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ORIGINAL RESEARCH

Evaluating the Knowledge of Computed Tomography and Magnetic Resonance Imaging Parameters Between Undergraduate Students and Radiographers in Jeddah, Saudi Arabia: A Cross-Sectional Study

Lamees A Aljuaid[1,2], Mathayel A Alblowi[1,2,*], Sarah Yahya Almary[1,2,*], Khalid M Alshamrani[1–3], Ahmad M Subahi[2,4]

[1]Department of Radiology Sciences, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Jeddah City, Saudi Arabia; [2]King Abdullah International Medical Research Center, Jeddah City, Saudi Arabia; [3]Medical Imaging Department, Ministry of the National Guard – Health Affairs, Jeddah City, Saudi Arabia; [4]Department of Basic Sciences, College of Science and Health Professions, King Saud bin Abdulaziz University for Health Sciences, National Guard, Jeddah City, Saudi Arabia

*These authors contributed equally to this work

Correspondence: Lamees A Aljuaid, Email lamiss1436@gmail.com

Introduction: Cross-sectional imaging modalities, such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), are essential for accurate diagnoses in medical care. Therefore, a solid understanding of CT and MRI parameters is necessary to obtain good image quality with minimal risk to patients. Previous studies have showed a significant knowledge gap regarding CT and MRI parameters; thus, this study aimed to evaluate the effectiveness of university curricula and clinical practice in hospitals among undergraduate students and technologists in Jeddah.

Methods: Quantitative data were collected through a validated structured cross-sectional survey administered to a cluster sample of undergraduate students and radiographers in Jeddah. The survey consisted of 36 closed-ended multiple-choice questions. Eleven questions were related to CT parameters and 25 were associated with MRI parameters.

Results: Normality tests revealed that both the CT and MRI scores were non-normally distributed ($p = 0.0001$). The Kruskal–Wallis test for the CT section yielded a p-value of 0.292, while all MRI sections also yielded $p > 0.05$ among the groups. Despite slight differences in knowledge scores across groups (3rd-year students, 4th-year students, internship students, radiographers, and others), internship students showed the highest mean CT knowledge scores. In terms of MRI scores, while the mean averages were similar across the groups, the technologists showed the lowest average standard deviation. These results could be attributed to the fact that the CT and MRI parameters were automated.

Conclusion: These findings indicate a variation in the knowledge levels of CT and MRI parameters within this sample. We recommend the implementation of an annual refresher course to enhance the quality of healthcare practices and radiology education programs.

Keywords: magnetic resonance imaging, radiography, computed tomography, education, medical, health care quality

Introduction

In recent years, cross-sectional medical imaging modalities such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) have undergone significant advancements.[1,2] CT is relatively cost-effective and allows for comprehensive examinations with excellent diagnostic performance.[3] Consequently, CT has become the standard in many medical settings. However, it still presents several challenges, particularly regarding tumor definition and delineation.[4] A CT scanner measures the x-ray attenuation properties of the body from different angles to create cross-sectional images.[5] Despite the substantial growth in CT usage, MRI has established itself as a cornerstone of modern medical practice, showcasing the remarkable

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advancements in contemporary medicine.[6] It is a measurement technique used to examine molecules and atoms.[7] Additionally, it allows for the visualization of anatomy in all three planes (axial, sagittal, and coronal) as well as the ability to show dynamic physiologic changes.[6,8]

The most crucial reason for increased radiation exposure is the frequent use of CT scans, which depends on factors such as exposure, age, and anatomical area (eg, depth and location). For instance, children are at a higher radiation risk than adults.[9] A previous study evaluating physicians' knowledge about radiation doses and risks associated with CT revealed a significant knowledge gap among practitioners.[9] Additionally, enhanced radiation doses can improve image quality by increasing contrast and reducing noise, which facilitates the detection of low-contrast structures. Therefore, selecting optimized protocols is important to minimize radiation exposure, ensuring that the benefits of improved imaging do not compromise patient safety.[10] On the other hand, MRI uses non-ionizing radiation, which, unlike x-rays and CT scans, does not cause known harm when utilized within specified technical limitations.[6] However, one limitation of MRI is the potential hazards posed by implanted medical devices.[11]

In Saudi Arabia, health science education has undergone significant changes.[12] In addition, according to Telmesani et al state that ensuring quality is one of the challenges that all Saudi higher education institutions face, which the National Commission for Academic Assessment and Accreditation (NCAAA) is responsible for it.[12] One way to indicate the quality of health science education is through the implementation of an impartial national graduation license examination.[12] Furthermore, a previous study evaluating knowledge of CT parameters in Medina found that both students and professionals had varying levels of awareness, highlighting a knowledge gap in this area. The study emphasized the necessity for ongoing education to maintain the accuracy of CT parameters.[13] Additionally, another study assessed the knowledge of MRI among radiographers in the United Kingdom using an Objective Structured Clinical Examination (OSCE). The findings showed that these radiographers could not correctly respond to more than half of the questions in the Objective Structured Clinical Examination.[14]

In this study, we aimed to evaluate the knowledge of CT and MRI parameters among undergraduate students and radiographers to improve healthcare practices and outcomes of radiology educational programs. We hypothesize that internship students will demonstrate a higher level of knowledge about CT and MRI parameters compared to 3rd and 4th-year undergraduate students, as well as practicing radiographers. Additionally, we seek to determine whether students possess more knowledge of CT and MRI parameters than the workers.

Materials and Methods

Study Design

This quantitative cross-sectional study was conducted at hospitals and universities in Jeddah, Kingdom of Saudi Arabia (KSA), between September 2023 and April 2024, after obtaining Institutional Review Board (IRB) approval from the King Abdullah International Medical Research Center (KAIMRC).

Population Study

The population for this study included 1000 undergraduate radiology students from universities in Jeddah and radiology technologists working in various hospitals across different geographical areas of the city, including the west, south, and east. The sample size of 277 was calculated using Raosoft software.[15] A total of 150 participants responded, comprising radiographers with bachelor's degrees, 3rd and 4th-year undergraduate radiology students, internship students, and other healthcare professionals in Jeddah.

Procedure and Instrument

A validated structured cross-sectional survey consisting of 36 closed-ended multiple-choice questions was conducted on a cluster sample of undergraduate students and radiographers in Jeddah, using Google Forms to collect quantitative data. The questionnaire was adapted from a previously published and validated survey.[16] The updated version was confirmed by King Abdullah International Medical Center. As detailed in Appendix 1, the survey was divided into six sections: The first section concerned CT parameters, including 11 questions about CT scan protocols. The MRI sections (A, B, C, D, and E) were consisted of 25 questions. Moreover, each section was about a different topic in terms of MRI parameters. Section A describes the basic principles of MRI, such as the Larmor frequencies, and the usage of radio frequency (RF) coils, whereas section B is about image weighting and contrast like T1 and T2 weighted image features. Section C concerns MRI pulse sequence, for example, the spin echo sequence and gradient echo sequence. Section D is about MRI parameters and tradeoffs, K-space, spatial encoding, and MRI safety are covered in section E, such as the Food and Drug Administration (FDA) limits, and emergency button in MRI machine. Questionnaires were distributed to students, and researchers also visited public hospitals, such as King Fahad General Hospital and King Abdullah Medical Complex, to gather additional responses from radiographers. Before participating, all individuals received an electronic consent form and provided their consent. Participants' privacy was fully protected throughout the process, and they typically completed the questionnaire in about ten minutes.

Statistical Analysis

This study utilized JMP software for data analysis, with data imported from Microsoft Excel and Google Forms. To achieve the research objectives, descriptive statistics, including frequency and percentage, as well as graphical representations such as pie charts, were employed to describe the demographic distribution among the groups. A scoring system coded correct answers as one and incorrect answers as zero to calculate overall scores. Additionally, summary statistics, including mean and standard deviation, along with bar charts and other graphical depictions, were used to describe and compare responses among the respondent groups for each section. Based on the normality test, the score data for each section was non-normal, the–Kruskal Wallis test was used to assess the significance of knowledge differences between the groups at a level of 0.0001.

Results

Participants Characteristics

Participants were categorized into groups based on their educational level, including 3rd-year students, 4th-year students, internship-year students, radiographers, and others. Of the 150 total responses, students comprised the largest group (51%), followed by radiology technologists (42%), and others (7%) (Figure 1).

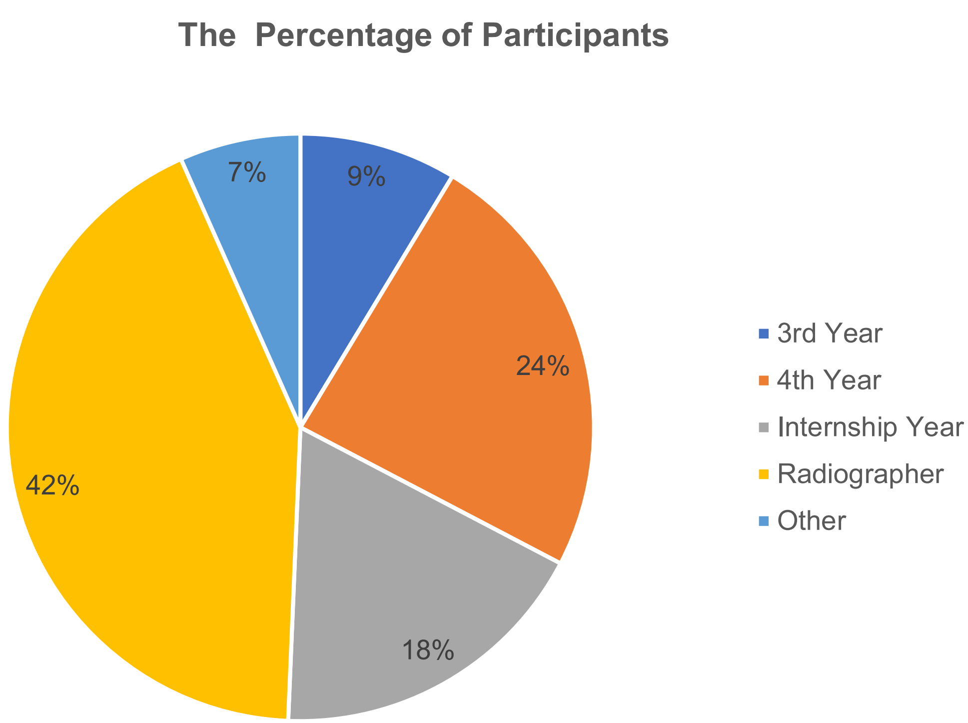

Figure 1 Demographic distribution of the participants.

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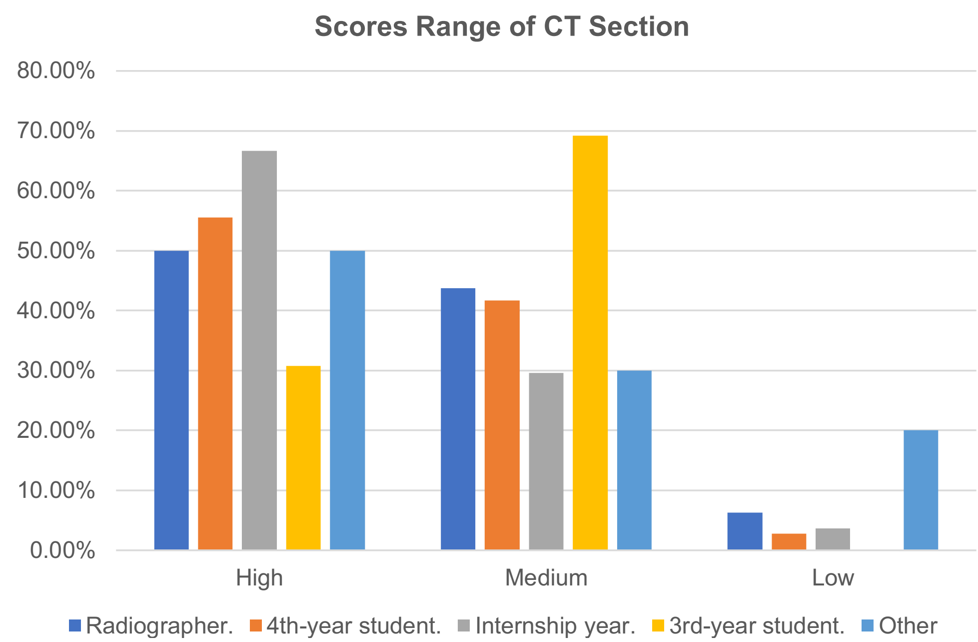

Figure 2 CT scores range of CT section.

Knowledge Assessment

Participants were asked multiple questions regarding CT and MRI parameters, and their knowledge levels were ranked as high, medium, or low.

CT Knowledge

Approximately 52.67% of the participants showed a high knowledge level about CT parameters, with internship students demonstrating the highest knowledge at 66.67%, compared to 50% for radiographers (Figure 2). Moreover, based on the normality test, the CT score data were non-normally distributed (p-value = 0.0001). The p-value obtained for the–Kruskal Wallis test was 0.292, indicating that there were minimal significant differences in the CT scores between the groups. The Eta-squared (η^2) effect size was calculated as −0.0256, indicating an almost meaningful effect size.

The calculations provided in Table 1 indicates that on average, the CT Scores for the diverse groups were similar, with slight variations in scores. The internship year group showed greater variability in CT parameter knowledge compared to other groups. Moreover, the CT mean values also showed a substantial overlap in the error bars across the different groups. For example, the error bars for 3rd-year students, 4th-year students, and radiographers all intersected, making it difficult to conclude that there were meaningful differences in CT knowledge between the groups (Figure 3).

MRI Knowledge

The MRI section was divided into five parts: MRI.A, MRI.B, MRI.C, MRI.D, and MRI.E. In the MRI.A section, covering the basic principles of MRI, 50.67% of participants demonstrated a high level of knowledge. In the MRI.B section, focusing on image weighting and contrast, 40.67% had a medium level of knowledge. Surprisingly, in the MRI.C section, which addressed the MRI pulse sequences, 60% showed a lower level of knowledge. For MRI.D (MRI parameters and tradeoffs,

Table 1 CT Scores Calculations of Standard Deviation (SD) for Each Different Group

	3rd-Year Students	4th-Year Students	Internship Year	Radiographers	Other
Standards Deviation	1.46	1.44	1.84	1.73	1.94

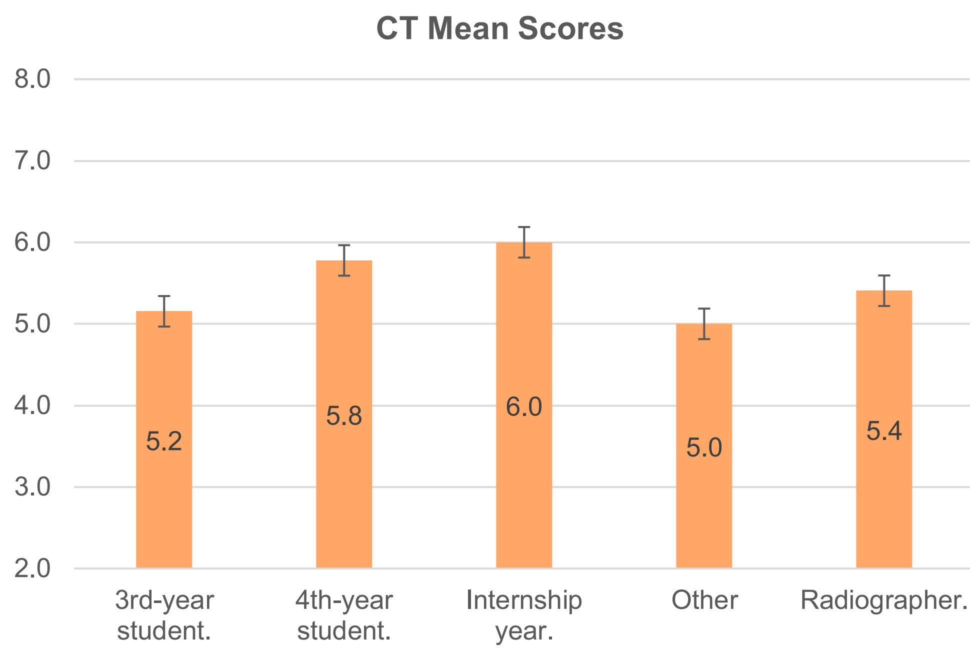

Figure 3 Error Bars graph for CT section mean scores of the participants.

K-space, special encoding), and MRI.E (MRI safety) sections, the majority had a medium level of knowledge. A normality test indicated that the distribution of MRI variable scores was not normal ($p = 0.0001$). The p-values obtained for the–Kruskal Wallis test were 0.152 for MRI.A, 0.7578 for MRI.B, 0.093 for MRI.C, 0.146 for MRI.D, and 0.103 for MRI.E. The calculated Eta-squared (η^2) values for each section were negative, indicating an almost meaningful effect size Table 2.

As shown in Table 3, there were variations in the spread of scores, as reflected by the different average standard deviation values, particularly for the radiographer group, which had a standard deviation (SD) of 1.06. Regarding the mean MRI scores, the internship year group had the highest average score at 12.26; however, the error bars indicate a relatively large amount of variability within this group. Similarly, the error bars for the other groups overlapped, suggesting that the differences in the mean scores were slightly different from one another (Figure 4).

Discussion

CT and MRI are precision imaging modalities that require careful adjustment of parameters, including contrast, noise, repetition time (TR), and echo time (TE). Even minor errors can harm patients, damage the equipment, or compromise image quality. Therefore, it is essential to ensure the quality of curricula in universities and healthcare practices in hospitals.

Table 2 CT and MRI Eta-Squared (η^2) Effect Size Calculations

	CT	MRI.A	MRI.B	MRI.C	MRI.D	MRI.E
η^2	−0.0256	−0.0265	−0.0223	−0.0270	−0.0266	−0.0269

Table 3 MRI Scores Calculations of Average Standard Deviation (SD) for Each Different Group

	3rd-Year Student Group	4th-Year Student Group	Internship Year Group	Radiographer Group	Other Group
Average Standards Deviation	1.22	1.22	1.15	1.06	1.24

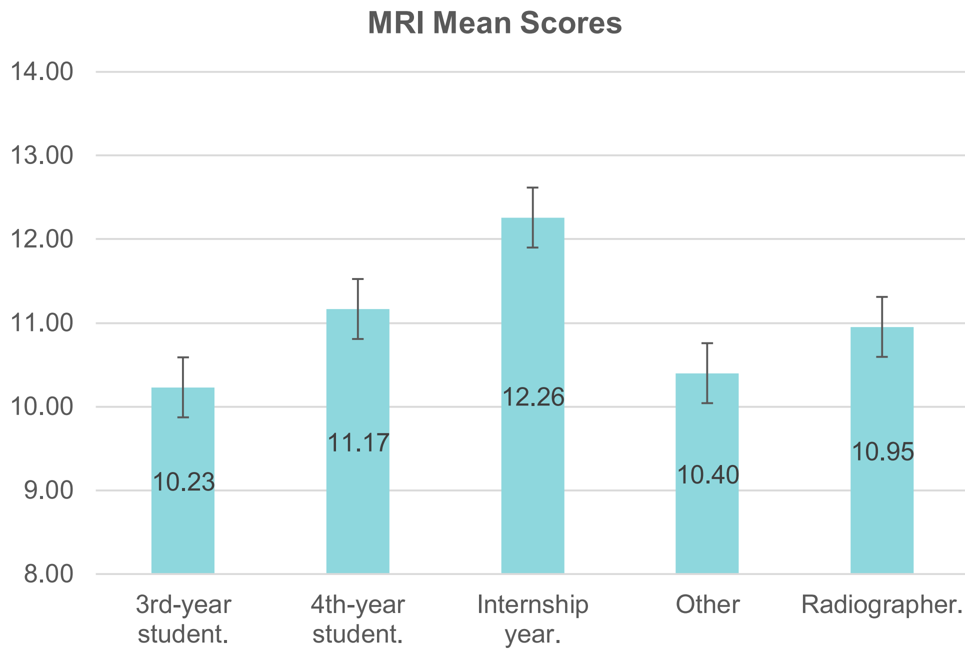

Figure 4 Error Bars graph for MRI sections means scores of the participants.

Main Findings

The results of this study indicated a slight difference in the knowledge scores of CT and MRI, assessed separately among various groups including 3rd-year students, 4th-year students, interns, radiographers, and other medical professionals. The average scores were consistent with the findings of previous research, which found that workers' and students' comprehension of CT parameters differed in a study evaluating Medina residents' awareness of these factors.[13] Additionally, a study examining MRI knowledge among radiographer in United Kingdom highlighted a significant lack of knowledge level.[14] When the groups were asked about the factors that increase contrast resolution in CT, 19 out of 27 interns provided correct responses. In comparison, 44 of the 64 radiographers (68.75%) gave incorrect answers, representing the majority of the radiographer group. Furthermore, when asked which factor did not influence noise in a CT scan, 39 of 64 radiographers (60.94%) provided incorrect responses, while 14 of 27 interns (51.85%) answered correctly. A similar pattern was observed for the MRI knowledge scores. However, because of the ongoing practice of internships, they were able to respond correctly. The Interns' average mean score was 1.15 and the radiographs' average mean score was 1.06. The respondents of the study were asked about the Larmor frequency of Hydrogen at 1.5T. Although Larmor frequency is one of the basic principles of MRI, radiographers could not answer this question correctly. On the other hand, most internship, 3rd, and 4th years students chose the correct answer. This may be because of the ongoing information provided to the students. Furthermore, the respondents were asked about the gradient echo pulse sequences in the MRI.C section. Most of the radiographers answered incorrectly. 19 of the 36 4th year students chose the correct answer, 18 out of 64 radiographers chose the correct answer, 14 out of 27 internship-year students answered correctly, and for the 3rd year 3 out of 13 students chose the correct answer. In addition, when radiographers were asked about the image weighting and contrast, 50% answered incorrectly. This finding can be due to the reliance on automated machine parameters. Moreover, the average knowledge scores for CT and MRI parameters were significantly different. The average score for the CT parameters was 5.55, while for the MRI parameters was much lower (2.24). This indicates that respondents had a greater understanding of CT parameters than of MRI parameters. As shown in Table 2, the calculated effect sizes for both CT and MRI sections were negative, indicating minimal differences in knowledge scores among the participant groups. These results suggest that educational interventions may not have significantly impacted knowledge levels regarding CT and MRI parameters in this sample.

Strength

A methodological strength of this study is the inclusion of multiple subsections within the MRI section, allowing for a detailed analysis of specific areas of MRI knowledge. The consistent lack of significant differences across these subsections supports the overall conclusions.

Limitations

The study relied on self-reported knowledge through a questionnaire, which may introduce response bias. Therefore, participants might overestimate their knowledge or be influenced by social desirability, affecting the accuracy of the results. Another limitation is related to sample size. Although we aimed to include 277 participants, the actual response rate may have limited the statistical power of the study. A smaller sample size can hinder the detection of significant differences in knowledge levels among groups. Future studies should aim for larger, more diverse samples to enhance the generalizability of the findings.

Implications for Clinical Practice and Research

The results emphasize the importance of ensuring that both students and radiographers remain updated on the latest developments in imaging technologies. Continuous education is crucial in the digital environment. Institutions should consider integrating more hands-on training and updated curricula that reflect current practices and technologies in CT and MRI. Furthermore, tracking knowledge progress through longitudinal studies could provide insights into how educational initiatives impact clinical practices over time.

Conclusions

This study revealed that, while there were slight statistically significant differences in CT and MRI knowledge scores across groups, each group demonstrated varying strengths in specific areas of understanding. Interns showed commendable performance on certain technical questions because of their ongoing studies and clinical practice. Radiographers rely on automated settings, highlighting the need for ongoing refreshing programs to support their practice. The consistent results across groups highlight shared foundational knowledge of imaging techniques, suggesting that all professionals possess baseline competence. Future research could track the progress of the knowledge level for these cross-sectional imaging modalities. Planning an annual refresh course for employees could help increase their knowledge and improve the efficiency of their healthcare practices.

Abbreviations

CT, Computed Tomography; MRI, Magnetic Resonance Imaging; NCAAA, National Commission for Academic Assessment and Accreditation; OSCE, Objective Structured Clinical Examination; KSA, Kingdom of Saudi Arabia; IRB, Institutional Review Board; KAIMRC, King Abdullah International Medical Research Center; SD, standard deviation; RF, radio frequency; FDA, Food and Drug Administration; TR, repetition time; TE, echo time.

Ethics Statement

We confirmed that the participants were informed about the purpose of the survey and that electronic consent was obtained from the study participants.

Data Sharing Statement

Data are available on reasonable request. To access data, researchers are welcome to contact the corresponding author.

Acknowledgments

This study was approved by the King Abdullah International Medical Research Center Ethics Committee (Study Number: SP23J/139/08)". This study did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

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Disclosure

The authors report no conflicts of interest in this work.

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