**RESEARCH PAPER**

# Assessment of Basic MRI Physics and Safety Knowledge Among Radiography Students, Interns, Technicians, and Technologists: A Questionnaire-Based Study

**Ritwik Biswas[1], Roshani Begum[2*], Prof (Dr.) Mahendra Kumar Verma[3]**

*[1]Department of Allied Health Care Sciences,*
*Radiology, (PG scholar) Vivekananda Global University, Jaipur, Rajasthan, India 302012.*
*[2*]Radiology, Department of Allied Health Care Sciences,*
*Faculty of Allied Health Care Professionals, (Supervisor) Vivekananda Global University,*
*Jaipur, Rajasthan, India,302012.*
*Email: roshanikhan426@gmail.com, Contact No.: 7800208924*
*[3]Professor & Principal, Department of Allied health care sciences,*
*Vivekananda Global University, Jaipur, Rajasthan, India,302012.*

**ABSTRACT**

**Background:** Magnetic Resonance Imaging (MRI) is a widely adopted diagnostic modality that operates without ionising radiation. However, strong static magnetic fields, pulsed radiofrequency (RF) energy, and rapidly switched gradient fields create a uniquely hazardous clinical setting. Consequently, robust knowledge of MRI physics and safety protocols is indispensable for all personnel who participate in MRI practice, ranging from undergraduate students to qualified technologists.

**Aim:** To evaluate the current level of understanding of fundamental MRI physics and safety concepts among radiography students, interns, technicians, and technologists.

**Methodology:** A questionnaire-based cross-sectional design was employed. Data were collected from 66 purposively selected participants via a validated 20-item structured questionnaire distributed through Google Forms. The tool comprised two domains: MRI Physics (14 items) and MRI Safety (6 items). Descriptive statistics (frequency, percentage, mean ± SD) summarised the data; Chi-square / likelihood-ratio tests examined associations between demographic variables and knowledge level (significance threshold: $p < 0.05$; SPSS v29.0).

**Results:** Overall, 56.1 % of participants demonstrated an average level of knowledge (score 7–13/20) and 43.9 % achieved a good level (score 14–20/20); none were classified as poor. The mean overall score was 13.30 ± 2.81 (range 8–18). Educational qualification was the only demographic variable that showed a statistically significant association with knowledge level ($\chi^2 = 7.54$; $p = 0.023$). Awareness of turbo-factor utility was notably low (21.2 % correct), representing a critical knowledge gap.

**Conclusion:** Radiography personnel demonstrate moderate MRI knowledge, with formal educational attainment as the principal determinant. Structured MRI safety curricula, simulation-based training, and continuing professional development are essential to close identified knowledge gaps and safeguard patients and staff.

**Keywords:** MRI physics; MRI safety; radiography education; knowledge assessment; questionnaire study; SAR; gradient hazards.

**How to cite this article:** Biswas R, Begum R, Verma MK. Assessment of Basic MRI Physics and Safety Knowledge Among Radiography Students, Interns, Technicians, and Technologists: A Questionnaire-Based Study. Int J Drug Deliv Technol. 2026;16(48s): 531-538. DOI: 10.25258/ijddt.16.48s.51

## 1. INTRODUCTION

Magnetic Resonance Imaging (MRI) stands as one of the foremost advances in contemporary medical imaging. By exploiting nuclear magnetic resonance (NMR) phenomena, MRI generates cross-sectional images of exquisite soft-tissue contrast without exposing patients to ionising radiation.[1] These attributes render it indispensable for neurological, musculoskeletal, oncological, and cardiovascular diagnosis.

Despite its inherent safety relative to X-ray-based modalities, MRI presents a constellation of hazard vectors: (i) the strong, always-on static magnetic field ($B_0$) capable of accelerating ferromagnetic projectiles; (ii) time-varying gradient fields that may induce peripheral nerve stimulation (PNS); (iii) pulsed RF energy characterised by its specific absorption rate (SAR); and (iv) high acoustic noise generated by gradient switching.[2–4] Each of these hazards can cause patient or staff injury if mitigation strategies are not understood and rigorously applied.

Radiography students, interns, technicians, and technologists are the frontline operators in MRI departments. Their comprehension of both MRI physics and

safety principles directly influences imaging quality and departmental safety culture. Emerging literature, however, documents persistent knowledge gaps—particularly regarding implant screening, MRI zoning, and SAR management—across training grades.[5–7]

The present study was therefore designed to quantify knowledge levels across these four professional groups, identify domains of deficiency, and examine whether demographic and educational variables modulate knowledge attainment. Findings are intended to inform curriculum development and continuing professional development (CPD) frameworks at institutional and national levels.

## 2. AIM AND OBJECTIVES

### 2.1 Aim

To evaluate the level of understanding of basic MRI physics and safety principles among radiography students, interns, technicians, and technologists using a structured questionnaire-based approach.

### 2.2 Objectives

1. To assess conceptual knowledge of MRI physics (SNR, relaxation times, k-space, imaging parameters) across study groups.
2. To evaluate awareness of MRI safety principles including implant classification, SAR, zoning, and emergency protocols.
3. To compare MRI Physics and MRI Safety domain scores to pinpoint specific knowledge deficits.
4. To determine whether demographic variables (gender, professional category, work experience, educational qualification, work setting) significantly influence knowledge level.
5. To propose evidence-based recommendations for strengthening MRI education and training.

## 3. REVIEW OF LITERATURE

The evidence base examining MRI safety knowledge among radiology personnel has grown steadily since the mid-2010s, revealing a consistent pattern of moderate-to-average awareness alongside targeted gaps.

**Asiri (2022)** conducted a questionnaire-based cross-sectional investigation among 166 radiology students, interns, and trainees. Most respondents correctly identified MRI as a non-ionising modality, yet knowledge of specific hazards—projectile effects, RF-induced heating, and implant risks—was limited. Safety-zone awareness and patient screening protocols were poorly understood by a substantial minority. The study called for structured curricula and workshop-based training.[8]

**Bhardwaj et al. (2025)** surveyed 120 radiology students and technicians and found that although common hazards such as the projectile effect were well-recognised, advanced protocols (emergency response, MR-conditional device limits) were inadequately understood. Mandatory training integration into degree programmes was recommended.[9]

**Kumar and Singh (2021)** evaluated 95 radiology technologists, reporting satisfactory basic knowledge but notable deficits in safety-zoning and implant-screening procedures. Periodic refresher training was advocated.[10]

**Ahmed et al. (2020)** demonstrated a positive association between clinical experience and MRI safety knowledge in a cohort of 110 healthcare professionals, underscoring the complementary roles of formal education and supervised practice.[11]

**Green and Patel (2019)** and **Johnson and Lee (2019)** independently reported that radiography students possessed foundational MRI physics understanding but lacked adequate safety-protocol competency for independent practice. Both advocated simulation-based curricula.[12,13]

**Wilson et al. (2016)** demonstrated that structured MRI safety workshops produced statistically significant knowledge improvements among 85 radiology staff members, validating CPD as an effective intervention.[14]

**Brown et al. (2017)** highlighted the gap between theoretical understanding and practical application among 130 radiography students, emphasising hands-on clinical exposure.[15]

Collectively, the literature establishes that moderate knowledge with domain-specific gaps is the modal finding across professional grades. Formal educational qualification, structured training, and clinical exposure are the primary modifiers. The present study contributes an Indian institutional perspective and a comparative analysis across four distinct professional groups, addressing a geographical and design gap in the published evidence.

## 4. METHODOLOGY

### 4.1 Study Design and Setting

A questionnaire-based, cross-sectional observational study was conducted among radiography students and professionals affiliated with hospitals, diagnostic centres, and academic institutions offering MRI services across India. The cross-sectional design was selected to enable simultaneous assessment of knowledge levels across professional grades at a defined time point.

### 4.2 Participants and Sampling

The study population comprised radiography students, interns, technicians, and technologists actively engaged in MRI-related education or clinical practice. Convenient sampling was employed; all 66 respondents who satisfied the eligibility criteria and provided informed consent were included.

Inclusion criteria: (i) current radiography student, intern, technician, or technologist; (ii) involvement in MRI training or practice; (iii) willingness to complete the questionnaire. Exclusion criteria: (i) personnel unrelated to the radiography field; (ii) incomplete questionnaire responses.

### 4.3 Data Collection Instrument

A 20-item structured questionnaire (Annexure I) was developed with reference to standard MRI physics and safety guidelines. The instrument comprised two sections: MRI Safety (6 items) and MRI Physics (14 items). Items were binary (true/false or yes/no). Correct answers were pre-defined based on established MRI physics principles

(Table 1). The questionnaire was digitised and distributed via Google Forms to maximise reach and facilitate automated data capture.

**4.4 Scoring and Knowledge Classification**

Each correct response attracted one mark, yielding a maximum score of 20. Knowledge level was categorised as: Poor (0–6), Average (7–13), and Good (14–20). Domain sub-scores were calculated separately for MRI Safety (max 6) and MRI Physics (max 14).

**4.5 Statistical Analysis**

Data were analysed using SPSS Statistics v29.0 (IBM Corp., Chicago, IL). Descriptive statistics (frequency, percentage, mean ± SD, range) were computed for all variables. Chi-square or likelihood-ratio tests were applied to evaluate associations between demographic variables and knowledge classification. Statistical significance was set at $p < 0.05$.

**4.6 Ethical Considerations**

Voluntary participation with the right to withdraw at any stage was assured. Written informed consent was obtained from all participants. Data were anonymised, stored securely, and used solely for academic purposes, in compliance with institutional ethical norms.

## 5. RESULTS

### 5.1 Questionnaire Answer Key

**Table 1: Pre-defined correct responses for the MRI knowledge questionnaire**

| Q No. | Question (Abbreviated) | Correct Answer |
|---|---|---|
| Q1 | Quench of superconducting magnet → instant restoration? | No |
| Q2 | MRI magnetic field turns off when not scanning? | No |
| Q3 | Body implants: two types (active & passive)? | Yes |
| Q4 | MR Conditional monitoring unit → cannot enter iso-centre? | Yes |
| Q5 | Insulin monitor attached → can patient be scanned? | No |
| Q6 | Increasing slice thickness increases relative SNR? | Yes |
| Q7 | Decreasing GRAPPA factor decreases scan time? | No |
| Q8 | TSE sequences deposit more energy than GRE? | Yes |
| Q9 | Fat suppression decreases SNR → grainy appearance? | Yes |
| Q10 | Increasing base resolution decreases SNR (lowers TE)? | No |
| Q11 | Phase oversampling removes phase-wrap artefact? | Yes |
| Q12 | Increasing receiver bandwidth always increases SNR? | No |
| Q13 | TR is proportional to acquisition time? | Yes |
| Q14 | In SE/TSE, TE does not determine T2 weighting? | No |
| Q15 | Imaging parameters identical at 1.5 T and 3 T? | No |
| Q16 | Decreasing phase resolution reduces scan time (under-samples k-space)? | Yes |
| Q17 | Decreasing TR + increasing flip angle reduces SAR? | No |
| Q18 | Turbo factor helps reduce scan time? | Yes |
| Q19 | Increasing FOV increases SNR without affecting resolution? | Yes |
| Q20 | Different gradient/RF transmission modes alter sequence timing? | Yes |

### 5.2 Demographic Profile

**Table 2: Demographic characteristics of participants (n = 66)**

| Variable | Category | n | % |
|---|---|---|---|
| Gender | Female | 22 | 33.3 |
| | Male | 44 | 66.7 |
| Professional category | Radiography student / Intern | 53 | 80.3 |
| | Technician / Technologist | 13 | 19.7 |
| Work experience | No experience | 27 | 40.9 |
| | < 6 months | 8 | 12.1 |
| | 6 months – 1 year | 11 | 16.7 |
| | 1 – 3 years | 13 | 19.7 |
| | 3 – 6 years | 7 | 10.6 |
| Educational qualification | B.Sc. Radiography / MIT | 49 | 74.2 |
| | M.Sc. Radiography / MIT | 13 | 19.7 |
| | Up to Non-Medical | 4 | 6.1 |
| Work setting | Private / Corporate Hospital | 34 | 51.5 |
| | Diagnostic Centre | 12 | 18.2 |

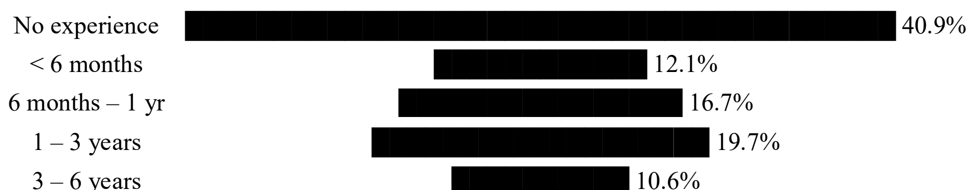
| | | | |
|---|---|---|---|
| | Government Hospital | 10 | 15.2 |
| | Research Facility | 10 | 15.2 |

The study comprised 66 participants: 44 males (66.7%) and 22 females (33.3%). Radiography students and interns constituted 80.3% of the cohort; technicians and technologists accounted for 19.7%. Regarding work experience, 40.9% were completely inexperienced, reflecting the predominantly student composition. B.Sc.-level qualification was most common (74.2%). Private or corporate hospital settings housed the majority of participants (51.5%).

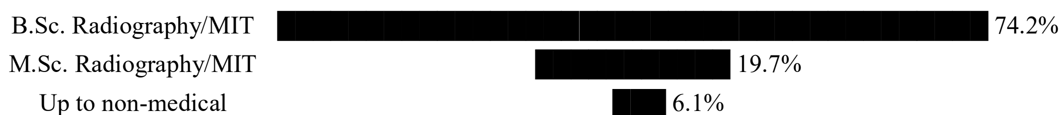
### 5.3 Graphical Representation of Demographics

**Graph 1: Gender Distribution**

**Graph 2: Professional Category**




**Graph 3: Work Experience**




**Graph 4: Educational Qualification**

**Graph 5: Work Setting**

### 5.4 MRI Safety Domain Performance

**Table 3: Assessment of understanding about MRI safety among participants (n = 66)**

| Safety Question (Abbreviated) | Correct n | Correct % | Incorrect n | Incorrect % |
|---|---|---|---|---|
| Quench → instant magnetisation restoration? | 47 | 71.2 | 19 | 28.8 |
| MRI field off when not scanning? | 47 | 71.2 | 19 | 28.8 |
| Active vs. passive implants: aware? | 58 | 87.9 | 8 | 12.1 |
| MR Conditional unit → cannot enter iso-centre? | 41 | 62.1 | 25 | 37.9 |
| Insulin monitor attached → scan feasible? | 39 | 59.1 | 27 | 40.9 |
| Decreasing TR + increasing flip angle reduces SAR? | 26 | 39.4 | 40 | 60.6 |

**Graph 6: MRI Safety Domain – Correct Response Rates (%)**

The highest correct response rate was recorded for implant type awareness (87.9%), while SAR management via TR and flip angle adjustments produced the lowest correct rate (39.4%), signifying a critical knowledge gap in radiation-dose management.

### 5.5 MRI Physics Domain Performance

**Table 4: Assessment of understanding about MRI physics among participants (n = 66)**

| MRI Physics Question (Abbreviated) | Correct n | Correct % | Incorrect n | Incorrect % |
|---|---|---|---|---|
| Decreasing phase resolution reduces scan time (under-samples k-space)? | 59 | 89.4 | 7 | 10.6 |
| Phase oversampling removes phase-wrap artefact? | 57 | 86.4 | 8 | 13.6 |
| TR proportional to acquisition time? | 55 | 83.3 | 11 | 16.7 |
| TSE deposits more energy than GRE? | 51 | 77.3 | 15 | 22.7 |
| Increasing FOV → SNR increase without change? | 50 | 75.8 | 16 | 24.2 |
| Fat suppression → decreased SNR/grainy image? | 50 | 75.8 | 16 | 24.2 |
| Increasing slice thickness → SNR increase? | 49 | 74.2 | 17 | 25.8 |
| 1.5 T and 3 T imaging parameters same? | 49 | 74.2 | 17 | 25.8 |
| Different gradient/RF modes alter timing? | 54 | 81.8 | 12 | 18.2 |
| Decreasing GRAPPA factor → reduced scan time? | 36 | 54.5 | 30 | 45.5 |
| Increasing receiver bandwidth → SNR increase? | 35 | 53.0 | 31 | 47.0 |
| SE/TSE: TE does not determine T2 weighting? | 31 | 47.0 | 35 | 53.0 |
| Increasing base resolution → decreased SNR? | 30 | 45.5 | 36 | 54.5 |
| Turbo factor reduces scan time? | 14 | 21.2 | 52 | 78.8 |

**Graph 7: MRI Physics Domain – Correct Response Rates (%)**

The lowest performance was observed for the turbo-factor question (21.2%), suggesting that advanced sequence optimisation concepts require dedicated instructional attention. Items relating to k-space sampling and phase oversampling were answered correctly by nearly 90% of participants.

### 5.6 Cumulative Domain Scores

**Table 5: Cumulative scores for MRI Safety and MRI Physics domains**

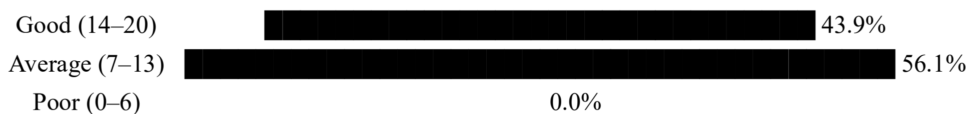
| Domain | Score Range | Mean | SD |
|---|---|---|---|
| MRI Safety (max 6) | 1 – 6 | 3.91 | 1.34 |
| MRI Physics (max 14) | 4 – 13 | 9.39 | 1.98 |
| Overall Score (max 20) | 8 – 18 | 13.30 | 2.81 |

**Graph 8: Mean Scores by Domain**

### 5.7 Overall Knowledge Classification

**Table 6: Level of understanding about MRI physics and safety**

| Level | Score Range | Frequency | Percentage (%) |
|---|---|---|---|
| Poor | 0 – 6 | 0 | 0.0 |
| Average | 7 – 13 | 37 | 56.1 |
| Good | 14 – 20 | 29 | 43.9 |




**Graph 9: Distribution of Knowledge Level**

### 5.8 Association of Knowledge Level with Demographic Characteristic

**Table 7: Association of knowledge level with demographic variables**

| Variable | Category | Average n (%) | Good n (%) | $\chi^2$/LR | p-value |
|---|---|---|---|---|---|
| Gender | Male | 22 (59.5) | 22 (75.9) | 1.97 | 0.161 |
| | Female | 15 (40.5) | 7 (24.1) | | |
| Professional category | Student/Intern | 29 (78.4) | 24 (82.8) | 0.20 | 0.657 |
| | Technician/Technologist | 8 (21.6) | 5 (17.2) | | |
| Work experience | No experience | 16 (43.2) | 11 (37.9) | 5.22# | 0.266 |
| | < 6 months | 5 (13.5) | 3 (10.3) | | |
| | 6 mo – 1 yr | 5 (13.5) | 6 (20.7) | | |
| | 1 – 3 years | 5 (13.5) | 8 (27.6) | | |
| | 3 – 6 years | 6 (16.2) | 1 (3.4) | | |
| Educational qualification* | B.Sc. | 31 (83.8) | 18 (62.1) | 7.54# | 0.023* |
| | M.Sc. | 3 (8.1) | 10 (34.5) | | |
| | Up to non-medical | 3 (8.1) | 1 (3.4) | | |
| Work setting | Diagnostic Centre | 8 (21.6) | 4 (13.8) | 0.91# | 0.824 |
| | Govt Hospital | 6 (16.2) | 4 (13.8) | | |
| | Private/Corporate | 18 (48.6) | 16 (55.2) | | |
| | Research Facility | 5 (13.5) | 5 (17.2) | | |

*# Likelihood ratio; * Statistically significant ($p < 0.05$)*

Educational qualification was the only significant predictor of knowledge level ($\chi^2$LR = 7.54; p = 0.023). Participants holding M.Sc. degrees were proportionally more likely to achieve good knowledge (34.5%) compared with B.Sc. holders (62.1% average). Gender, professional category, work experience, and work setting did not reach statistical significance.

## 6. DISCUSSION

This investigation adds to a growing body of evidence

confirming that radiography personnel, across training levels, possess moderate rather than comprehensive MRI knowledge. The finding that 56.1% achieved average and 43.9% achieved good scores—with zero in the poor category—is encouraging; it suggests a functional baseline awareness adequate for supervised practice but insufficient for independent advanced operation.

The identification of educational qualification as the sole significant demographic predictor (p = 0.023) aligns with findings by Asiri (2022),[8] Bhardwaj et al. (2025),[9] and Wilson et al. (2016),[14] all of whom emphasised the primacy of formal academic training in shaping safety knowledge. The gradient from non-medical → B.Sc. → M.Sc. qualification mirrors the hierarchical depth of MRI physics teaching within respective curricula.

The absence of a significant association between work experience and knowledge level (p = 0.266) challenges the intuitive assumption that clinical exposure automatically translates to better safety understanding. This may reflect the absence of standardised in-service training programmes or structured workplace learning pathways—a gap that echoes the concerns raised by Kumar and Singh (2021).[10]

Within the MRI Safety domain, the low correct response rate for SAR management (39.4%) is particularly concerning given that uncontrolled RF energy deposition can cause tissue heating and burns, especially in patients with implants or conductive accessories. This finding replicates the pattern reported by Green and Patel (2019)[12] and Brown et al. (2017).[15] Conversely, implant-type classification achieved 87.9% correct responses, suggesting that categorical concepts are well-taught but operationalised knowledge—how to act on that classification in complex scenarios—remains weak.

In the MRI Physics domain, the critically low turbo-factor awareness (21.2%) is a notable new finding. Turbo factor (or echo train length) directly governs scan duration and SAR in fast spin-echo sequences; its misapplication can simultaneously prolong examinations and increase patient energy deposition. This gap warrants urgent curricular attention.

The study's cross-sectional design and self-reported data introduce the familiar limitations of knowledge-attitude-practice surveys. Nonetheless, the consistent direction of findings with the international literature supports the validity of the conclusions.

## 7. CONCLUSION

Radiography students and professionals in India demonstrate a moderate, predominantly average level of knowledge regarding MRI physics and safety principles. Educational qualification is the primary determinant of knowledge attainment, underscoring the critical role of formal academic training. Specific gaps—particularly in SAR management and turbo-factor application—represent actionable targets for curricular reform.

The following evidence-based recommendations are proposed: (1) integrate structured MRI safety and advanced physics modules into both B.Sc. and M.Sc. radiography curricula; (2) mandate periodic, assessable CPD workshops in MRI safety for all clinical staff; (3) adopt simulation-based training for patient screening, emergency drills, and implant management scenarios; (4) develop institutional MRI safety policies with regular audits; (5) conduct multi-centre longitudinal studies with larger samples to monitor knowledge trends over time.

Addressing identified knowledge gaps through targeted educational interventions will strengthen the safety culture within MRI departments, reduce adverse event risk, and ultimately enhance patient outcomes.

## REFERENCES


1. Westbrook C, Talbot J. MRI in Practice. 5th ed. Wiley-Blackwell; 2018.
2. Shellock FG, Spinazzi A. MRI safety update 2008: part 1, MRI contrast agents and nephrogenic systemic fibrosis. AJR Am J Roentgenol. 2008;191(4):1129-1139.
3. McRobbie DW, Moore EA, Graves MJ, Prince MR. MRI from Picture to Proton. 3rd ed. Cambridge University Press; 2017.
4. Bushong SC. Magnetic Resonance Imaging: Physical and Biological Principles. 4th ed. Mosby; 2014.
5. Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013;37(3):501-530.
6. Calamante F. MRI Physics for Clinicians. Springer; 2021.
7. Delfaut EM, Beltran J, Johnson G, et al. Fat suppression in MR imaging: techniques and pitfalls. Radiographics. 1999;19(2):373-382.
8. Asiri AA. Assessment of knowledge and awareness of MRI safety among radiology students and trainees: a questionnaire-based cross-sectional study. J Radiol Prot. 2022;42(3):031501.
9. Bhardwaj P, Yadav R, Gupta S, et al. Evaluation of MRI safety knowledge among radiology students and technicians: a cross-sectional study. Indian J Radiol Imaging. 2025;35(1):45-52.
10. Kumar R, Singh A. MRI hazard awareness among radiology technologists: a descriptive cross-sectional study. J Med Imaging Radiat Sci. 2021;52(2):310-316.
11. Ahmed M, Hassan W, Khan F, Raza A. MRI safety awareness among healthcare professionals: impact of clinical experience. Radiography. 2020;26(4):e209-e214.
12. Green S, Patel R. MRI safety knowledge among radiography students: identifying the gaps. Radiography. 2019;25(3):e70-e75.
13. Johnson T, Lee K. Continuing education and MRI safety awareness: a cross-sectional investigation. J Radiol Nurs. 2019;38(2):112-118.
14. Wilson J, Davies A, Sharma N. Evaluating the impact of MRI safety training workshops on knowledge improvement. Br J Radiol. 2016;89(1066):20160382.
15. Brown L, Adams P, Patel K. MRI physics and safety knowledge among radiography students: a survey-

based study. Radiography. 2017;23(1):48-54.

16. Shrestha R, Khadka S. Knowledge and perception of patients regarding MRI safety: a descriptive cross-sectional study. J Nepal Med Assoc. 2020;58(228):607-612.
17. Altelaihi A, Al-Shenqiti A, Al-Harbi R. Patient awareness regarding MRI safety: a questionnaire-based study. Saudi J Health Sci. 2024;13(1):22-28.