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Original Article

Assessing Radiography Student's Knowledge of Diverse X-Ray Special Procedures

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ABSTRACT

Background: Medical imaging continues to play a vital role in modern diagnostic medicine, with specialized X-ray procedures such as Barium Meal Follow Through (BMFT), Intravenous Pyelography (IVP), and Hysterosalpingography (HSG) retaining diagnostic value, especially in resource-constrained settings. Despite the increasing reliance on advanced cross-sectional imaging modalities, proficiency in these foundational techniques remains crucial. Assessing the knowledge of radiography students regarding such procedures is essential to ensure safe practice and clinical preparedness. **Aim:** The present study aimed to assess and compare the knowledge levels of Bachelor of Medical Radiology and Imaging Technology (BMRIT) and Master of Medical Radiology and Imaging Technology (MMRIT) students concerning specialized X-ray procedures, with the goal of identifying educational gaps and informing curriculum improvements. **Materials and Methods:** This cross-sectional study employed a validated questionnaire administered to 79 radiography students, comprising 45 BMRIT and 34 MMRIT participants. The questionnaire evaluated theoretical and procedural knowledge related to BMFT, IVP, HSG, Barium Enema, and Percutaneous Transhepatic Cholangiography (PTC). Statistical analysis included descriptive measures and inferential testing via paired t-tests to determine significant differences in knowledge levels between the two groups. **Results:** MMRIT students achieved a significantly higher mean score (21/25) compared to BMRIT students (13/25), with statistical significance ($t = -4.49$, $p < 0.001$). The study identified substantial knowledge deficiencies, particularly regarding complex procedures such as PTC, where only 13% of responses were correct. A strong positive correlation ($r = 0.807$) was observed between academic level and knowledge scores. **Conclusion:** Advanced-level students demonstrated better understanding of specialized procedures, whereas foundational students displayed notable knowledge gaps. These findings underscore the need for curricular reinforcement through simulation-based training and targeted clinical exposure to enhance competency in specialized diagnostic imaging techniques.

Keywords: Radiography education, Specialized X-ray procedures, Knowledge assessment, Curriculum development, Clinical competency, Radiation safety, Diagnostic imaging

INTRODUCTION

Medical imaging is a central component of modern healthcare, and it is the foundation for precise diagnosis, treatment planning, and disease monitoring[(1)]. Radiography, one of the main modalities of medical imaging, utilizes ionizing radiation in the form of X-rays to generate high-resolution images of internal anatomical structures[(2)(3)]. Whereas traditional radiography continues to be prevalent in the form of routine diagnostics, a wide range of specialty X-ray tests under one collective banner termed X-ray special procedures provides enhanced diagnostic information on intricate pathologies that cannot be satisfactorily imaged by routine imaging methods. Some of these specialty tests are Barium Meal Follow-Through (BMFT), Intravenous Pyelography (IVP), Hysterosalpingography (HSG), Barium Enema, and Percutaneous Transhepatic Cholangiography (PTC) [(4)(5)(6)]. Each of these modalities is specifically designed to evaluate specific organ systems and pathophysiologic conditions and yield information critical to clinicians and directly affecting clinical decision-making and patient outcomes[(7)]. As the breadth of radiographic practice expands with increases in medical technology, it becomes crucial that students of radiography not only become well-

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rounded on a theoretical basis but also attuned with technical competence to implement and interpret such intricate procedures appropriately and safely[8]. The training and education of students of radiography include both clinical skills as well as basic knowledge, usually provided through an immersive curriculum that synthesizes anatomy, physiology, radiographic physics, image acquisition, patient positioning, and radiation protection[9]. Nonetheless, with the fast pace of technological change and increasing convergence of cross-sectional imaging techniques like CT, MRI, and MRCP, there have been changes in imaging taste, at times leaving older special X-ray procedures secondary to the newer imaging techniques. In spite of these trends, procedures such as BMFT and IVP have remained relevant, specially in settings where there is limited availability of advanced modalities[10]. Accordingly, it becomes essential to evaluate the extent of knowledge and awareness of radiography students regarding the clinical indications, procedural methods, and safety precautions involved with these specialized X-ray examinations. BMFT continues as an important diagnostic tool for the assessment of small bowel motility, obstructions, and inflammatory diseases employing barium sulfate as the contrast medium under fluoroscopic control[11]. Likewise, IVP allows precise imaging of the urinary tract through intravenous administration of contrast material, yielding information about renal calculi, neoplasms, and anatomic abnormalities. While newer modalities like CT urography are more sensitive, the cost-effectiveness and availability of IVP in some clinical settings guarantee its persistent usefulness[12][13][14]. HSG, where contrast media are injected into the fallopian tubes and uterine cavity under fluoroscopy, serves as a gold standard in assessing tubal patency and uterine abnormalities, particularly in infertility examinations[15][16][17][18][19]. In turn, barium enema, although less commonly used nowadays, still provides diagnostic information in the identification of large bowel pathology, including ulcerative colitis and colorectal cancers, via single or double contrast methods[20][21][22]. PTC, an invasive intervention radiographic exam employed to investigate and treat obstructions of the biliary tree, especially in cases where endoscopic retrograde cholangiopancreatography (ERCP) is contraindicated, is another example demonstrating the necessity of expertise in difficult image-guided interventions[23][24][25]. Hence, radiography students are assumed to have a strong grasp over the indications and contraindications, step-by-step process, contrast medium pharmacodynamics, and possible complications of each one of these interventional procedures. With the numerous clinical applications and technical complexities of these modalities, assessing the knowledge of radiography students presents a singular possibility to determine learning strengths and deficits that can potentially affect future clinical performance. Discrepancy in curriculum construction, clinical exposure, teaching strategies, and institution resources can possibly lead to varied levels of preparedness among the students. Therefore, this investigation aims to thoroughly evaluate radiography students' understanding of different X-ray special procedures through a detailed knowledge assessment survey. The survey is intended to test understanding from several areas that encompass procedural purpose, anatomical emphasis, technical performance, radiographic safety regulations, and care following the procedures. By localizing gaps in knowledge areas, instructors and curriculum developers can make deliberate changes to instructional design, improve clinical simulations, and augment experiential learning opportunities in a way that ensures that graduates are adequately prepared to respond to the requirements of contemporary radiologic practice. Evidence-based suggestions for change, grounded in the research of this study, will also be made available as a guide for curriculum reform, thus ensuring alignment of educational output with current clinical expectations and technological innovation. Furthermore, as radiographers play a critical role in ensuring diagnostic accuracy, patient comfort, and radiation safety, fostering a thorough understanding of these procedures among students contributes not only to individual competency but also to broader public health objectives. The integration of this knowledge into radiography training programs is essential for maintaining high standards of patient care and optimizing diagnostic efficacy in diverse clinical environments. Finally, this study seeks to bridge the knowledge-practice gap through an emphasis of the present level of student readiness in special radiographic procedures to further enhance radiography education through continuous quality improvement. As the healthcare systems around the globe develop and imaging devices become more

advanced, the skill of future radiographers in carrying out and comprehending special X-ray procedures will continue to be a key driver of effective diagnostic imaging services.

MATERIALS AND METHODS

The present study uses a quantitative research approach to assess the demographic profiles, academic achievement, and knowledge levels of students who are pursuing Bachelor of Medical Radiology and Imaging Technology (BMRIT) and Master of Medical Radiology and Imaging Technology (MMRIT) courses. A descriptive survey design was adopted to gather data pertaining to demographic attributes like age, gender, study level, course of study, and study year. To measure the level of understanding of the participants regarding radiological procedures, specifically specialized X-ray procedures, a structured questionnaire was used. Quantitative data collected through this tool were processed using descriptive and inferential statistical techniques. Descriptive statistics were applied for aggregating demographic information and overall responses, while inferential analysis, such as paired t-tests, was used to determine statistically significant differences between the knowledge levels of BMRIT and MMRIT students. The evaluation was centered on specialized X-ray examinations like Barium Meal Follow Through (BMFT), Intravenous Pyelography (IVP), Hysterosalpingography (HSG), Barium Enema, and Percutaneous Transhepatic Cholangiography (PTC). These examinations were studied in the context of their clinical use, underlying radiological principles, safety factors, and technological advancements. The aim of the study is to quantitatively and qualitatively analyze students' knowledge and determine areas of potential deficiency to guide curriculum development and improve radiography education.

Research Design

A cross-sectional, prospective, questionnaire-based study design was used. The study population were the students of BMRIT and MMRIT courses. A purposive sampling method was utilized so that the sample could be representative of the intended population, including students of all academic years and both degree levels.

Study Population and Sampling

The sample comprised undergraduate and postgraduate radiography students. The sample size was calculated via an a priori power analysis with a point biserial correlation model. Assuming an effect size of 0.3, a significance level (α) of 0.05, and a power of 0.80, the sample size required was estimated to be 82 participants. The statistical measures provided a noncentrality parameter (δ) of 2.847869, a critical t-value of 1.990064, and degrees of freedom (df) of 80, which ensured that the sample would be able to detect a significant correlation at the chosen level of confidence.

Variables of the Study

The research considered the following variables:
Independent Variables: These were demographic variables such as:
Age
Gender
Course Level (BMRIT or MMRIT)
Year of Study (BMRIT 2nd Year, BMRIT 3rd Year, MMRIT 1st Year, MMRIT 2nd Year)
Dependent Variables: These included:
Knowledge Assessment Score (quantitative)
Academic Performance (qualitative and quantitative as available)

Description of Tools

The main tool for data collection was a standardized questionnaire used to assess radiography students' knowledge of a number of specialized X-ray procedures. The questionnaire contained several sections:

Demographic Information: Questions collecting data on age, gender, level of study, and program.

Knowledge Assessment: This section had multiple-choice questions (MCQs), scenario questions, and some open-ended questions. The questions evaluated the students' knowledge of procedure indications, contraindications, technical protocols, interpretation, and radiation safety protocols. For content validity of the questionnaire, it was subjected to a validation process by radiology and medical imaging subject matter experts. Their input was included to improve question clarity, relevance, and suitability.

Data Collection Procedure

Ethical clearance for conducting the study was granted by the Institutional Research Committee of SCPM College of Nursing and Paramedical Sciences. All the students who took part in the study signed written informed consent prior to the handing out of the questionnaire. The research strictly followed the principles as outlined in the updated version of the Declaration of Helsinki. Questionnaires were copied and distributed in person to students during timetabled class hours to guarantee high response levels. The students were informed of the research aims, confidentiality procedures, and their voluntary participation prior to distribution. One week was provided for participants to complete and return the questionnaire to the researchers. Only those questionnaires that were fully completed were taken into analysis; incomplete responses or missing data were discarded to ensure data integrity.

Study Setting

The study was carried out within the facility of SCPM College of Nursing and Paramedical Sciences. Data collection took place over two months, between November and December 2024. The location facilitated easy access to the population of interest, as well as logistical convenience for follow-ups if needed.

Data Analysis Plan

Following collection, the data were coded and transferred into Microsoft Excel for organization and analysis. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to provide summaries of demographic information and answers to the knowledge-based questions. To investigate relationships and differences between knowledge levels across various demographic groups (e.g., BMRIT vs. MMRIT students, year-wise comparisons), inferential statistical techniques were utilized. A paired t-test was utilized to investigate the significance of differences in knowledge scores between the two main groups.

Ethical Considerations

The research design strictly followed ethical principles. All participants were provided with written informed consent, and their participation was completely voluntary. No individual identifiers were gathered, and the responses were maintained confidentially. The participants were told that they had the right to withdraw from the study at any moment without incurring any academic or personal consequences. Institutional research committee clearance of the ethics further guaranteed that all procedures aligned with academic and ethical standards.

Significance and Implications

The methodological approach used in this study presents a solid foundation for assessing radiography students' knowledge of advanced imaging techniques. The results are anticipated to identify strengths and locate areas of enhancement in the current radiography curriculum. Through alignment of educational planning with the identified knowledge gaps, this study hopes to improve radiography training programs and eventually enhance graduates' readiness for clinical practice. The larger implication is in enhancing the quality of medical imaging practices and delivery of patient care through enhanced academic training.

Demographic Distribution

The demographic information indicated that most of the participants (42 out of 79) were from the 18–22 age category, typical of undergraduate admissions. A decline was seen in the increasing order of age, with 21 participants in the 23–27 age category, 13 in the 28–32 age category, and just 3 in the 33–50 category. The gender distribution was somewhat male-biased at 46 males and 33 females, reflecting a male-dominated admission in the program. Regarding academic level, participants were either pursuing the Bachelor of Medical Radiology and Imaging Technology (BMRIT, n=45) or Master of Medical Radiology and Imaging Technology (MMRIT, n=34) courses. No diploma-level courses were represented, indicating a greater predisposition or institutional emphasis toward degree-based education in radiology. When divided by the year of study, the greatest participation was from BMRIT 2nd year (n=26) followed by MMRIT 2nd year (n=23), BMRIT 3rd year (n=19),

and MMRIT 1st year (n=11). This shows a well-balanced distribution across years of study with a minor focus on mid-term and final-year students.

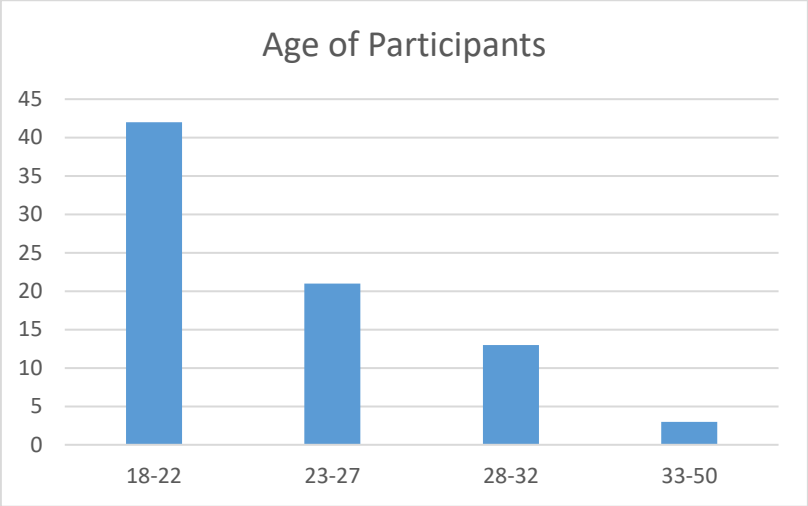

Figure 1 The graph is showing participants span across four age groups

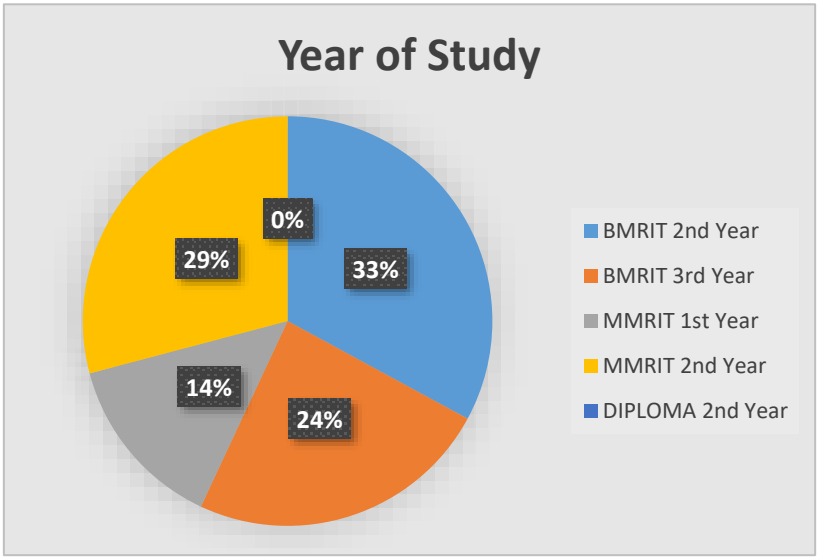

Figure 2 The participants are distributed across different academic years

Knowledge Assessment and Interpretation

The evaluation of graph 6, indicating the count of correct answers among academic groups, revealed a distinct trend. MMRIT 2nd years always performed better than other groups, and several students obtained scores between 20–23 out of 25. This was followed by BMRIT 3rd years and BMRIT 2nd years, whose scores varied from 3–18. MMRIT 1st year participants generally scored lower (2–11), indicating a knowledge gap likely due to limited exposure to clinical practices and theoretical depth at the early postgraduate stage. This trend strongly supports the hypothesis that academic progression correlates with increased knowledge and understanding of radiological procedures. The findings suggest that exposure to higher-level academic content, practical training, and research components in the MMRIT curriculum enhances competency.

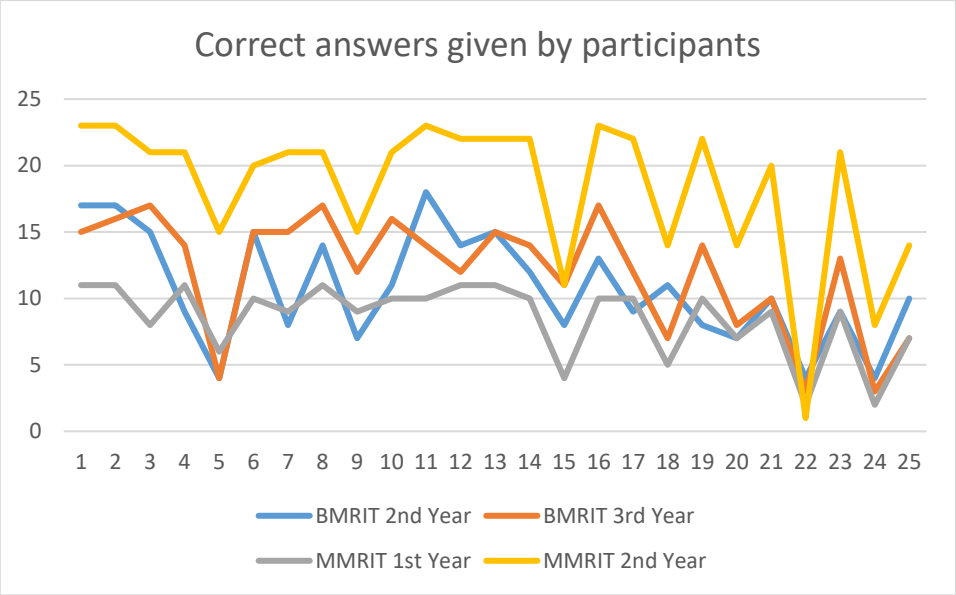

Figure 3 Graph Illustrates the number of correct answers provided by participants across four groups: BMRIT 2nd Year, BMRIT 3rd Year, MMRIT 1st Year, and MMRIT 2nd Year

Questionnaire-Based Knowledge Evaluation

Table 2 specifies the number of correct and incorrect responses for 25 multiple-choice questions. The high correct response rates in some questions (e.g., Q1: 66 correct, Q2: 67 correct) indicate easily understood topics, especially in Barium Meal and IVP tests. Yet there were some regions like PTC (e.g., Q22: just 10 correct responses) that displayed general misunderstanding and point to areas where targeted improvement in the curriculum is necessary to cover less well-known or more complicated topics.

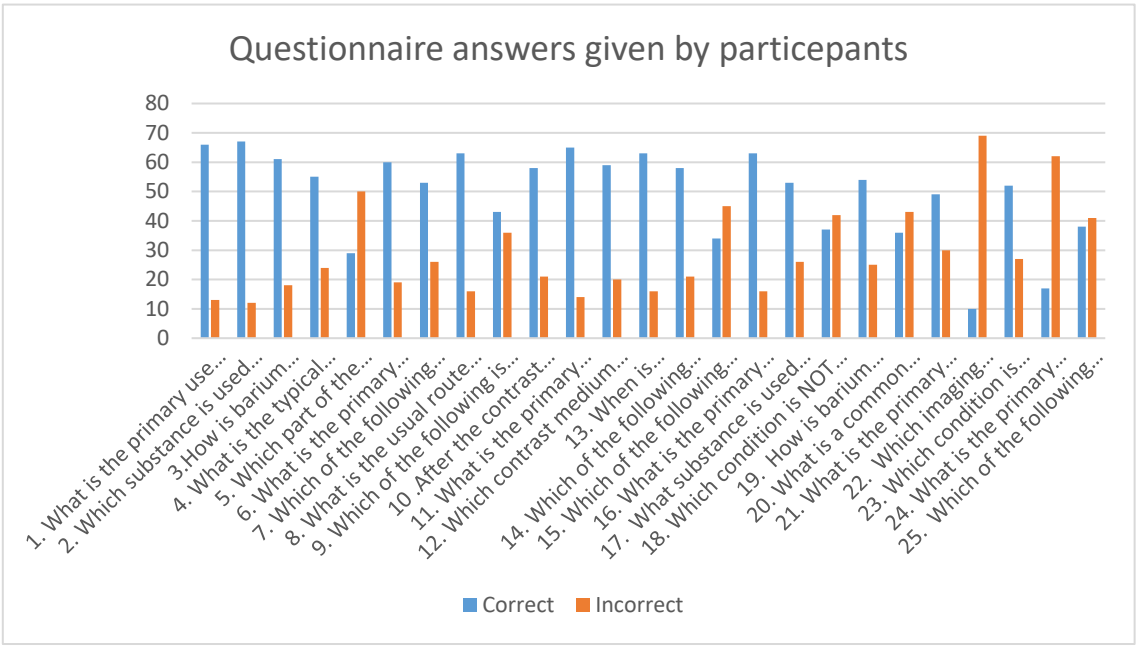

Figure 4 Questionnaire answers given by participants

The comparative paired t-test between BMRIT and MMRIT scores was statistically significant ($t = -4.49$, $p < 0.001$). The MMRIT participants had a significantly higher mean score compared to BMRIT participants (27.32 vs. 22.8). The significant Pearson correlation ($r = 0.807$) reaffirms that academic level is positively related to better performance. The small p-values (< 0.05) favor rejecting the null hypothesis, confirming the conclusion that the MMRIT group showed significantly better knowledge of radiological procedures.

DISCUSSION

This study gives an insight into the demographic and academic distribution, knowledge levels, and gaps of radiology students. Demographic data showed that the participants were mostly young people (18–22 years of age) and mostly male, as is often observed in the radiology education trend of such setups. It is also important to note that students from higher academic levels, such as MMRIT 2nd Year, performed significantly better in answering domain-specific questions compared to their counterparts in BMRIT 2nd Year and MMRIT 1st Year, which shows progressive enhancement with advancing education. This is in agreement with the research by Eze and Abonyi et al. (2013), which pointed out knowledge gaps among radiography professionals and the need for constant education and practice improvement to bridge foundational gaps. Despite the positive trend of better knowledge at higher levels, the analysis revealed specific knowledge gaps, particularly on the choice of imaging modalities for specific procedures and complications associated with advanced radiographic techniques[10]. Consistent with previous studies, which may include the study from Amaoui et al. 2023, identified insufficiency in physicians from Morocco in knowledge pertaining to risk from radiation, leading to a global call to augment education on technical aspects along with safety issues as these form crucial components of radiology practice(26). Similarly, Inah and Efanga et al. (2021) reported that the radiology knowledge among the final-year medical students in Nigeria was mediocre, indicating that radiology needs early integration into curricula and innovative methods of teaching(27). The paired t-test result in this study indicated significant differences between BMRIT and MMRIT students with a positive correlation that is strongly related to the scores, showing steady progression in knowledge acquisition. This supports the findings of Nghipukuula et al. (2021), who underscored the importance of experiential learning and effective communication in improving student outcomes in radiographic procedures(28). The gaps in communication and practical application of knowledge noted in their study parallel the gaps in procedural knowledge and practical skills identified in this research. The findings of this study also call for targeted interventions such as updated curricula, hands-on workshops, and comprehensive training modules to address the identified knowledge deficits. The lack of modern equipment and adherence to radiation protection practices, as highlighted in the study by Eze and Abonyi et al. (2013), further emphasizes the importance of equipping students and professionals with up-to-date resources and training. Adding that besides these, radiation protection training, as recommended by Amaoui et al. (2023), and developing a friendly learning atmosphere, as emphasized by Inah and Efanga et al. (2021), would be essential to address radiology education holistically. Overall, this study calls for continuous improvement in education, innovative teaching methods, and enhanced clinical supervision to bridge knowledge gaps and develop competent radiology professionals. This can be achieved by improving the areas mentioned above so that students are adequately prepared to face the challenges of modern medical imaging practices and to ensure patient safety.

CONCLUSION

This research presents a qualitative and quantitative analysis of the level of knowledge of radiography students—BMRIT and MMRIT students—in specialized X-ray investigations like BMFT, IVP, HSG, Barium Enema, and PTC. The results show a clear and pronounced association between level of study and knowledge gain, as indicated by both descriptive statistics and inferential testing. Out of the 79 subjects, MMRIT 2nd year students showed the highest knowledge level, wherein 84% (mean score: 21/25) of them answered all but a few questions, mostly procedural indications and basic techniques. This was followed by BMRIT 3rd year students at around 61% (mean score: 15.25/25), and BMRIT 2nd year students at around 52% (mean score: 13/25). MMRIT 1st year students exhibited the lowest performance, with an average knowledge score of just 36% (mean score: 9/25), indicating a significant knowledge gap likely due to limited exposure and experience. Overall, the cumulative data showed that only 54% of all students demonstrated satisfactory knowledge (defined as scoring above 60% correct answers), with the remaining 46% falling into the category of either poor (below 40%) or fair (40–60%) knowledge levels. Specific procedural areas like IVP and BMFT were quite well known by most (above 80% correct answers in Q1 and Q2) pointing towards

proper curricular exposure and potentially improved clinical exposure. On the other hand, PTC-related questions (e.g., Q22) had correct answers in just 13% of students, pointing out a critical lack of awareness regarding more complex and lesser done procedures. The paired t-test analysis was statistically significant regarding knowledge difference among BMRIT and MMRIT students ($t = -4.49$, $p < 0.001$), thereby confirming the hypothesis that increased academic exposure is related to better radiological practice understanding. A very high Pearson correlation coefficient ($r = 0.807$) further confirmed that academic level improvement results in greater competency, probably due to more clinical exposure, advanced courses, and greater research activity at postgraduate level. These recommendations highlight the need for curriculum revision, particularly in areas of underrepresentation such as PTC and advanced fluoroscopic procedures. It is imperative that there be better integration of complex procedural information using simulation-based training, hands-on workstations, and improved faculty mentoring. Additionally, institutional focus on radiation safety, pharmacologic principles of contrast media, and interventional radiographic procedures must be strengthened to address needs in contemporary diagnostic imaging. In summary, although higher-year students, especially those in the MMRIT program, showed impressive competence, the research identifies significant gaps among lower-level students that need to be addressed with urgency. Closing these knowledge gaps through curriculum revisions, enhanced clinical training, and creative pedagogical strategies will be crucial in generating competent radiographers who can maintain diagnostic accuracy, patient safety, and clinical excellence in an increasingly dynamic healthcare environment.

Conflict of Interest:

There is no conflict of interest declared by the author. The research was undertaken independently and not influenced by external entities or data collection, analysis, and interpretation bias.

Funding Status:

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