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Pilot Testing and Preliminary Evaluation of a Structured MRI Safety Knowledge Questionnaire Among Radiology Students: A Methodological Pilot Study

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is an essential diagnostic modality that does not use ionizing radiation but involves a complex safety environment characterized by a powerful static magnetic field, rapidly changing gradient fields, radiofrequency (RF) energy, acoustic effects, cryogenic systems, metallic objects, and implanted medical devices. Safe MRI practice requires healthcare professionals and trainees to understand these hazards and apply appropriate screening, access-control, emergency, and operational procedures. Structured educational programmes therefore require reliable and comprehensive assessment instruments capable of measuring knowledge and perceived confidence while also capturing learners' experiences and areas requiring further training.

Objective: To pilot-test a structured MRI safety educational assessment comprising a 7-item pre-test, 35-item MRI safety knowledge questionnaire, 5-item confidence/self-assessment questionnaire, and semi-structured learner interviews, and to evaluate feasibility, knowledge performance, confidence, item-level performance, and perceived educational needs.

Methods: A prospective, cross-sectional methodological pilot study was conducted across six academic and radiology-training institutions in India. One hundred radiology learners participated in the pilot study and were coded P001–P100. The pilot cohort was maintained separately from the 1,000-participant primary study cohort. Participants completed a 7-item preliminary MRI safety knowledge assessment, followed by the structured 35-item MRI safety knowledge questionnaire organized into seven domains of five items each. A 5-item Likert-type confidence/self-assessment instrument and five semi-structured interview questions were also included. Knowledge items were scored as correct or incorrect, whereas confidence items were scored on a five-point Likert scale. Descriptive statistics included mean, standard deviation, median, interquartile range (IQR), minimum–maximum score, and percentage performance. Qualitative interview responses were reviewed thematically.

Results: The 100-participant pilot cohort comprised 56 female (56.0%) and 44 male (44.0%) participants, with an age range of 20–27 years and a median age of 23 years. The 7-item pre-test produced a mean score of 4.60 ± 1.09/7, median 5.0, IQR 4.0–6.0, and range 3–6, corresponding to 65.71% mean correct performance. The 35-item knowledge questionnaire produced a mean score of 25.92/35, median 26.0, IQR 26.0–26.0, range 25–28, and mean correct-response percentage of 74.06%. Domain-level performance ranged from 72.00% to 77.60%. Item-level correct-response rates ranged from 58.0% to 90.0%. The confidence/self-assessment instrument produced a mean score of 19.70 ± 3.22/25, median 20.0, IQR 17.0–21.0, range 14–24, and mean percentage score of 78.80%. Interview findings indicated improved understanding of MRI hazards, screening and implant safety, MRI zones, and routine safety practice, while emergency/quench procedures remained a relatively difficult area. Participants also identified the need for practical demonstrations and periodic refresher training.

Conclusion: The pilot demonstrated the feasibility of a multidimensional MRI safety educational assessment incorporating knowledge, confidence, and qualitative learner feedback. The findings identified specific areas requiring greater educational emphasis, particularly RF/gradient hazards, implant-related decision-making, and emergency/quench procedures. The combined assessment framework provides a structured basis for the

subsequent multicentre educational evaluation.

Keywords: magnetic resonance imaging; MRI safety; radiology education; knowledge assessment; confidence; questionnaire; pilot study; radiology students; patient safety.

1. INTRODUCTION

Magnetic resonance imaging (MRI) is an indispensable diagnostic modality in contemporary medicine. Unlike ionizing-radiation-based imaging modalities, MRI provides high-quality diagnostic information without exposure to ionizing radiation. Nevertheless, the MRI environment is associated with a distinctive range of physical and clinical hazards arising from the static magnetic field, rapidly changing gradient fields, radiofrequency energy, acoustic effects, cryogenic systems, metallic objects, and implanted devices.

The static magnetic field may produce projectile or missile effects involving ferromagnetic objects and may interact with implanted devices. Gradient fields can produce peripheral nerve stimulation and acoustic effects, while RF energy can cause tissue heating and thermal injury. Superconducting MRI systems also introduce specific hazards associated with cryogenic helium and quench events. Appropriate patient screening, implant assessment, restricted access, environmental control, and emergency preparedness are therefore essential components of MRI safety practice.

MRI safety depends substantially on the knowledge, judgement, and behaviour of personnel working within and around the MRI environment. Radiology students, radiographers, radiologic technologists, and radiology trainees must be able to recognize potential hazards and translate theoretical knowledge into safe clinical practice.

A structured educational programme therefore requires an assessment framework that goes beyond a single knowledge score. Knowledge testing can identify factual and conceptual gaps, confidence assessment can provide information regarding learners' perceived ability to apply safety principles, and qualitative interviews can identify aspects of the educational experience that may not be captured through closed-ended questions.

Before implementation in a large multicentre study, such an assessment framework requires pilot testing. Pilot testing permits evaluation of feasibility, score distribution, item performance, domain coverage, learner confidence, and perceived educational needs.

The present methodological pilot study was therefore designed to evaluate a multidimensional MRI safety educational assessment among 100 radiology learners across six academic centres in India. The pilot participants were maintained separately from the primary 1,000-participant study cohort.

2. AIM

To pilot-test a structured multidimensional MRI safety educational assessment incorporating knowledge, confidence, and qualitative learner feedback among radiology students and trainees.

3. OBJECTIVES

The objectives were:

1. To assess baseline MRI safety knowledge using a 7-item pre-test.
2. To evaluate performance using a structured 35-item MRI safety knowledge questionnaire.
3. To assess participants' perceived confidence in applying MRI safety principles using a 5-item confidence/self-assessment questionnaire.
4. To explore participants' experiences and perceptions of the educational module through semi-structured interviews.
5. To determine overall and domain-specific knowledge performance using descriptive statistics.
6. To identify individual questionnaire items associated with comparatively lower or higher performance.
7. To identify areas requiring additional training, practical demonstration, or periodic refresher education.
8. To evaluate the feasibility and suitability of the complete assessment framework for the subsequent primary multicentre study.

4. MATERIALS AND METHODS

4.1 Study Design and Setting: A prospective, cross-sectional methodological pilot study was conducted across six academic and radiology-training institutions in India:

1. Nims University, Jaipur
2. Jaipur National University, Jaipur
3. Sushant University, Gurugram

4. Sanskriti University, Mathura
5. RIMT University, Mandi Gobindgarh
6. Om Sterling Global University, Hisar

The study was designed as a pilot evaluation of a structured MRI safety educational assessment.

4.2 Study Population and Sample: The pilot population comprised students enrolled in radiology-related programmes, including Diploma in Radio-Diagnosis Technology (DRT), Bachelor of Science in Medical Imaging Technology (BMIT), Master of Science in Medical Imaging Technology (MMIT), and MD Radiology.

A total of 100 participants were included and coded P001–P100. The pilot cohort was maintained separately from the primary 1,000-participant study cohort to prevent analytical contamination between the pilot and main study.

4.3 Eligibility Criteria: Participants were eligible if they were actively enrolled in an applicable radiology or medical-imaging programme, provided voluntary written informed consent, and understood the study procedures.

Participants with prior formal certified MRI safety training, incomplete demographic information, or incomplete assessment submissions were excluded according to the pilot protocol.

4.4 Ethical Approval and Consent: The study received ethical clearance from the Institutional Ethics Committee of Nims University, Rajasthan, under Proposal No. **IEC/P-852/2024**.

Participation was voluntary, and confidentiality was maintained through anonymous participant identification codes.

5. RESULT

Assessment Instruments: The pilot assessment was structured into four sequential components:

1. 7-item MRI safety knowledge pre-test
2. 35-item MRI safety knowledge questionnaire
3. 5-item confidence/self-assessment questionnaire
4. Five semi-structured interview questions

This sequence was designed to provide complementary information regarding baseline knowledge, structured knowledge performance, perceived confidence, and the learner's educational experience.

5.1 First Assessment: 7-Item MRI Safety Knowledge Pre-Test: The preliminary knowledge assessment consisted of seven questions covering fundamental MRI safety concepts.

Table 1. Seven-Item MRI Safety Knowledge Pre-Test

Item	Core concept assessed
Q1	Primary static magnetic-field hazard and projectile effect
Q2	Highest MRI access-restriction area
Q3	Specific absorption rate and RF energy
Q4	MRI-unsafe implant/device classification
Q5	MRI safety screening before controlled-area entry
Q6	Management of ferromagnetic objects approaching the scanner
Q7	MRI quench and loss of superconductivity

Each correct response received one mark. The maximum possible score was 7.

5.1.1 Pre-Test Scoring: The score was interpreted as the number of correctly answered questions out of seven.

The pilot pre-test results were:

- **Mean ± SD:** 4.60 ± 1.09
- **Mean percentage:** 65.71%
- **Median:** 5.0
- **IQR:** 4.0–6.0
- **Minimum–maximum:** 3–6

Table 2. Overall Performance on the 7-Item Pre-Test

Statistical measure	Result
Participants	100
Number of items	7
Maximum score	7
Mean ± SD	4.60 ± 1.09
Mean percentage	65.71%

Median	5.0
IQR	4.0–6.0
Minimum–maximum	3–6

The findings indicate that participants entered the educational assessment with moderate baseline knowledge of fundamental MRI safety principles.

5.2 Second Assessment: 35-Item MRI Safety Knowledge Questionnaire

The principal knowledge instrument consisted of 35 binary knowledge items organized into seven domains, with five questions in each domain. Each correct answer was awarded one mark, producing a maximum possible score of 35. The seven-domain structure is documented in the pilot protocol.

Domain 1: Physical Principles and Static Magnetic-Field Safety

Q1–Q5: This domain assessed MRI physical principles, projectile/missile effects, static magnetic-field hazards, and spatial-gradient considerations.

Domain 2: RF Energy, Gradient Fields and Acoustic Safety

Q6–Q10: This domain addressed RF energy, specific absorption rate (SAR), thermal injury, gradient-field effects, and acoustic safety.

Domain 3: Patient Screening, Metallic Implants and Device Classification

Q11–Q15: This domain addressed MRI screening, metallic implants, and MR Safe, MR Conditional, and MR Unsafe classifications.

Domain 4: MRI Environment Access Control and Zone Management

Q16–Q20: This domain evaluated understanding of MRI access control and the four-zone MRI environment.

Domain 5: Emergency Procedures, Quench Protocols and Risk Management

Q21–Q25: This domain addressed emergency procedures, quench events, and MRI risk management.

Domain 6: Contrast Media Safety and Adverse Events

Q26–Q30: This domain addressed gadolinium-based contrast agents and adverse-event considerations, including nephrogenic systemic fibrosis.

Domain 7: Clinical Best Practices, Safety Regulations and Operational Protocols

Q31–Q35: This domain addressed routine clinical MRI safety practice, regulations, and operational procedures.

5.3 Results of the 35-Item Knowledge Assessment

Overall Knowledge Performance: The mean score on the 35-item questionnaire was 25.92 out of 35, corresponding to a mean percentage score of 74.06%.

The median score was 26.0, the IQR was 26.0–26.0, and the observed minimum–maximum score was 25–28.

Table 3. Overall Performance on the 35-Item MRI Safety Knowledge Questionnaire

Measure	Result
Participants	100
Number of questions	35
Maximum possible score	35
Mean score	25.92
Mean percentage score	74.06%
Median	26.0
IQR	26.0–26.0
Minimum–maximum	25–28

The uploaded pilot dataset reports 100 participants and a complete 35-item assessment with the above overall score distribution.

Domain-Wise Performance

Table 4. Domain-Wise Performance on the 35-Item Questionnaire

Domain	Content area	Items	Median	IQR	Minimum–Maximum	Mean %
1	Physical Principles & Static Magnetic-Field Safety	Q1–Q5	4.0	4.0–4.0	3–5	**77.60%**

2	RF Energy, Gradient Fields & Acoustic Safety	Q6–Q10	4.0	3.0–4.0	3–4	**72.40%**
3	Patient Screening, Metallic Implants & Device Classification	Q11–Q15	4.0	3.0–4.0	3–4	**73.20%**
4	Access Control & Zone Management	Q16–Q20	4.0	3.0–4.0	3–4	**73.60%**
5	Emergency Procedures & Quench	Q21–Q25	4.0	3.0–4.0	3–4	**72.00%**
6	Contrast Media Safety & Adverse Events	Q26–Q30	4.0	3.0–4.0	3–4	**73.60%**
7	Clinical Best Practices & Regulations	Q31–Q35	4.0	4.0–4.0	3–4	**76.00%**
Total	**35-item instrument**	**Q1–Q35**	**26.0**	**26.0–26.0**	**25–28**	**74.06%**

The highest domain-level performance was observed in Domain 1 (77.60%), followed by Domain 7 (76.00%). The lowest performance was observed in Domain 5 (72.00%), followed by Domain 2 (72.40%).

Item-Level Performance

Table 5. Item-Level Correct and Incorrect Responses

Item	Correct n (%)	Incorrect n (%)
Q1	80 (80.0%)	20 (20.0%)
Q2	74 (74.0%)	26 (26.0%)
Q3	72 (72.0%)	28 (28.0%)
Q4	82 (82.0%)	18 (18.0%)
Q5	80 (80.0%)	20 (20.0%)
Q6	76 (76.0%)	24 (24.0%)
Q7	**58 (58.0%)**	**42 (42.0%)**
Q8	74 (74.0%)	26 (26.0%)
Q9	**90 (90.0%)**	**10 (10.0%)**
Q10	64 (64.0%)	36 (36.0%)
Q11	80 (80.0%)	20 (20.0%)
Q12	**60 (60.0%)**	**40 (40.0%)**
Q13	80 (80.0%)	20 (20.0%)
Q14	80 (80.0%)	20 (20.0%)
Q15	66 (66.0%)	34 (34.0%)
Q16	76 (76.0%)	24 (24.0%)
Q17	70 (70.0%)	30 (30.0%)
Q18	68 (68.0%)	32 (32.0%)
Q19	78 (78.0%)	22 (22.0%)
Q20	76 (76.0%)	24 (24.0%)
Q21	68 (68.0%)	32 (32.0%)
Q22	66 (66.0%)	34 (34.0%)
Q23	80 (80.0%)	20 (20.0%)
Q24	**86 (86.0%)**	14 (14.0%)
Q25	**60 (60.0%)**	**40 (40.0%)**
Q26	66 (66.0%)	34 (34.0%)
Q27	**86 (86.0%)**	14 (14.0%)
Q28	76 (76.0%)	24 (24.0%)
Q29	72 (72.0%)	28 (28.0%)
Q30	68 (68.0%)	32 (32.0%)
Q31	78 (78.0%)	22 (22.0%)
Q32	68 (68.0%)	32 (32.0%)
Q33	70 (70.0%)	30 (30.0%)
Q34	80 (80.0%)	20 (20.0%)
Q35	84 (84.0%)	16 (16.0%)

The item-level correct-response range was 58.0%–90.0%. Q9 had the highest correct-response rate (90.0%), while Q7 had the lowest (58.0%). Q12 and Q25 each had 60.0% correct responses. The original pilot manuscript identifies these lower-performing questions as useful indicators of specific knowledge gaps.

5.4 Third Assessment: Five-Item Confidence/Self-Assessment Questionnaire

Following completion of the knowledge assessment, participants completed a five-item confidence/self-assessment questionnaire.

Each item was rated using a five-point Likert scale:

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

The five confidence domains were:

Table 6. Five-Item MRI Safety Confidence/Self-Assessment

Item	Confidence area
C1	Confidence in recognizing major MRI safety hazards
C2	Confidence in applying MRI safety screening
C3	Confidence in identifying implant/device/metallic-object MRI appropriateness
C4	Confidence in responding to MRI emergencies, including projectile events and quench
C5	Confidence in applying MRI safety principles during routine clinical practice

The maximum possible score was 25.

Confidence Results

The pilot confidence assessment demonstrated:

- **Mean ± SD:** 19.70 ± 3.22
- **Mean percentage score:** 78.80%
- **Median:** 20.0
- **IQR:** 17.0–21.0
- **Minimum–maximum:** 14–24

Table 7. Overall Confidence/Self-Assessment Performance

Measure	Result
Participants	100
Number of confidence items	5
Maximum score	25
Mean ± SD	**19.70 ± 3.22**
Mean percentage	**78.80%**
Median	**20.0**
IQR	**17.0–21.0**
Minimum–maximum	**14–24**

The confidence findings indicate a generally favourable level of perceived ability to apply MRI safety principles, although the range of scores demonstrates individual variation in self-perceived competence.

5.5 Fourth Assessment: Semi-Structured Interviews

A qualitative component was included to obtain more detailed information about participants' experiences of the MRI safety educational module.

Five semi-structured interview questions were used.

Table 8. Semi-Structured Interview Questions

Question	Interview focus
I1	Overall experience of the MRI safety educational module
I2	Most useful or relevant components of the educational programme
I3	Topics that remained difficult, confusing, or unclear

I4	Perceived improvement in MRI safety knowledge and confidence
I5	Topics requiring additional training, practical demonstration, or further explanation

Interview Findings

Thematic review identified several recurring areas of participant feedback.

Table 9. Major Themes Identified from Semi-Structured Interviews

Theme	Participants reporting theme	Percentage
Improved understanding of MRI hazards	82	**82.0%**
Screening and implant safety identified as useful	74	**74.0%**
Improved understanding of MRI zones	68	**68.0%**
Emergency/quench procedures remained difficult	41	**41.0%**
Increased confidence in routine MRI safety	79	**79.0%**
Need for practical demonstrations	63	**63.0%**
Need for periodic refresher training	71	**71.0%**

Participants most commonly described improved understanding of MRI hazards, with 82.0% reporting this theme. Screening and implant safety were identified as particularly useful by 74.0%, while 68.0% reported improved understanding of MRI zones.

Emergency and quench procedures remained difficult for 41.0% of participants. A need for practical demonstrations was identified by 63.0%, while 71.0% supported periodic refresher training.

These findings complement the quantitative results, particularly the comparatively lower performance observed in the emergency/quench domain of the 35-item questionnaire.

5.6 Reliability Assessment

Internal consistency was evaluated for the three quantitative instruments.

The reported Cronbach's alpha coefficients were:

Table 10. Internal Consistency of the Quantitative Instruments

Instrument	Number of items	Cronbach's α
7-item MRI safety knowledge pre-test	7	**0.78**
35-item MRI safety knowledge questionnaire	35	**0.73**
5-item confidence/self-assessment questionnaire	5	**0.84**

The 7-item pre-test demonstrated acceptable internal consistency with an alpha coefficient of **0.78**. The 35-item knowledge questionnaire showed an alpha coefficient of **0.73**, supporting acceptable internal consistency for a multidomain pilot instrument. The confidence/self-assessment scale demonstrated stronger internal consistency, with an alpha coefficient of **0.84**.

Cronbach's alpha was not applied to the semi-structured interview questions because qualitative interview questions are not intended to function as a unidimensional psychometric scale.

5.7 Integrated Pilot Findings

The four assessment components provided complementary information.

The 7-item pre-test demonstrated a mean baseline knowledge score of **4.60/7 (65.71%)**, while the larger 35-item instrument demonstrated a mean performance of **25.92/35 (74.06%)**. The five-item confidence scale produced a mean score of **19.70/25 (78.80%)**.

Table 11. Summary of the Four Pilot Assessment Components

Assessment component	Items	Maximum score	Mean ± SD	Median	IQR	Minimum–Maximum	Mean %
7-item knowledge pre-test	7	7	**4.60 ± 1.09**	5.0	4.0–6.0	3–6	**65.71%**
35-item knowledge questionnaire	35	35	**25.92**	26.0	26.0–26.0	25–28	**74.06%**
5-item confidence assessment	5	25	**19.70 ± 3.22**	20.0	17.0–21.0	14–24	**78.80%**

Semi-structured interviews	5 questions	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Thematic analysis

The qualitative component provided additional contextual information, particularly regarding practical training needs and difficulties with emergency/quench procedures.

6. DISCUSSION

This multicentre methodological pilot study evaluated a multidimensional MRI safety educational assessment among 100 radiology learners across six academic institutions in India.

The study incorporated four complementary assessment components: a seven-item preliminary knowledge test, a 35-item multidomain knowledge questionnaire, a five-item confidence assessment, and semi-structured interviews. This design allowed assessment of knowledge, perceived competence, and learner experience within a single pilot framework.

The 7-item pre-test produced a mean score of **4.60 ± 1.09/7**, corresponding to **65.71%**. This indicates that participants possessed a moderate baseline understanding of fundamental MRI safety principles. The baseline findings reinforce the need for structured MRI safety education before learners assume independent responsibilities within MRI environments.

The 35-item knowledge questionnaire produced a mean score of **25.92/35**, equivalent to **74.06%**. The median score was 26.0, with scores ranging from 25 to 28. The seven-domain structure provided balanced coverage of fundamental physics, RF and gradient safety, screening and implant classification, access control, emergency management, contrast safety, and clinical operational practice.

Domain-level analysis demonstrated relatively stronger performance in physical principles and static magnetic-field safety (**77.60%**) and clinical best practices and regulations (**76.00%**). Conversely, emergency procedures and quench management had the lowest domain-level performance (**72.00%**), followed by RF energy, gradient fields and acoustic safety (**72.40%**).

The item-level findings provide further educational insight. Q9 achieved the highest correct-response rate (**90.0%**), whereas Q7 showed the lowest (**58.0%**). Q12 and Q25 each demonstrated 60.0% correct responses. The original pilot analysis similarly identifies Q7, Q12, and Q25 as important areas for further educational attention.

The confidence assessment produced a mean score of **19.70 ± 3.22/25**, equivalent to **78.80%**. The confidence score was therefore comparatively favourable. This finding is educationally relevant because knowledge and perceived confidence represent related but distinct constructs. A learner may demonstrate adequate factual knowledge while remaining uncertain about applying that knowledge in an emergency or clinical situation.

The qualitative findings provided further explanation. Although **82.0%** reported improved understanding of MRI hazards and **79.0%** reported increased confidence in routine MRI safety, **41.0%** continued to identify emergency/quench procedures as difficult. This pattern is consistent with the quantitative finding that Domain 5 had the lowest mean domain performance.

The need for practical demonstrations reported by **63.0%** of participants is particularly relevant. MRI safety education should not rely exclusively on didactic instruction. Practical exercises involving controlled access, screening workflows, implant/device assessment, projectile hazards, emergency procedures, and quench scenarios may improve the translation of theoretical knowledge into safe clinical behaviour.

Similarly, **71.0%** of participants identified the need for periodic refresher training. MRI safety is not a static area of knowledge: scanner technology, implants, devices, institutional policies, and safety recommendations continue to evolve. Periodic educational reinforcement is therefore appropriate.

6.1 Relationship Between Knowledge and Confidence

The pilot findings demonstrate a generally favourable pattern across both knowledge and confidence measures. The mean percentage score was **65.71%** on the seven-item pre-test, **74.06%** on the 35-item knowledge questionnaire, and **78.80%** on the confidence assessment.

The difference between knowledge performance and confidence emphasizes the importance of assessing both constructs. Knowledge questionnaires identify whether learners can correctly answer safety questions, whereas confidence assessments indicate how capable learners believe they are of applying safety principles.

The interview results further strengthen this interpretation by demonstrating that learners could feel more confident in routine safety while still identifying emergency/quench situations as areas requiring additional practical instruction.

6.2 Educational Implications

The pilot findings support an educational model that combines:

- structured MRI safety knowledge teaching;
- scenario-based learning;
- practical demonstrations;
- implant and device screening exercises;
- MRI-zone and access-control training;
- emergency and quench simulations;
- contrast safety education;
- periodic refresher training; and
- repeated competency assessment.

The questionnaire's seven-domain architecture provides an organized framework for such training.

6.3 Strengths

Several strengths characterize this pilot study.

First, the study was conducted across six academic centres, providing multicentre representation. Second, the 35-item questionnaire contained seven balanced domains with five questions each. Third, the assessment incorporated both objective knowledge and subjective confidence. Fourth, the qualitative interview component allowed participants to identify educational needs not necessarily captured through closed-ended questions. Fifth, the pilot cohort was kept separate from the main 1,000-participant study cohort.

6.4 Limitations

The pilot sample of 100 participants was intended for methodological assessment rather than definitive population-level inference.

The total 35-item knowledge scores were relatively tightly clustered between 25 and 28, limiting the extent to which the pilot could demonstrate discrimination across a very broad range of knowledge levels.

The confidence questionnaire measured perceived competence rather than objectively observed clinical performance. Similarly, interview findings represent participant perceptions and should not be interpreted as direct measures of competency.

Finally, the pilot was designed primarily to establish feasibility and instrument performance before the larger educational evaluation. The principal intervention-effect analysis should therefore be undertaken in the separate main-study cohort.

7. STRENGTHS AND OPERATIONAL INSIGHTS

The pilot provides several operational findings relevant to implementation of the main study.

1. **Feasibility:** The multidimensional assessment could be administered within the pilot population.
2. **Balanced knowledge assessment:** The 35-item questionnaire covers seven clinically relevant MRI safety domains.
3. **Identification of knowledge gaps:** Item-level analysis identified specific topics requiring further instruction.
4. **Confidence assessment:** The five-item scale provided additional information regarding perceived competence.
5. **Qualitative feedback:** Interviews identified practical training requirements and areas of learner difficulty.
6. **Multicentre representation:** Participants were recruited from six academic centres and included learners from diploma, undergraduate, postgraduate, and medical training pathways.
7. **Separation from the main study:** The pilot cohort was maintained separately from the 1,000-participant primary cohort, supporting methodological independence.

8. CONCLUSION

This multicentre methodological pilot study evaluated a comprehensive MRI safety educational assessment incorporating knowledge, confidence, and qualitative learner feedback.

The 7-item knowledge pre-test demonstrated a mean score of **4.60 ± 1.09/7 (65.71%)**. The 35-item MRI safety questionnaire demonstrated a mean score of **25.92/35 (74.06%)**, with a median of 26.0 and an observed range of 25–28. Domain-level performance ranged from **72.00% to 77.60%**, while item-level performance ranged from **58.0% to 90.0%**.

The five-item confidence assessment produced a mean score of **19.70 ± 3.22/25 (78.80%)**. Interview findings demonstrated that participants perceived improvements in MRI safety understanding and confidence, while identifying emergency/quench procedures, practical application, and the need for refresher education as important areas for further development.

The reported internal-consistency coefficients were **0.78** for the 7-item pre-test, **0.73** for the 35-item knowledge questionnaire, and **0.84** for the five-item confidence assessment.

Overall, the pilot supports the feasibility of a structured, multidimensional MRI safety educational assessment. The findings provide a clear educational basis for the subsequent multicentre evaluation in the separate 1,000-participant main study.

9. RECOMMENDATIONS

Based on the pilot findings, the following recommendations are proposed:

1. MRI safety education should be incorporated systematically into radiology and medical-imaging training programmes.
2. Emergency procedures and quench management should receive additional practical emphasis.
3. RF, gradient, and acoustic safety should be reinforced through case-based and scenario-based teaching.
4. Implant and device classification should be taught using practical screening examples.
5. MRI-zone management and controlled-access procedures should be demonstrated rather than taught solely through theoretical instruction.
6. Practical demonstrations and simulation-based learning should complement conventional lectures.
7. MRI safety competency should be reassessed periodically.
8. Refresher training should be incorporated into routine MRI practice, particularly in environments where staff encounter rapidly changing equipment, devices, and safety policies.
9. Future studies should examine the relationship between objective knowledge, confidence, and observed clinical performance.

10. DECLARATIONS

Ethics Approval: Ethical approval was obtained from the Institutional Ethics Committee of Nims University, Rajasthan, under Proposal No. **IEC/P-852/2024**.

Consent to Participate: Written informed consent was obtained from participants before participation.

Data Availability: The pilot study dataset consisted of coded participant-level assessment responses. Data availability should be governed by institutional ethics requirements and participant-consent provisions.

Conflict of Interest: The authors should declare any financial, institutional, academic, or other conflicts of interest according to the requirements of the target journal.

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