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Evaluating Radiology Students' Understanding And Awareness Of Key Concepts In Radiologic Sciences

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Abstract

Background: *Students studying radiology must understand the foundational concepts in the subject in order to obtain quality training and progress professionally. The purpose of this study is to assess Radiology students understanding and awareness of fundamental concepts in the discipline, such as imaging methods, radiation safety, anatomical knowledge, and diagnostic interpretation. Undergraduate radiology students from several institutions participated in a cross-sectional survey. The survey evaluated students' theoretical knowledge and practical awareness in several key areas of the radiologic sciences curriculum. To find frequent misconceptions, knowledge gaps, and the impact of academic level on concept mastery, data were studied.*

Method: *This cross-sectional survey was conducted in Department of Radio-diagnosis from several institutions where minimum 104 undergraduate students were taken in this study in which both male and female undergraduate students were included during survey. The survey included multiple choice questions (MCQs) related to radiology, and this study will demonstrate howstudents' theoretical knowledge and practical awareness is necessary for the several key areas of the radiologic sciences*

Result:*This cross-sectional survey was administered to 104 undergraduate radiography students in the Department of Radio - diagnosis at several institutions. There were 58 (55.8%) female and 46 (44.2%) male students in the sample; most of them were in their third or fourth year of study only 52% of students showed sufficient awareness and comprehension of the fundamental ideas in radiologic sciences, according to an analysis of the multiple-choice test. A notable knowledge gap within the cohort was highlighted by the remaining 48%, who either lacked adequate theoretical underpinnings or showed little practical insight.*

Conclusion:*This study concludes that although some undergraduates studying radiography have a moderate comprehension of radiologic sciences, almost half lack proficiency in critical areas, namely safety procedures and clinical application. These results highlight the critical need for improved teaching methods that close the knowledge gap between clinical competency and theoretical learning.*

Keywords: *Ionizing Radiation, Radiation Protection, Radiation protection Equipments, Radiation physics.*

INTRODUCTION

The use of ionizing radiation in medicine has been quickly growing since Wilhelm Conrad Roentgen discovered X-rays in 1985. This is due to recent developments in imaging technology, which hold promise for resolving a wide range of clinical issues [(1)].The greatest source of ionizing radiation exposure for humans is medical exposure. In actuality, medical imaging accounts for almost 90% of radiation exposure from unnatural sources. In addition to its medical use, it poses a risk to biological systems. As a result, it's critical that a radiology student comprehends both the possible risks and the advantages of radiation [(2)].The number of

examinations and, consequently, the population's overall radiation exposure has increased due to the recent dramatic evolution and increased use of ionizing radiation-based diagnostic modalities like multidetector computed tomography (CT), which currently accounts for roughly 50% of the total radiation burden for medical purposes [3]. The safe use of radiation in medical settings is governed by the justification, optimization, and use of dose limitation, which emphasizes the necessity of balancing the potential risks of imaging against its benefits [4].

Importance of Radiological knowledge and Awareness

With extensive uses of radiations in business, research, health, and energy production, radiation is essential to modern society. Radiation technology has many advantages, from improved diagnostic imaging to cancer therapy, but there are also possible hazards to the environment and human health when using it [5].Therefore, thorough radiological knowledge and awareness are necessary to guarantee safe procedures, efficient risk management, and well-informed decision-making for both the general public and experts.Understanding radiation kinds, sources, biological consequences, precautions, and regulatory frameworks are all included in radiological knowledge [6].Contrarily; awareness is the deliberate understanding of radioactive hazards, safety precautions, and suitable reaction tactics in diverse situations. They serve as the cornerstone for upholding safety regulations, reducing exposure, and encouraging the prudent use of radiological technologies.The demand for better education, training, and public outreach grows as the use of ionizing radiation expands worldwide, especially in the industrial and medical sectors. In order to protect health, improve readiness, and promote sustainable technological advancement, this study examines the existing level of radiological knowledge and awareness, identifies gaps and obstacles, and highlights the need of enhancing radiological literacy[7].

Radiologic knowledge among Radiology students

In addition to guaranteeing precise diagnostic imaging and efficient patient care, radiological education is essential for shielding patients and medical personnel from needless radiation hazards [8].Studies have shown that radiology students in various institutions and nations have differing degrees of radiological expertise, despite the fact that radiation plays a crucial role in both academic and clinical training [9]. This disparity may have an effect on the general radiation safety culture in healthcare systems as well as the caliber of radiological services. Therefore, determining educational gaps and improving curriculum design depend heavily on evaluating radiology students' depth of knowledge. This essay seeks to assess radiography students' present level of understanding, identify any knowledge gaps, and offer suggestions methods to improve their comprehension and readiness [10].

Knowledge and importance of Radiation protection

Radiation protection is the collection of procedures, rules, and ideas designed to reduce ionizing radiation exposure for the benefit of both patients and healthcare workers. It is essential in areas where radiation is commonly utilized for medical purposes, such as nuclear medicine, radiotherapy, and diagnostic radiography. All healthcare professionals, particularly those in radiology, must have a thorough awareness of radiation protection in order to guarantee patient safety and adherence to legal requirements [11].Dose limitation, optimization, and justification are important ideas in radiation protection. International agencies including the International Atomic Energy Agency (IAEA) and the International Commission on Radiological Protection (ICRP) have included these concepts in their recommendations.Radiation safety training frequently includes instruction in methods including shielding, keeping a safe distance, minimizing exposure time, and wearing personal protective equipment [12].

Purpose of the study This study aims to assess radiology students' knowledge and comprehension of fundamental ideas in the radiologic sciences, with an emphasis on radiation physicsand radiation safety concepts, as aspiring medical professionals who will have direct contact with ionizing radiation

METHODS & METHODOLOGY

Research Design.

A quantitative survey research design was used in this study to collect participant data. The survey's structured multiple-choice questions (MCQs) were designed to gather quantifiable and impartial data in order to meet the goals of the study.

Participants.

Survey-based 104 undergraduate students participated in the study, which was carried out in the Department of Radio-diagnosis at multiple institutions. Both male and female undergraduate students were surveyed.

Instrument.
A systematic questionnaire with sixteen multiple-choice questions (MCQs) was created. The MCQs were created to address important factors including theoretical knowledge and practical awareness in several important radiologic scientific disciplines. To guarantee topic authenticity, the questions were developed using a review of the literature and expert input.
Data Collection Procedure.
The online survey was conducted between March 3, 2025, and June 30, 2025. The questionnaire was given to participants voluntarily. To make sure participants knew how to choose their responses, clear instructions were given.
Data Analysis.
The MCQ responses were numerically coded and subjected to statistical software analysis. To summarize the data, descriptive statistics were calculated, including mean scores, percentages, and frequencies. Additional inferential statistical tests were used to investigate the connections between the variables.
Selection criteria:
Inclusion criteria:
Radiology students who are enrolled in the Department of Radio-Diagnosis
Exclusion criteria:
Students who are not enrolled in the Department of Radio-Diagnosis
Ethical Considerations.
Participation in the survey was voluntary, and informed consent was obtained from all respondents. Anonymity and confidentiality of the participants' responses were strictly maintained throughout the research process.

RESULT
The cross-sectional survey was administered to 104 undergraduate radiography students in the Department of Radio-diagnosis at several institutions. There were 58 (55.8%) female and 46 (44.2%) male students in the sample; most of them were in their third or fourth year of study.
Overall Performance: Only 52% of students showed sufficient awareness and comprehension of the fundamental ideas in radiologic sciences, according to an analysis of the multiple-choice test. A notable knowledge gap within the cohort was highlighted by the remaining 48%, who either lacked adequate theoretical underpinnings or showed little practical insight.
Theoretical Knowledge Assessment: The survey's theoretical section assessed students' knowledge of radiologic imaging modalities, radiation safety guidelines, the fundamentals of image interpretation, and how to apply contrast media conclusions include
1. For typical clinical situations, 65% of students were able to properly identify the right imaging modality.
2. 58% showed that they understood the difference between ionizing and non-ionizing radiation.
3. Just 43% of respondents correctly identified questions about ALARA (As Low As Reasonably Achievable) principles and radiation protection requirements.
4. 49% demonstrated an understanding of fundamental image interpretation standards, such as differentiating between normal and abnormal signals.
Practical Awareness and Application: Questions about clinical case decision-making, equipment handling procedures, and real-world application scenarios were used to gauge practical knowledge. The findings revealed:
1. Only 47% of respondents knew how to properly place patients in various modalities.
2. Merely 39% of respondents accurately recognized the contrast agent administration protocol and associated contra indications.
3. 51% of respondents were able to correctly distinguish between CT and MRI indications in Neurological and trauma cases.
4. When imaging pregnant patients, 45% of respondents correctly identified the safety Considerations that must be taken.
Gender-Based Analysis: Male and female participants' performance did not differ statistically significantly ($p > 0.05$). Male students had significantly greater awareness of practical issues (mean score: 53% vs. 49%), but female students slightly surpassed their male counterparts in theoretical knowledge (mean score: 63% vs. 59%).

Institutional Variability: Students from institutions that offer integrated clinical-radiologic education programs score higher (average accurate response rate: 61%) than students from institutions that do not (average: 48%), according to preliminary comparisons between institutions that showed some variation in overall student performance.

Table 1: Overall Student Performance in Radiologic Sciences Survey (N = 104)

Performance Area	**Students** (%)	**Interpretation**
Overall Adequate Understanding	52%	Moderate awareness of key radiologic concepts
Overall Inadequate Understanding	48%	Significant knowledge and application gaps
Predominant Academic Year	3rd & 4th Year	Most students were advanced undergraduates

Table 2: Breakdown of Theoretical and Practical Knowledge Scores.

Knowledge Component	**% of Students Answered Correctly**
Theoretical Knowledge	
Identification of appropriate imaging modality	65%
Understanding ionizing vs. non-ionizing radiation	58%
Knowledge of ALARA and radiation protection principles	43%
Basic image interpretation (normal vs. abnormal findings)	49%
Practical Application	
Patient positioning across modalities	47%
Safety considerations for imaging pregnant patients	45%
Contrast agent protocols and contraindications	39%

Fig 1: Performance Comparison by Gender and Institution Type

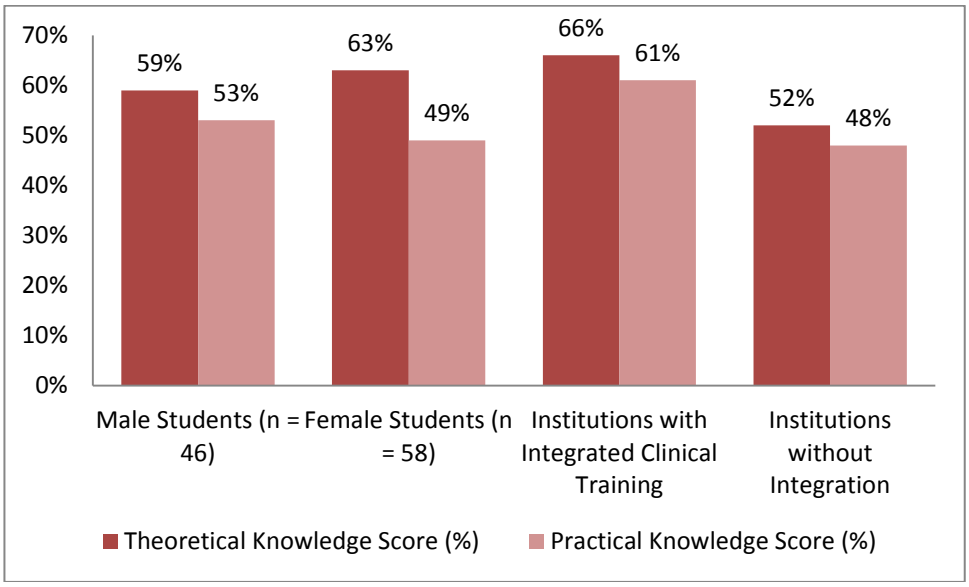

Fig 1: The figure illustrates the comparative performance of undergraduate radiography students based on two key demographic variables: gender (male vs. female) and type of educational institution (with integrated clinical-radiologic training vs. without

DISCUSSION

To ensure that future radiology practitioners are qualified, it is crucial to assess students' comprehension and awareness of important topics in the discipline. This procedure gives information about how well students understand fundamental concepts like radiation physics, imaging techniques, patient safety, and radiation protection. The results of these assessments frequently point out areas in which students perform well, such their familiarity with imaging equipment, as well as those that need more practice, like radiation dose optimization and interpretation accuracy. This study's primary goal was to evaluate radiology experts' and students' understanding of radiation protection in a medical college context. This important study emphasizes the knowledge of radiation protection. [13]It is challenging to measure outcome measures related to clinical practice and patient health care performance improvement in medical education, and post-assessments of e-learning interventions might not be able to measure these measures. According to Mahnken, a change in the educational environment is unlikely to result in an abrupt shift in practice or health outcomes. However, it is also well established that shifts in learners' abilities, knowledge, and attitudes are powerful predictors of shifts in practice or behavior. Therefore, pompous learning settings have a significant impact on clinical competencies and performances [14].Additionally, students knew more than non-students did, which suggested that working staff members were not up to date on radiation safety training. At the institutional and national levels, specific regular training programs ought to be created at regular intervals. Numerous scholarly articles have also indicated that radiographers need to become more knowledgeable about radiation protection issues and that study periods should place more emphasis on this. Current study materials with sufficient radiation protection training protocols and recommendations should be required for medical health workers' in-service training. [15]Developing pupils' comprehension of the subject matter is the aim of education, not merely improving their fact-reciting skills. The first goal of assessment in education is to improve and advance the learning process; the second is to gauge how well students have grasped the main ideas. These ideas encompass general competencies and dispositions in higher education. Performance in the context of clinical education for radiography refers to the capacity to do all tasks necessary for the occupation. Although it is acknowledged that not all professional knowledge can be evaluated in the workplace, this performance is what is measured when evaluating a student's clinical competency. [16]The development of medical imaging in recent years has expanded the clinical indications for a number of imaging procedures, which has increased the number of imaging requests made by referring professionals. [17]However, compared to medical students, radiology residents and students believed their level of knowledge was lower, despite having a much greater understanding of radiation protection issues. These data may be explained by the fact that, because of the specialized nature of their academic programs, radiology residents and radiography students receive more focused and intensive radiation protection training than medical students. They also support the finding by Borgen et al. that radiologists and radiographers have a greater understanding of radiation issues and referral guidelines than clinicians. Furthermore, it's possible that radiology residents and radiography students are

more aware of and maybe a little intimidated by the radiation safety standards because of their superior training. [18] Assessment instruments, which might include case-based discussions, written exams, and practical examinations, can highlight discrepancies between clinical application and theoretical understanding.

CONCLUSION

This study offers a thorough assessment of undergraduate radiography students' knowledge and comprehension of important radiologic science concepts. 104 students, mostly in their third or fourth year of study, with a roughly equal gender distribution participated in the cross-sectional survey, which was administered across several institutions within the Department of Radio diagnosis. The findings highlight both important shortcomings and positive aspects of undergraduate radiologic education as it stands now.

Summary of Findings:

Overall, only 52% of the students showed that they understood the theoretical and practical aspects of radiologic sciences enough. The remaining 48% showed clear knowledge gaps, suggesting that over half of the future radiography staff is not prepared. Both the survey's theoretical and application-based parts showed same disparities. Regarding theoretical knowledge, fewer students demonstrated sufficient comprehension of fundamental radiation protection concepts, such as ALARA (43%) and fundamental image interpretation standards (49%), even though a respectable percentage of students could accurately identify appropriate imaging modalities (65%) and differentiate between ionizing and non-ionizing radiation (58%). These findings suggest a lack of depth in areas directly important to patient safety and diagnostic accuracy, but a partial grasp of fundamental radiologic principles.Although students may have a superficial understanding of radiologic theory, many lack the skills necessary to apply this knowledge safely and effectively in real-world clinical environments. Gender-based analysis revealed no statistically significant difference in performance between male and female students, though slight trends were observed—female students showed marginally higher performance in theoretical knowledge. Practical knowledge, which is crucial for clinical competency, revealed even greater deficiencies—less than half of the students knew proper patient positioning (47%), and only 39% understood the correct protocols for contrast media administration—an essential area with significant patient safety implications.However, when it came to practical application, male students performed marginally better. Although both genders need to improve overall, this suggests that readiness levels are roughly matched. Students from programs that offered integrated clinical-radiologic training did better than their counterparts from more conventionally structured programs, as seen by institutional variability. These students demonstrated improved clinical awareness and higher theoretical understanding, with an average correct response rate of 61%. This highlights the need of early clinical exposure and experience learning in radiography education.

Implications and Significance:

The study's conclusions highlight the urgent need for curriculum changes in the teaching of radiologic science. The clear gaps between theoretical knowledge and real-world application imply that many students are not receiving the proper training to handle the rigors of clinical practice. Additionally, there is a risk to patient outcomes and practitioner liability due to a lack of knowledge about radiation safety and contrast material guidelines.

Undergraduate radiography programs should incorporate more practical learning opportunities, simulation-based instruction, and problem-based case discussions, according to educators and curriculum architects. Enhancing students' early exposure to authentic clinical settings could aid in bridging the knowledge and practice divide.The study concludes that although some undergraduates studying radiography have a moderate comprehension of radiologic sciences, almost half lack proficiency in critical areas, namely safety procedures and clinical application. These results highlight the critical need for improved teaching methods that close the knowledge gap between clinical competency and theoretical learning. To build a skilled, informed, and secure radiography workforce that can handle the expanding needs of contemporary diagnostic imaging, these deficiencies must be filled.

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