	
2.years of experience	Less than 1 year	73.33%	3	5.774	**0.010**
	1-3 years	93.75%	24	10.135	
	4-7 years	97.33%	15	4.577	
	8-15 years	98.00%	5	4.472	
	More than 15 years	90.00%	1	.	
3.level of education					
	Bachelor’s Degree	94.00%	30	9.322	0.927
	Master’s Degree	92.86%	7	11.127	
	Doctoral Degree	94.55%	11	10.357	
4.completed any formal training or certification in radiation safety?	Yes, extensive training	94.00%	5	13.416	0.385
	Yes, basic training	95.67%	30	6.789	
	No, but I am planning to	88.18%	11	13.280	
	No, and I do not plan to	100.00%	2	-	
5.gender	Male	91.87%	16	11.673	0.294
	Female	95.00%	32	8.424	
6.Age	Under 25	76.67%	3	11.547	0.231
	25-34	95.67%	30	7.739	
	35-44	94.29%	14	10.163	

	45-54	90.00%	1	.	
7.primary method of staying updated on radiation safety practices?	Professional journals and publications	97.78%	9	4.410	0.090
	Training courses and workshops	94.48%	29	8.696	
	Online resources and forums	85.00%	4	17.321	
	Colleagues and mentors	91.67%	6	11.690	

The findings presented in **Table 5** reveal that the levels of radiation safety attitudes among different independent variables the first correlative analysis is done on various job titled staff members, thus the attitude level of almost all professional groups are notably high, with all participants achieving scores exceeding 90.00%. Moreover, statistical analysis shows that there are no significant differences in attitudes based on profession with p value of 0.339 ($p > 0.05$).

In Service de Médecine Nucléaire at CHU de Bab El Oued, this research has indicated a statistically significant difference in the radiation safety attitudes among nuclear medicine staff members as it correlates with their years of experience, achieving a level of significance at **0.010** ($p<0.05$). This finding highlights how experience plays an essential role in influencing the radiation safety attitudes of professionals in this specific area. For instance, participants who possessed less than one year of experience exhibited a relatively lower attitude score, averaging 73.33% with a standard deviation of 5.7, suggesting a gap in their perception of safety protocols compared to their more experienced counterparts.

The analysis of the participants' highest level of education reveals that there is no statistically significant difference in the attitudes observed across different educational backgrounds. However, participants holding a doctorate degree exhibit a relatively higher attitude score, averaging 94.55% with a standard deviation of 10.35. In contrast, those with bachelor's and master's degrees scored lower, although the differences did not reach statistical significance with p value of 0.927 ($p > 0.05$).

Observations regarding participants' opinions on radiation safety reveal that those who have completed formal training courses exhibit a more favorable attitude towards radiation safety

compared to those who have not received any training. However, it is important to note that statistical analysis indicates this difference is not significant with p value 0.385 ($p > 0.05$).

In an analysis of participants' attitudes based on gender, it was observed that female participants exhibited a higher average positive attitude score of 95.00% (SD = 8.42) compared to their male counterparts, who scored an average of 91.87% (SD = 11.67). While the data indicates a trend suggesting that females may have a more positive attitude, this difference did not reach statistical significance, as evidenced by a p-value of 0.294 ($p > 0.05$).

In this study examining attitudes towards radiation safety, participants were categorized by age, in their responses. Individuals aged under 25 displayed a less favorable attitude towards radiation safety, achieving an average score of 76.67% with a standard deviation of 11.54%. In contrast, older age groups demonstrated a more positive attitude, recording attitude scores exceeding 90%. Although these findings suggest a variance in attitudes based on age, the statistical analysis indicated that the difference was not significant, with a p-value of 0.231 ($p > 0.05$).

Analysis relating participants' sources of information on radiation safety with their respective attitude on radiation safety, it was found that the majority relied on online resources for their knowledge, this group demonstrated a relatively lower attitude toward radiation safety compared to those who utilized other information sources, such as official training or expert consultations. However, it is important to note that the difference in attitudes between the two groups was not statistically significant with level of significance of 0.090 ($p > 0.05$).

Generally, in examining the attitude section of our study, it became evident that years of experience significantly influenced participants' perceptions and attitudes toward radiation safety with level of significance of **0.010** ($p<0.05$). Notably, individuals with less than one year of experience, despite demonstrating a solid understanding of the foundational principles of radiation safety knowledge, exhibited a negative attitude towards the importance of these safety measures.

The findings presented in Table 6 below summarize the correlation between the average levels of radiation safety practices and various independent variables.

Table 6. Additional Analysis on Practice assessments regarding radiation safety among nuclear medicine staff members in CHU de Bab El Oued, Algiers, Algeria, 2024

Characteristic		*Mean*	*Frequency*	*Std. Deviation*	*P-value*
1.job title	Nuclear Medicine Technologist	89.74%	6	9.316	0.495
	Nuclear Medicine physician and residents	91.17%	27	13.443	
	Radio pharmacist	94.87%	3	4.441	
	RIA laboratory technician	91.03%	6	12.324	
	Nuclear medicine Nurse	90.38%	4	11.538	
	Radio chemist	100.00%	1	_	
	Medical physicists	100.00%	1	_	
2.years of experience	Less than 1 year	84..62%	3	20.352	0.774
	1-3 years	91.99%	24	10.265	
	4-7 years	92.31%	15	13.943	
	8-15 years	92.31%	5	9.421	
	More than 15 years	84.62%	1	.	
3.level of education	Bachelor's Degree	94.10%	30	8.495	**0.016**
	Master's Degree	92.31%	7	11.750	
	Doctoral Degree	83.92%	11	16.660	
4.completed any formal training or certification in radiation safety?	Yes, extensive training	90.77%	5	8.427	0.128
	Yes, basic training	93.33%	30	8.743	
	No, but I am planning to	90.21%	11	13.364	
	No, and I do not plan to	73.08%	2	38.075	
5.gender	Male	87.02%	16	15.053	0.062
	Female	93.75%	32	9.255	
6.Age	Under 25	82.05%	3	16.013	0.327
	25-34	92.05%	30	12.853	
	35-44	91.76%	14	8.243	

	45-54	100.00%	1	–	
7.primary method of staying updated on radiation safety practices?	Professional journals and publications	89.74%	9	17.201	0.060
	Training courses and workshops	95.23%	29	6.634	
	Online resources and forums	82.69%	4	20.230	
	Colleagues and mentors	82.05%	6	9.316	

Table 6 presents findings related to the radiation protection practices among nuclear medicine staff members, highlighting the actual practical behavior associated with radiation safety in their professional roles.

The analysis on radiation safety practice among different independent variables the first correlational analysis is done on various job titled staff members, indicates that there were no statistically significant differences with p value of 0.495 ($p > 0.05$) in radiation protection practices based on job titles within the field. However, it is notable that nuclear medicine technologists exhibited comparatively lower practical scores (89.74%) in their adherence to radiation safety protocols when evaluated alongside other nuclear medicine professionals.

In analysis of radiation safety practices among professionals with varying years of experience, it was observed that participants with 4 to 15 years of experience demonstrated superior practical score compared to their less experienced counterparts. However, the differences were not statistically significant with p value 0.774 ($p > 0.05$).

In examining the relationship between educational attainment and practical proficiency in radiation safety, a statistically significant difference occurred, underscored by a p-value of ***0.016*** *($p < 0.05$).*This finding highlights an interesting dynamic where staff members possessing doctorate degrees, while demonstrating a strong theoretical understanding and a positive attitude towards radiation safety, did not perform as effectively in practical assessments compared to their counterparts with bachelor's and master's degrees. Specifically, individuals with doctoral qualifications achieved an average score of 83.92%, accompanied by a standard deviation of 16.66,

indicating some variability in their performance. In contrast, participants holding bachelor's degrees scored an average of 94.10% (SD=8.49), while those with master's degrees secured an average score of 92.31% (SD=11.75).

In examining the practical behaviors of individuals regarding radiation safety, participants who completed a training course exhibited a higher level of practical compliance than those who had not received any formal instruction. Specifically, individuals without training scored an average of 73.08% (SD=38.075) in their practice of safety protocols; however, this disparity was not statistically significant, as indicated by a p-value of 0.128 ($p > 0.05$).

When comparing the results between genders, the analysis indicates that female participants achieved a higher practical outcome than their male counterparts, with scores of 93.75% (SD = 9.25) for females and 87.02% (SD = 15.05) for males. However, the observed difference is not statistically significant, as the p-value of 0.062 ($p > 0.05$).

In examining the practical assessments of participants based on age, it was found that individuals under 25 years demonstrated lower levels of engagement in radiation safety practice behaviors with score of 82.05% compared to their older counterparts who scored more than 91.76%. However, observed differences in practical activity levels across age groups were not statistically significant with level of significant value of 0.327($p > 0.05$).

9. Discussion

The primary objective of the research undertaken at the Service de Médecine Nucléaire—CHU de Bab El Oued, located in Algiers, Algeria, was to evaluate the Knowledge, Attitude, and Practice (KAP) regarding Radiation Safety among the nuclear medicine staff members. A detailed evaluation of the KAP allows for the identification of specific gaps. By systematically addressing these deficiencies nuclear medicine institutions implement targeted training programs and educational initiatives regarding radiation safety tailored to the needs of their staff members. Over time, such interventions can reinforce culture of safety within the institution. (Danial.et.al.2019).

The study conducted at the Service de Médecine Nucléaire-CHU de Bab El Oued in Algiers, Algeria, surveyed 48 nuclear medicine staff members to assess their KAP towards radiation safety, yielding a response rate of 96%. One of notable demographic characteristic was the gender distribution, with females constituting the majority at 66.7% (32 individuals), indicating a higher representation of women within the nuclear medicine centre's professional workforce, which could suggest positive trends in gender inclusivity within this advanced nuclear medicine institutions.

Furthermore, the age distribution revealed a predominance of younger individuals, specifically those between 25 and 34 years old, suggesting that the centre benefits from a relatively youthful and energetic team. A significant proportion of the participants, approximately 72.9%, reported having completed both basic and extensive training courses in radiation safety, indicating the institution's commitment to providing comprehensive radiation safety education to a large segment of its staff, thereby ensuring a high standard of safety practices within the facility.

The analysis result on general knowledge assessment on radiation safety conducted within the Service de Médecine Nucléaire at the CHU de Bab El Oued in Algiers, Algeria, showed an overall score of 91.45% had correct understanding concerning general knowledge in Radiation Safety among the nuclear medicine staff members. This remarkably high percentage shows the competency and high level of theoretical understanding in basic radiation safety knowledge among the personnel in this nuclear medicine institution. Such a level of proficiency reflects the effectiveness of the training courses and educational programs. The continued emphasis on education and awareness in Radiation Safety is proven to be vital in maintaining these high standards. (National Council on Radiation Protection and Measurements, NCRP.2009).

The questionnaire responses have indicated that 93.34% of nuclear medicine staff members at the Service de Médecine Nucléaire of CHU de Bab El Oued possess a positive attitude towards radiation safety showing the commitment of these professionals to maintain safety standards in their practices. This high percentage indicates the collective understanding among the staff members of the critical importance of radiation safety. The attitude assessment revealed a strong consensus among nuclear medicine personnel regarding the importance of radiation safety.

Furthermore, all respondents overwhelmingly stressed the necessity of regular refresher training to maintain and enhance radiation safety protocols.Such a strong consensus regarding attitude of radiation safety is indicative of effective training, ongoing education, and a shared dedication among the team to enhance their knowledge and application of safety measures as also mentioned by a study done by Aspasia et al 2012, about radiation protection attitude. Consequently, this favourable attitude contributes significantly to minimizing potential risks associated with radiation exposure, thereby promote a safer environment for both healthcare providers and those they serve. (Aspasia Goula et al,2021)

The data reflects a practice rate of 88.46% towards Radiation Safety among the nuclear medicine staff members at the Service de Médecine Nucléaire at CHU de Bab El Oued this result shows that the commitment by these professionals in practicing based on the established safety protocols and guidelines. This high percentage of good practical response has a critical importance of maintaining safety measures. Furthermore, practical assessment revealed interesting result regarding there dosimeter usage, all survey participants reported wearing dosimeters daily while performing their duties. Dosimeter usage is a critical component of ensuring the safety and well-being of personnel working in radiation environments as also suggested by Hasan's et al 2017. (Hasan, S., McGowan, M. .2017).

The Additional assessment on knowledge levels among various professionals in the field of nuclear medicine revealed that there were no statistically significant relationships ($p>0.05$) between the outcome variables related to knowledge and the independent variables observed. This suggests that the staff members exhibited a solid foundational understanding of radiation safety, indicating that their basic knowledge of radiation protection is quite satisfactory.

A study conducted within the Service de Médecine Nucléaire at CHU de Bab El Oued revealed a statistically significant correlation between nuclear medicine staff members' years of experience and their attitudes towards radiation safety, participants who possessed less than one year of experience exhibited a relatively lower attitude than there more experienced counterpart with significance level of **(p=0.010, p<0.05)** ,this significant result align with the study done by Aspasia et.al, 2021 mentioning that radiation protection attitude is significantly correlated with years of experience with significant level of p= 0.037, p<0.05 . This suggests that experience is a key factor in shaping professionals' perspectives on radiation safety within this specialized field. (Aspasia Goula et al,2021)

Understanding these distinctions is vital, not only for enhancing staff members training programs but also for ensuring that patient safety and care quality are maintained within nuclear medicine practices. Therefore, targeted interventions that address the specific needs of less experienced staff members may prove beneficial in strengthening their radiation safety attitudes, eventually developing a safer environment for both healthcare workers and patients this result aligns with a similar study conducted by Alomairy N.A.et al 2024,in that study, participants with over six years of experience scored highest on positive attitude measures versus those with 1-5 years of experience but the reviled difference was not statistically significant with p value of 0.60(p>0.05). (Alomairy N.A.et al ,2024 &).

Generally, in examining the attitude section of our study, it became evident that years of experience significantly influenced participants' perceptions and attitudes toward radiation safety with level of significance of 0.010 (p <0.05). Notably, individuals with less than one year of experience, despite demonstrating a solid understanding of the foundational principles of radiation safety knowledge, exhibited a negative attitude towards the importance of these safety measures. This finding suggests that while knowledge about radiation safety protocols may be present, it is not sufficient to adopt a positive attitude towards their application in practice.

In examining the relationship between educational attainment and practical proficiency in radiation safety, a statistically significant difference occurred, underscored by a p-value of **0.016 (p <**

0.05). This finding highlights an interesting dynamic where staff members possessing doctorate degrees, while demonstrating a strong theoretical understanding and a positive attitude towards radiation safety, did not perform as effectively in practical assessments compared to their counterparts with bachelor's and master's degrees. Specifically, individuals with doctoral qualifications achieved an average score of 83.92%, indicating some variability in their performance. In contrast, participants holding bachelor's degrees scored an average of 94.10% while those with master's degrees secured an average score of 92.31%.

This trend raises important questions regarding the applicability of theoretical knowledge in real-world scenarios, suggesting that while advanced education may equip individuals with critical insights into radiation safety principles, it might not necessarily translate to superior radiation safety practice. This observation aligns with a study conducted by A. Alyami and colleagues in 2022, which found that while nurses in the nuclear medicine department displayed satisfactory awareness awareness & knowledge on radiation protection (approximately 93.1%), only 27.5% exhibited acceptable radiation safety practices. Our findings echo this trend, highlighting that participants with strong knowledge and positive attitudes regarding radiation safety but demonstrated relatively low competency in practical applications. (A.Alyami et.al 2022).

Furthermore, in a study done by A. Kalkidan, and others in 2024 to assess KAP of radiation safety precautions among orthopedic residents and surgeons across two institutions revealed concerning statistics: 48.2%, 52.6%, and 43.9% of the orthopedic residents and consultants had inadequate knowledge, negative attitudes, and poor practice regarding radiation safety, respectively. This suggests that nearly half of the participants lacked sufficient knowledge, held negative attitudes, and demonstrated unsatisfactory practices concerning radiation safety precautions, reinforcing the need for enhanced training and education across various levels of healthcare professionals. Awareness creation about radiation safety precaution should be given through training or other possible educational approach for orthopedic residents and consultants. Training on radiation safety and prevention should be given for all orthopedic residents and consultants. (Kalkidan .A. et al.2024).

10. Strength and Limitation of the study

10.1 Strength of the Study

One of the major strengths of this survey is that it represents the first pilot study conducted in the Service de Médecine Nucléaire at CHU de Bab El Oued, located in Algiers, Algeria, aimed at assessing the knowledge, attitudes, and practices related to radiation safety among the staff members. Being the first of its kind in this specific context is a significant advantage, as it lays the groundwork for future research and provides a baseline understanding of the current state of staff's radiation safety KAP within the institution. Furthermore, the research design emphasizes inclusivity, as efforts were made to involve a broad spectrum of staff members in the survey process. The principal investigator took the initiative to explain the purpose and importance of the survey to each participant individually before distributing the questionnaires, which not only improvs transparency but also encourages thoughtful and informed responses from the staff members. This personalized approach enhances the quality of the data collected, as participants are more likely to engage meaningfully when they understand the relevance of the study. Additionally, the study's strength lies in its comprehensive attempt to include the majority of the study population, ensuring that the findings reflect a diverse range of perspectives and experiences related to radiation safety practices within the department. Collectively, these elements contribute to the strength of the research, highlighting its potential to update policy and training initiatives aimed at improving radiation safety protocols in this nuclear medicine institution.

11.2 Limitations of the study

This study has some notable limitations that needs careful consideration when interpreting the findings. Firstly, as a cross-sectional study, it is constrained by the limitations associated with this design, such as its inability to establish causality or observe changes over time. Additionally, because this research is conducted within a single institution, its conclusions are primarily relevant to that specific setting and may not be generalizable to other nuclear medicine institutions throughout Algiers, Algeria, or beyond. This restriction is particularly significant given that

healthcare practices, patient demographics, and resource availability can differ widely between institutions, which could potentially impact the results. Finally, the study employs the mean as a principal criterion for measuring and classifying the values of the outcome variables, which might oversimplify complex data sets and obscure important variations. The dependence on mean values can mask outliers or skewed distributions, potentially leading to misleading conclusions about the overall results and also the sample size was small. Thus, while this study provides valuable insights, its limitations highlight the need for cautious interpretation and underscore the necessity for further research to extend its findings across different contexts.

11. Conclusion

This study reveals that while staff members generally possess a solid understanding and knowledge of fundamental radiation safety principles, certain concerning trends have emerged regarding their attitudes and practices. Specifically, it was found that staff members with less than one year of experience demonstrated a lower attitude score towards radiation safety, suggesting a need for enhanced training and awareness among newer employees specifically by focusing on their beliefs and attitude towards radiation safety. Additionally, study participants holding doctorate degrees shows admirable knowledge levels and a positive attitude towards radiation safety; but, their practical application of this knowledge was not adequate. These findings highlight the necessity for targeted education and interventions to bridge the gap between theoretical understanding and practical implementation of radiation safety measures among various experience levels within the staff members.

12. Recommendations

In light of the findings from our study on radiation protection and safety, it is evident that similar issues have been observed in other institutions regarding knowledge, attitudes, and actual practices. To address these challenges, it's recommended that nuclear medicine centers implement ongoing professional training programs, particularly targeting newer staff members These short-term training sessions should focus on developing a positive attitude towards radiation safety, conveying essential knowledge and principles, bridging the gap between theory and practice, and emphasizing the importance of radiation protection for both patients and healthcare providers. Furthermore, it is crucial to establish a system for monitoring and supervising the practices of nuclear medicine professionals. When instances of malpractice are identified during these observations, immediate corrective action should be taken, including on-the-spot practical lessons for the involved staff members. Such measures will not only enhance the understanding and knowledge on radiation safety but also develops a culture of good radiation safety practice.

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Annexes—1. Comprehensive questionnaire

Informed Consent

Informed Consent for Participation in Research Study

Title*:* Assessment of Knowledge, Attitude, and Practice on Radiation Safety among Nuclear Medicine Staff members in Service de Medicine Nuclear-CHU de Bab El Oued, Algiers, Algeria

You are invited to participate in a research study aimed at assessing the knowledge, attitudes, and practices concerning radiation safety among nuclear medicine staff members. Participation is voluntary, and you may withdraw at any time without consequence. The survey will be conducted via questionnaire. The information collected will be used solely for research purposes, ensuring confidentiality and anonymity. The information that will be obtained in this survey is only for scientific research and your involvement will contribute significantly to enhancing radiation safety protocols.

By clicking "Yes" below, you acknowledge that you have read and understood that:

- Your participation in this survey is voluntary. You may withdraw your consent and discontinue participation in the project at any time. Your refusal to participate will not in any way adversely impact upon you.
- You have given consent to be a subject of this research and respond to the survey / questionnaire(s) as truly as possible

Do you wish to participate in this study?

- **Yes, I am consenting to participate**
- **No, I am NOT consenting to participate**

Comprehensive questionnaire designed to assess the knowledge, attitude, and practices regarding radiation safety among nuclear medicine staff members. in Service de medicine nuclear-CHU de Bab El Oued, Algiers, Algeria:

This questionnaire is divided into four sections: Demographic, Knowledge, Attitude, and Practice questions.

Section 1; Demographic questions

Questions in this section aim to evaluate demographic information.

1. What is your job title?

a) Nuclear Medicine Technologist
b) Radiation Safety Officer
c) Nuclear Medicine physician
d) Nuclear Medicine Resident
e) Radiopharmacist
f) RIA laboratory technologists
g) Other (please specify)

2. How many years of experience do you have in nuclear medicine?

a) Less than 1 year
b) 1-3 years
c) 4-7 years
d) 8-15 years
e) More than 15 years

3.What is your highest level of education?

a) Bachelor's Degree
b) Master's Degree
c) Doctoral Degree

4. Have you completed any formal training or certification in radiation safety?

a) Yes, extensive training
b) Yes, basic training
c) No, but I am planning to
d) No, and I do not plan to

5. What is your gender?

a) Male
b) Female

6.How old are you?

a) Under 25
b) 25-34
c) 35-44
d) 45-54
e) 55 and older

7.What is your primary method of staying updated on radiation safety practices?

a) Professional journals and publications
b) Training courses and workshops
c) Online resources and forums
d) Colleagues and mentors
e) Other (please specify)

Comprehensive questionnaire designed to assess the knowledge, attitude, and practices regarding radiation safety among nuclear medicine staff members.

Section 2: Knowledge

Questions in this section aim to evaluate the respondent's basic knowledge towards radiation safety.

1.What is the unit of measurement for radiation dose?

a) Grays
b) Sieverts
c) Rads
d) All of the above

2.What is the primary purpose of radiation shielding in nuclear medicine?

a) To protect the equipment
b) To reduce radiation exposure to patients
c) To protect staff from unnecessary radiation exposure
d) To enhance image quality

3.Which of the following is considered a common source of radiation exposure in nuclear medicine?

a) X-ray machines
b) Radioactive tracers
c) MRI machines
d) Ultrasound devices

4.What is the maximum annual dose limit for radiation exposure to nuclear medicine staff as recommended by regulatory bodies?

a) 1 mSv
b) 5 mSv
c) 20 mSv
d) 50 mSv

5.Which type of radiation is most commonly used in nuclear medicine procedures?

a) Alpha particles
b) Beta particles
c) Gamma rays
d) Neutrons

6.How often should radiation surveys be conducted in areas where radioactive materials are used?

a) Daily
b) Weekly
c) Monthly
d) Annually

7. What is the primary role of a dosimeter in radiation safety?

a) To detect radioactive contamination
b) To measure radiation dose received by personnel
c) To monitor radiation levels in the environment
d) To protect against radiation

8.Which principle is most effective in minimizing radiation exposure?

a) Time
b) Distance
c) Shielding
d) All of the above

9. What is the purpose of a radiation safety officer (RSO) in a nuclear medicine facility?

a) To operate radiation equipment
b) To provide patient care
c) To ensure compliance with radiation safety regulations
d) To handle financial aspects of radiation safety

10.What should be done if a major spill of radioactive material occurs?

a) Ignore it if it is minor
b) Evacuate the area immediately
c) Clean the spill with disinfectant
d) Inform the media

Section 3: Attitude

Questions in this section aim to evaluate the respondent's attitude towards radiation safety.

11. How important do you think radiation safety is in your daily work?

a) Extremely important
b) Moderately important
c) Slightly important
d) Not important

12. Do you feel adequately trained to handle radiation safety issues?

a) Yes
b) No
c) Somewhat
d) Not sure

13. How confident are you in identifying potential radiation hazards in your work environment?

a) Very confident
b) Somewhat confident

c) Not very confident
d) Not confident at all

14. Do you believe that radiation safety procedures are always followed in your facility?

a) Always
b) Often
c) Sometimes
d) Rarely

15. How would you rate the importance of regular refresher training on radiation safety?

a) Very important
b) Important
c) Neutral
d) Not important

16. Do you think your colleagues take radiation safety seriously?

a) Yes
b) No
c) Sometimes
d) Not sure

17. How do you feel about the adequacy of personal protective equipment (PPE) provided for radiation protection?

a) Completely adequate
b) Mostly adequate
c) Somewhat inadequate
d) Completely inadequate

18. Do you believe that proper radiation safety practices can significantly reduce health risks for staff members?

a) Strongly agree
b) Agree
c) Disagree
d) Strongly disagree

19.How satisfied are you with the level of support from management regarding radiation safety?

a) Very satisfied
b) Satisfied
c) Neutral
d) Dissatisfied

20. Do you feel that there is a culture of safety in your workplace regarding radiation exposure?

a) Yes
b) No
c) Somewhat
d) Not sure

Section 4: Practice

Questions in this section are designed to assess the respondent's practices regarding radiation safety.

21.How frequently do you wear your dosimeter during work?

a) Always
b) Often
c) Occasionally
d) Rarely

22.Do you regularly check your dosimeter readings?

a) Yes
b) No
c) Sometimes
d) Not sure

23. How often do you perform radiation safety checks in your work area?

a) Daily
b) Weekly
c) Monthly
d) Rarely

24. Do you follow established protocols for patient handling and positioning during procedures?

a) Always
b) Usually
c) Sometimes
d) Rarely

25. How do you ensure that radioactive waste is properly disposed of?

a) Follow facility procedures
b) Rely on others to handle it
c) Dispose of it in regular trash
d) Not sure

26. Do you report unsafe conditions or practices related to radiation safety?

a) Always
b) Often
c) Sometimes
d) Never

27. Do you document and report any incidents of radiation overexposure or contamination?

a) Always
b) Often
c) Sometimes
d) Never

28.How often do you clean and maintain your radiation protection equipment?

a) Regularly
b) Occasionally
c) Rarely
d) Never

29. How often do you review radiation safety policies and procedures?

a) Frequently
b) Occasionally
c) Rarely
d) Never

30. Do you use protective barriers or lead shields during procedures with radioactive materials?

a) Always
b) Often
c) Sometimes
d) Never

31. How do you handle and store radioactive materials safely?

a) Follow established protocols
b) Store them in a safe place
c) Leave them unsecured
d) Not sure

32. How do you ensure that patient doses are kept as low as reasonably achievable (ALARA)?

a) By justifying the procedures
b) By limiting the dose
c) All of the above

33. Do you actively seek feedback on your radiation safety practices from supervisors or peers?

a) Yes
b) No
c) Occasionally
d) Not sure