Medical Science

pISSN 2321–7359; eISSN 2321–7367

Assessment of the knowledge and attitude regarding magnetic resonance imaging safety among the general population in Saudi Arabia

Siraj Fahad Wally[1], **Shouq Abdullah O Alwabisi**[2], **Lama Mueysh M Aljohani**[2], **Amal Naif Muidh Althobaiti**[2], **Mei Khalid S Alfaqiri**[2], **Shahad Ali M Rfadh**[2], **Abdullah Dhafer A Alshehri**[3], **Afnan Saleh M Alsaiari**[2], **Amal Ayedh S Alenazi**[2], **Abdullah Mohammed A Al Madshush**[3], **Sarah Muqbil B Altmimi**[2*], **Rahaf Naif A Alenezi**[2]

To Cite:
Wally SF, Alwabisi SAO, Aljohani LMM, Althobaiti ANM, Alfaqiri MKS, Rfadh SAM, Alshehri ADA, Alsaiari ASM, Alenazi AAS, Al-Madshush AMA, Altmimi SMB, Alenezi RNA. Assessment of the knowledge and attitude regarding magnetic resonance imaging safety among the general population in Saudi Arabia. *Medical Science* 2023; 27: e30ms2695. doi: https://doi.org/10.54905/disssi/v27i131/e30ms2695

Authors' Affiliation:
[1]Assistant Professor, Faculty of Medicine, University of Tabuk, Tabuk, Saudi Arabia
[2]Medical Intern, Faculty of Medicine, University of Tabuk, Tabuk, Saudi Arabia
[3]6th Year Medical Student, Faculty of Medicine, University of Tabuk, Tabuk, Saudi Arabia

*Corresponding author
Medical Intern, Faculty of Medicine, University of Tabuk, Tabuk, Saudi Arabia
Email: sarah.altmimi5577@gmail.com

Peer-Review History
Received: 17 December 2022
Reviewed & Revised: 21/December/2022 to 03/January/2023
Accepted: 05 January 2023
Published: 09 January 2023

Peer-review Method
External peer-review was done through double-blind method.

URL: https://www.discoveryjournals.org/medicalscience

ABSTRACT

Objective: To assess knowledge and attitude of the Saudi general population toward MRI safety and investigate the association between different participants' characteristics and their knowledge and attitude toward MRI safety. *Methods:* This cross-sectional survey included adult male and female Saudi participants. An online, self-administered questionnaire was designed and disseminated using social media. The knowledge and attitude scores were calculated. The percentage of correct responses for each participant was computed. The participant with a percentage of correct responses above 50% was considered to have adequate knowledge/attitude. *Results:* The study included 385 responses from the participants. The median knowledge score was 6. The median attitude score was 13. Having a medical profession, receiving information and history of undergoing MRI scan were significantly associated with adequate knowledge. Multivariate analysis revealed that secondary school education, university education, post-graduate studies and medical profession were significantly associated with a higher probability of having an adequate attitude. *Conclusions:* Nearly half the patients had adequate knowledge and 86% exhibited a good attitude regarding MRI safety. Both knowledge and attitude had a significant association with having a medical profession.

Keywords: Magnetic Resonance Imaging, Safety, Knowledge, Attitude, Saudi Arabia

1. INTRODUCTION

Magnetic resonance imaging (MRI) is widely used in medicine as a non-invasive imaging tool. Compared to compute tomography, MRI creates 3D images, hence providing superior anatomical and physiological information about the imaged body part. In addition, ionizing radiation is not used, thus MRI can be safely used for follow-up without exposing the patients to radiation hazards (Tsai et al., 2015; Beek et al., 2019).

The technique of MRI depends mainly on exciting the nuclei of hydrogen within the molecules of water and recording the changes in their rotational axis direction. This technique makes MRI an ideal diagnostic tool for human body soft tissues due to the provided high contrast resolution of soft tissues, without injecting a contrast agent (Shu et al., 2022).

Reporting the occurrence of some adverse events with MRI usage raised concerns about its safety (Muranaka et al., 2011; Hawkinson et al., 2012; Kim et al., 2015). These adverse events during MRI scans may result from the strong static magnetic field, the radiofrequency field or the excessive noises (Hoff et al., 2019; Stafford, 2020). To ensure patient safety, some measures must be considered before MRI scanning (European Society of Radiology and European Federation of Radiographer Societies, 2019).

Knowledge of the public about a medical technique affects the person's behavior and attitude. Therefore, patients' knowledge and attitude play an essential role in improving the effectiveness of the provided care. Having sound knowledge and attitude for persons undergoing any medical procedure is crucial to reduce patients' anxiety and ensure cooperation (Ajam et al., 2020). Before undergoing an MRI scan, the patients should be notified about the technique and how to protect themselves from all potential MRI-related hazards (Bolejko and Hagell, 2021). In addition, patients' understanding and cooperation can reduce the image artefacts that result from movement during imaging (Havsteen et al., 2017). This study aimed to evaluate the knowledge level and explore the attitude of the general population in Saudi Arabia toward MRI safety and to investigate the association between different participants' characteristics and their knowledge level and attitude toward MRI safety.

2. METHODS

Ethical considerations

The study protocol obtained approval from the Ethics Committee of King Salman Armed Forces Hospital of Tabuk (KSAFH-REC-2022-485). The participants were informed about the study objectives, methodology, risks and benefits. Participants were asked to give an informed consent before starting to fill the questionnaire. Subjects who agreed to fill the questionnaire implied that they agreed to join in the study. The study conserved the participants' privacy and each subject got a unique identifier code. The investigators were responsible for keeping the security of the data and they confirm that the participants' data would not be used for any other purpose outside this study. Personal data (e.g., name, contact info) were not included in the study data entry software to conserve the participants' privacy.

Study design, setting and data

This cross-sectional survey study was conducted all over Saudi Arabia during a period of two months (September and November 2022). The study included adult male and female participants. All adult populations of Saudi Arabia were invited to participate. We excluded subjects who refused to participate and those with incomplete data.

Study tool and its validation

An online, structured, self-administered questionnaire was designed and presented to the participants to collect data. The questionnaire was reviewed by three consultants. Then, a pilot study was carried out on a small number of participants. Finally, the questionnaire was applied to the estimated sample of participants. The knowledge score was calculated by assigning 1 point for each correct answer and zero for an incorrect response or "I do not know". The score was calculated by adding the points of the 13 questions assessing knowledge. The responses to the attitude questions were similarly graded (1 point for correct behavior and zero for incorrect behavior) and the sum of all questions assessing the attitude constituted the attitude score. The percentage of correct responses for each participant was computed by dividing the score by the total number of questions used in score calculation and then multiplying by 100. The participant with a percentage of correct responses above 50% was considered to have adequate knowledge/attitude.

Data collection

The online survey was created using Google Forms for data collection. It was disseminated to the community using several social media platforms. The survey collected data about the participants' socio-demographics as well as their knowledge about and

attitude toward MRI safety. The outcome measures were the level of participants' knowledge toward MRI safety, the participants' attitude toward MRI safety and the determining factors for the participants' knowledge and attitude.

Sampling and sample size

A non-probability convenience sampling technique was used to collect the predetermined response rate. The sample size was estimated with an online sample size calculator (Raosoft, http://www.raosoft.com/samplesize.html) using a margin of error of 5% and a confidence interval of 95%, assuming an average response for most of the questions of 50% and depending on an average population size of nearly 23.3 million adult population in Saudi Arabia (Statistics, 2022). The required sample size was 385.

Statistical analysis

Statistical analysis was performed using the SPSS program (IBM SPSS Statistics), version 26 for Windows (IBM Corp., Armonk, N.Y., USA). The questionnaire responses consisted of categorical variables that were summarized as counts and percentages. Numerical variables were computed including the calculated scores and the percentages of correct responses. These numerical variables did not follow the normal distribution and were summarized as the median and interquartile range (IQR; expressed as the 25^{th} – 75^{th} percentiles). Spearman's rank-order correlation was performed to evaluate the relationship between the knowledge and attitude scores. Logistic regression analysis was conducted to assess the association between the participants' characteristics and their knowledge and attitude concerning MRI. A p-value<0.05 was selected to interpret the statistical significance.

3. RESULTS

The present study included 385 responses from the participants regarding their knowledge and attitude towards MRI scanning. The age of most participants ranged between 18 and 29 years (61.6%). Female participants outnumbered male participants (68.8% vs. 31.2%). Most participants had a university degree (68.6%) and 12.7% had postgraduate degrees, thus most participants were highly educated. Most participants had no jobs, as students, housewives and non-employed individuals accounted for 41.3%, 11.2%, and 8.3% of the studied sample, respectively. The participants who had a job belonged to a non-medical profession in 24.2% and a medical profession in 15.1% of cases. Only 29.4% of participants underwent MRI scanning before and 77.7% received information about MRI before (Table 1).

Table 1 Characteristics of the participants (total n = 385)

Characteristics of the participants		Total participants = 385
Age (years)	18 – 29	237 (61.6%)
	30 – 39	68 (17.7%)
	30 – 49	40 (10.4%)
	50 – 59	31 (8.1%)
	60 – 70	8 (2.1%)
	>70	1 (0.3%)
Sex	Male	120 (31.2%)
	Female	265 (68.8%)
Educational level	Primary	5 (1.3%)
	Intermediate	3 (0.8%)
	Secondary	64 (16.6%)
	University	264 (68.6%)
	Postgraduate	49 (12.7%)
Occupation	Housewife	43 (11.2%)
	Student	159 (41.3%)
	Non-employed	32 (8.3%)
	Non-medical profession	93 (24.2%)
	Medical profession	58 (15.1%)

Have you received information before about MRI	No	86 (22.3%)
	Yes	299 (77.7%)
Have you undergone an MRI scan before?	No	272 (70.6%)
	Yes	113 (29.4%)

The main source of information about MRI scanning was healthcare providers (33.8%), followed by medical websites (15.1%), family and friends (11.7%), media (8.4%) and lastly the non-medical websites (7.7%) (Figure 1).

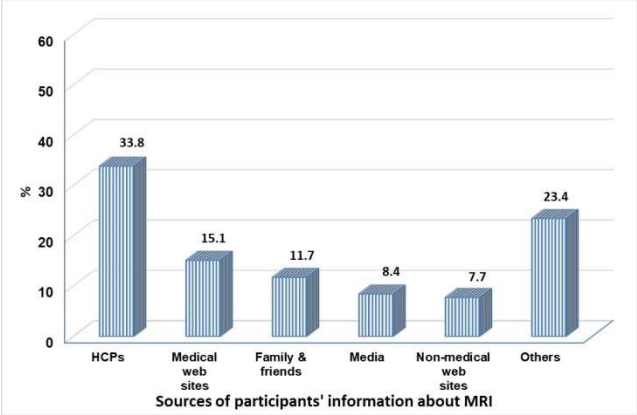

Figure 1 Sources of the participants' information about MRI (total n = 299)

HCP: Healthcare providers

The participants' responses to questions assessing knowledge are presented in Figure 2. The questions that were answered correctly by most participants were "removing all metallic objects before the MRI scan (84.9%), remaining still during the scan (82.6%) and resuming normal activities after the MRI scan (71.7%). However, correct answers for the other questions were provided by less than 60% of participants. The questions with the least correct responses were about undergoing an MRI scan during pregnancy (24.9%) and the inability of the people with tattoos to undergo MRI scanning (18.2%).

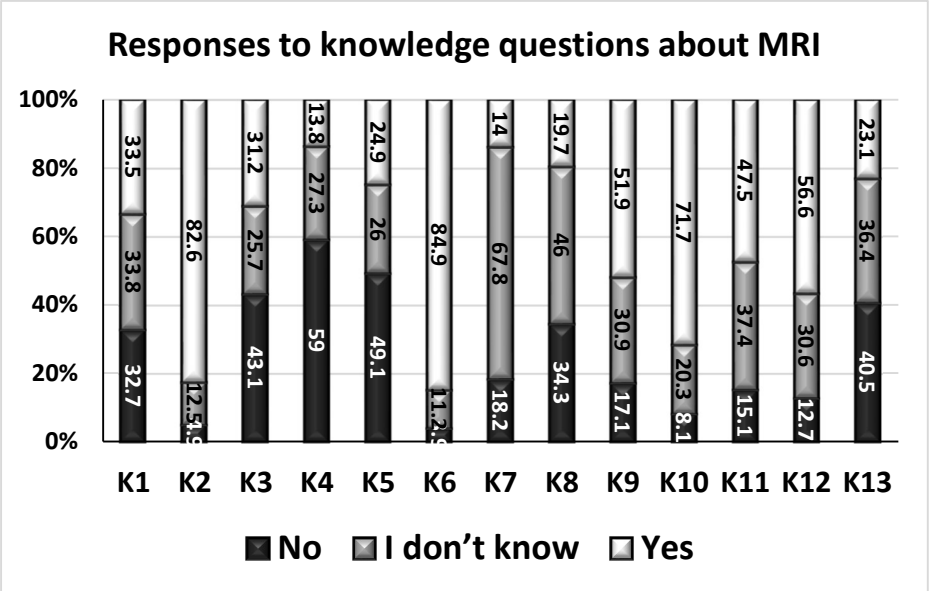

Figure 2 Bar chart showing the percentage of responses to questions assessing knowledge about MRI (total n = 385)

K1: Does MRI use harmful ionizing radiation like radiography and computed tomography scan?; K2: During the MRI scan, you need to remain still; K3: Will you be able to talk to the person carrying out the scan during imaging?; K4: All MRI examinations require injection with a dye; K5: Can pregnant women undergo an MRI scan at any time during pregnancy?; K6: Before the MRI scan, you must remove all metallic objects; K7: All people with tattoos cannot have an MRI examination; K8: Are pacemakers and metallic implants safe for the MRI scan?; K9: A loud noise is produced by the MRI scanner; K10: After the MRI scan, you can immediately resume your normal activities; K11: Should renal function tests be checked before undergoing MRI scanning with contrast agents?; K12: Should you remove makeup, nail polish or other cosmetics that may contain metallic particles applied to the body part to be examined by MRI?; K13: Can you enter the MRI room in a wheelchair?

The responses to the questions assessing the participants' attitudes regarding MRI scanning are demonstrated in Figure 3. The question with the highest percentage of correct responses was informing the technologist about any metallic objects before entering the MRI scanner room (90.9%), followed by informing the radiologist of any heat or discomfort while undergoing an MRI scan with a contrast agent (90.6%). The responses were generally reflecting a good attitude. However, the responses to the last question (about the items that should be removed before the scan) showed a lower percentage of correct responses as none of the participants was able to recognize all the items. The least recognized item was "shoes" (17.4%).

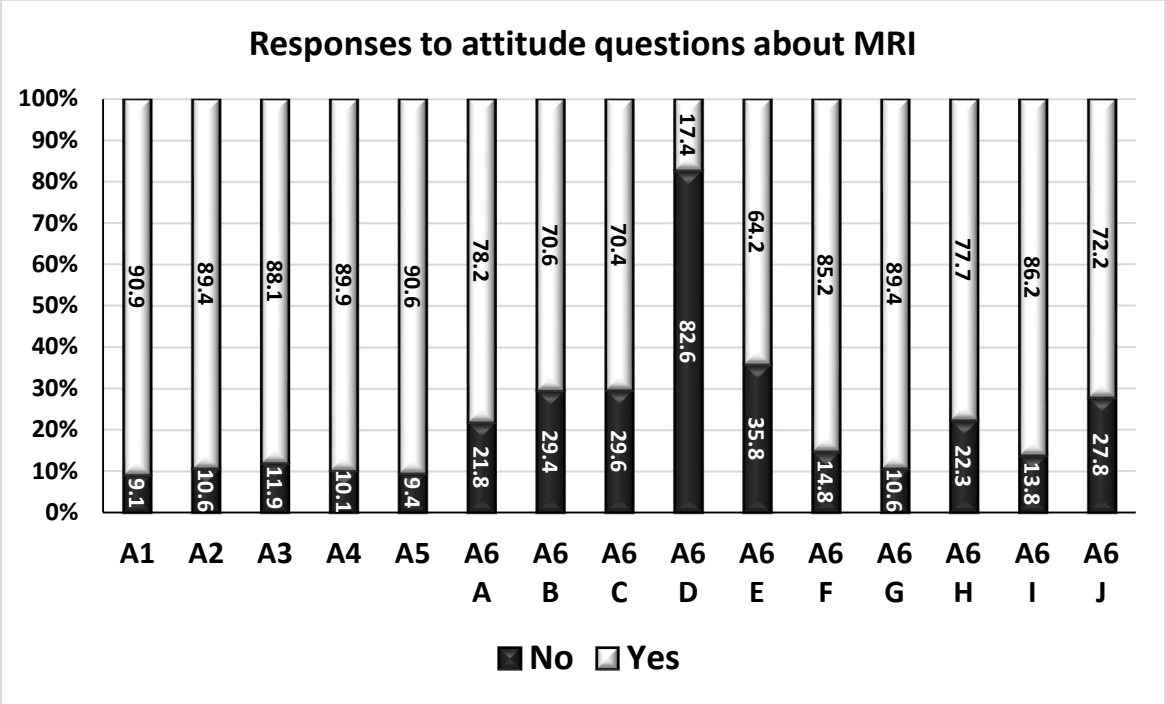

Figure 3 Bar chart showing the percentage of responses to questions assessing attitude about MRI (total n = 385)

A1: You must inform the MRI technologist about any metallic internal or external object that you may have before entering the MR scanner room; A2: You must inform the MRI technologist about any claustrophobia that you may have before entering the MR scanner room; A3: Before undergoing an MRI scan with contrast, you should inform the radiologists if you have any renal problems; A4: Before undergoing an MRI scan with contrast, you should inform the radiologists if you have any allergy to dyes; A5: During an MRI scan with contrast, you should inform the radiologists if you have any heat or any discomfort; A6: If you are going to undergo an MRI scan, you should remove the following objects:; A6-A: buckle belts; A6-B: Ext hearing aids; A6-C: Clothes with metallic threads; A6-D: Shoes; A6-E: Credit cards; A6-F: Coins; A6-G: Jewellery; A6-H: Hair clips & pins; A6-I: Keys; A6-J: Safety pins.

Figure 4 and 5 shows the calculated scores and percentages of correct responses per participant. The knowledge score was found ranging between 0 and 13, with a median value of 6. The attitude score ranged between 0 and 14, with a median value of 13. The median percentage of correct responses per participant was lower for knowledge than attitude questions (46.2 and 86.7, respectively). This was reflected in the categorization of the participants into groups based on their knowledge and attitude, as 49.4% of participants had adequate knowledge while 86% exhibited a good attitude. The knowledge score correlated positively, significantly and moderately with the attitude score ($r_s = 0.405$, $p < 0.001$) (Figure 6).

Binomial logistic regression analysis was conducted to assess the contribution of the participants' characteristics to their knowledge about MRI scans. Univariate analysis showed that having a medical profession, receiving information and undergoing an MRI scan before were significantly associated with having adequate knowledge ($p < 0.001$). On multivariate analysis, having a medical profession, receiving information and undergoing an MRI scan before were significantly associated with a higher probability of having adequate knowledge by 4.313, 3.307 and 3.316 times, respectively (Table 2).

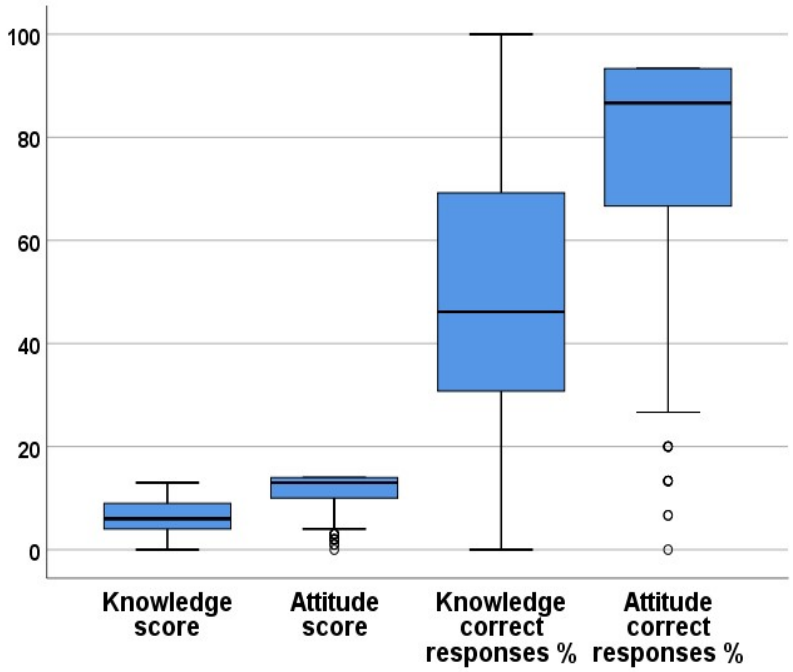

Figure 4 The distribution of the scores as well as the percentages of the correct responses of knowledge and attitude (total n = 385)

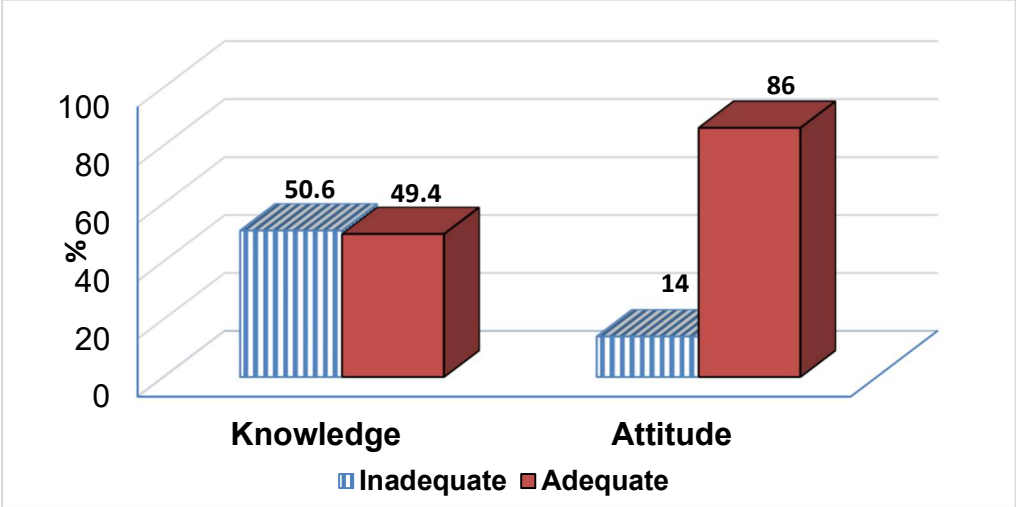

Figure 5 Bar chart showing the distribution of knowledge and attitude groups (total n = 385)

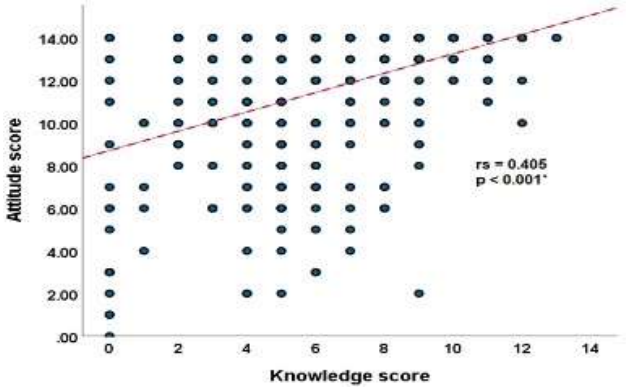

Figure 6 Spearman's rank-order correlation between the knowledge and attitude scores (total n = 385)

Table 2 Univariate and multivariate analysis for knowledge and attitude (total n = 385)

Participants' characteristics	Univariate analysis			Multivariate analysis		
	p-value	OR	95% CI for OR	p-value	OR	95% CI for OR
Age (reference category: 18 – 29 years)						
30 – 39	0.950	0.983	0.573 to 1.686			
30 – 49	0.166	0.618	0.312 to 1.222			
50 – 59	0.299	0.669	0.314 to 1.428			
>60 a	0.285	0.463	0.113 to 1.896			
Male sex (reference category: female)	0.406	1.201	0.780 to 1.850			
Educational level (reference category: primary school)						
Intermediate school	0.999	0.000				
Secondary school	0.632	0.633	0.098 to 4.100			
University	0.601	1.618	0.266 to 9.842			
Postgraduate degree	0.280	2.824	0.429 to 18.567			
Occupation (reference category: unemployed) b						
Non-medical profession	0.279	0.763	0.467 to 1.245	0.103	0.628	0.360 to 1.098
Medical profession	<0.001*	5.796	2.798 to 12.007	<0.001*	4.313	1.948 to 9.552
Received information before about MRI (reference category no)	<0.001*	4.349	2.509 to 7.539	<0.001*	3.307	1.832 to 5.968
Underwent an MRI scan before? (reference category no)	<0.001*	2.695	1.704 to 4.262	<0.001*	3.316	1.981 to 5.551

a: One case aged over seventy years was added to from 60 – 70 in the regression analysis; b: Unemployed include students, housewives and non-employed;
** CI: Confidence interval; OR: Odds ratio; significant <0.05*

As regards the impact of the participants' characteristics on their attitude towards MRI scans, univariate analysis showed a significant association with the medical profession. The p-value for university and post-graduate degrees was above the selected level of significance ($p<0.05$), but also below the p-value usually used for including the variables in regression analysis ($p<0.1$). Therefore, both occupation and education were entered into the multivariate analysis. Multivariate analysis revealed that secondary school education, university education, post-graduate studies and the medical profession were significantly associated with a higher probability of having an adequate attitude by 2.916, 6.337, 6.690 and 4.681 times, respectively (Table 3).

Table 3 Univariate and multivariate analysis for attitude (total n = 385)

Participants' characteristics	Univariate analysis			Multivariate analysis		
	p-value	OR	95% CI for OR	p-value	OR	95% CI for OR
Age (reference category: 18 – 29 years)						
30 – 39	0.446	0.755	0.366 to 1.557			
30 – 49	0.272	1.995	0.582 to 6.844			
50 – 59	0.741	0.841	0.302 to 2.345			
60 – 70	0.811	1.294	0.157 to 10.686			
Male sex (reference category: female)	0.792	1.088	0.58 to 2.04			
Educational level (reference category: primary school)						
Intermediate school	0.851	1.333	0.067 to 26.618	0.571	2.000	0.181 to 22.056
Secondary school	0.469	2.000	0.306 to 13.062	<0.001*	2.916	1.637 to 5.195
University	0.084	5.011	0.805 to 31.174	<0.001*	6.337	4.133 to 9.716
Postgraduate degree	0.055	7.500	0.955 to 58.893	0.001*	6.690	2.165 to 20.665
Occupation (reference category: unemployed (including students, housewives and non-employed))						

Non-medical profession	0.351	1.392	0.694 to 2.789	0.641	1.187	0.578 to 2.438
Medical profession	0.018*	5.773	1.353 to 24.634	0.044*	4.681	1.046 to 20.957
Received information before about MRI (reference category no)	0.982	0.992	0.497 to 1.982			
Underwent an MRI scan before? (reference category no)	0.711	0.889	0.478 to 1.655			

a: One case aged over seventy years was added to from 60 – 70 in the regression analysis; b: Unemployed include students, housewives and non-employed;
** CI: Confidence interval; OR: Odds ratio; significant <0.05.*

4. DISCUSSION

There is a need to increase the knowledge about safety of MRI among healthcare professionals and patients because of the increased clinical demand for MRI (Feychting, 2005; Kanal et al., 2013). Magnetic resonance imaging is a diagnostic tool that uses magnetism and radio waves to produce high-resolution images of internal body structures. The powerful magnetic field can cause serious and possibly fatal injuries to patients and other personnel in the area (Gilk and Latino, 2011; Crisp and Dawdy, 2018). Our study explored the knowledge level and attitude of the Saudi population toward MRI safety and to investigate the association between participants' characteristics and the level of their knowledge and attitude. An online questionnaire was disseminated through social media for this purpose.

According to our study, almost half the participants had adequate knowledge and 86% showed a good attitude towards MRI safety. This was different from the reported poor knowledge of MRI safety aspects shown in previous studies. In Saudi Arabia, an earlier survey on 200 randomly selected patients requiring MRI (2022) concluded that patients did not have sufficient knowledge about the procedure. Another research was carried out at King Khalid hospital. The participants had poor knowledge about MRI safety (Alelyani et al., 2021). It is worth mentioning that the previous two studies were conducted among patients while our study included all population not exclusively patients. In fact, 15.1% of our participants had a medical profession. However, a Malaysian study conducted on a group of healthcare workers showed low awareness of MRI safety (Abd-Aziz et al., 2022).

Metal objects are subject to translational attraction and torque when exposed to strong magnetic forces, possibly leading to dislodgement or unnecessary heating (Gianesin et al., 2015). The majority of our participants correctly answered the questions regarding the necessity to remove and inform the technologist about any metallic objects prior to MRI scanning. On the other hand, the questions with the least correct answers were about the possibility of pregnant women and people with tattoos to have MRI scan. Pregnant women can undergo an MRI scan in any stage of pregnancy if the requested data could not be obtained by ultrasound, the needed data would affect the outcome of the patient or fetus and the physician believes that waiting until the patient is no longer pregnant is not the best option (Sammet, 2016). Patients with cosmetic and traditional tattoos can undergo routine MRI (Alsing et al., 2020). The results of the answers to the aforementioned questions are comparable to the results of earlier studies (Prezzia et al., 2013; Abd-Aziz et al., 2022; Alahmari et al., 2022).

According to our study, having a medical profession, receiving information and undergoing a previous MRI scan were significantly associated with better knowledge. Attitude towards MRI scans was also associated with medical profession. While it is expected that medical personnel would have good knowledge about the imaging method they would request for the patient, several studies demonstrated a need to increase awareness and knowledge about radiological modalities and safety among physicians (Sadigh et al., 2014; Qutbi et al., 2021; Alyahyawi et al., 2022). A Turkish study on health professionals revealed that emergency physicians had better knowledge on radiological imaging than other specialties (with the exception of radiologists). However, very few physicians provided information regarding the risks of imaging methods to the patients (Demir and Akkas, 2019).

The present study concluded that age and gender were not significantly associated with knowledge and attitude scores. Abd-Aziz et al., (2022) found no association between participants' knowledge of MRI safety and any of their demographic data. The lack of significant association with gender was in accordance with Alelyani et al., (2021), even though they stated that knowledge scores were higher in patients younger than 29 years compared with the other groups. On the other hand, Alahmari et al., (2022) concluded that male participants above 40 years were less knowledgeable than younger participants. The majority of our study participants were highly educated. Interestingly, educational level did not significantly associate with higher knowledge scores. Knowledge level also showed no significant association with the education level of the participants in (Alelyani et al., 2021).

5. CONCLUSION

Our study showed that almost half of the participants had adequate knowledge and 86% had good attitude towards MRI study. Safety information of MRI must be disseminated for health workers as well as patients. Health facilities should implement MRI safety programs to avoid unnecessary hazards.

Acknowledgement

We thank the participants who were all contributed samples to the study.

Author Contributions

All authors shared in the study conception as well as the study design. Material preparation, data collection and analysis were carried out by Shouq Abdullah O Alwabisi, Lama Mueysh M Aljohani, Amal Naif Muidh Althobaiti, Mei Khalid S Alfaqiri and Shahad Ali M Rfadh. The first draft of the manuscript was prepared by Abdullah Dhafer A Alshehri, Afnan Saleh M Alsaiari, Amal Ayedh S Alenazi, Abdullah Mohammed A Al Madshush and Rahaf Naif A Alenezi. The manuscript was revised by Siraj Fahad Wally and Sarah Muqbil B Altmimi. All authors have read and approved the final manuscript.

Ethical approval

The study was approved by the Ethics Committee of King Salman Armed Forces Hospital of Tabuk (KSAFH-REC-2022-485).

Informed consent

Written informed consent was obtained from all individual participants included in the study.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES AND NOTES

1. Abd-Aziz NNS, Zakaria WFWC, Yamin LSM. Assessment of knowledge and perception toward magnetic resonance imaging (MRI) safety among healthcare workers. Healthscope: The Official Research Book of Faculty of Health Sciences. UiTM 2022; 5:42-7
2. Ajam AA, Tahir S, Makary MS, Longworth S, Lang EV, Krishna NG, Mayr NA, Nguyen XV. Communication and team interactions to improve patient experiences, quality of care and throughput in MRI. Top Magn Reson Imaging 2020; 29:131-4. doi: 1097/rmr.0000000000000242
3. Alahmari DM, Alsahli FM, Alghamdi SA, Alomair OI, Alghamdi A, Alsaadi MJ. Assessment of patient knowledge level towards MRI safety before the scanning in Saudi Arabia. Int J Gen Med 2022; 15:6289-99. doi: 10.2147/ijgm.s368652
4. Alelyani M, Alqahtani M, Alamri S, Alghamdi A, Alghamdi AJ, Asiri AA, Alshehri N, Shafei A, Assiri A. Saudi Arabian health workers' perception and attitudes toward magnetic resonance imaging safety. J Radiol Nurs 2021; 40:279-85. doi: 10.1016/j.jradnu.2021.03.004
5. Alelyani M, Gameraddin M, Alasmari A, Alshahrani F, Alqahtani N, Musa A. Patients' perceptions and attitude towards MRI safety in Asir Region, Saudi Arabia. Patient Prefer Adherence 2021; 15:1075-81. doi: 10.2147/ppa.s309186
6. Alsing KK, Johannesen HH, Hansen RH, Serup J. Tattoo complications and magnetic resonance imaging: A comprehensive review of the literature. Acta Radiol 2020; 61:1695-700. doi: 10.1177/0284185120910427
7. Alyahyawi A, Elasbali AM, Ahmed HG. Practice, knowledge and awareness of the diverse effects of diagnostic radiology among radiology staff and students in Saudi Arabia. Curr Med Imaging 2022; 18:1335-42. doi: 10.2174/1573405618666220119102334
8. Beek EJRV, Kuhl C, Anzai Y, Desmond P, Ehman RL, Gong Q, Gold G, Gulani V, Hall-Craggs M, Leiner T, Lim CCT, Pipe JG, Reeder S, Reinhold C, Smits M, Sodickson DK, Tempany C, Vargas HA, Wang M. Value of MRI in

medicine: More than just another test? J Magn Reson Imaging 2019; 49:e14-e25. doi: 10.1002/jmri.26211
9. Bolejko A, Hagell P. Effects of an information booklet on patient anxiety and satisfaction with information in magnetic resonance imaging: A randomized, single-blind, placebo-controlled trial. Radiography 2021; 27:162-7. doi: 10.1016/j.radi.2020.07.011
10. Crisp S, Dawdy K. Building a magnetic resonance imaging safety culture from the ground up. J Med Imaging Radiat Sci 2018; 49:18-22. doi: 10.1016/j.jmir.2017.10.005
11. Demir MC, Akkas M. Awareness of risks associated with the use of plain X-ray, computed tomography and magnetic resonance imaging among emergency physicians and comparison with that of other physicians: A survey from Turkey. Med Sci Monit 2019; 25:6587-97. doi: 10.12659/msm.918381
12. European Society of Radiology (ESR), European Federation of Radiographer Societies (EFRS). Patient safety in medical imaging: A joint paper of the European Society of Radiology (ESR) and the European Federation of Radiographer Societies (EFRS). Insights Imaging 2019; 10:45. doi: 10.1186/s13244-019-0721-y
13. Feychting M. Health effects of static magnetic fields: A review of the epidemiological evidence. Prog Biophys Mol Biol 2005; 87:241-6. doi: 10.1016/j.pbiomolbio.2004.08.007
14. Gianesin B, Zefiro D, Paparo F, Caminata A, Balocco M, Carrara P, Quintino S, Pinto V, Bacigalupo L, Rollandi GA, Marinelli M, Forni GL. Characterization of ferromagnetic or conductive properties of metallic foreign objects embedded within the human body with magnetic iron detector (MID): Screening patients for MRI. Magn Reson Med 2015; 73:2030-7. doi: 10.1002/mrm.25604
15. Gilk T, Latino R. MRI safety 10 years later. Patient Saf Qual Healthc 2011; 8:22-3
16. Havsteen I, Ohlhues A, Madsen KH, Nybing JD, Christensen H, Christensen A. Are movement artifacts in magnetic resonance imaging a real problem? A narrative review. Front Neurol 2017; 8:232. doi: 10.3389/fneur.2017.00232
17. Hawkinson JE, Ross AJ, Parthasarathy S, Scott DJ, Laramee EA, Posecion LJ, Rekshan WR, Sheau KE, Njaka ND, Bayley PJ, Charms RCD. Quantification of adverse events associated with functional MRI scanning and with real-time fMRI-based training. Int J Behav Med 2012; 19:372-81. doi: 10.1007/s12529-011-9165-6
18. Hoff MN, Mc-Kinney A, Shellock FG, Rassner U, Gilk T, Watson RE, Greenberg TD, Froelich J, Kanal E. Safety considerations of 7-T MRI in clinical practice. Radiol 2019; 292:509-18. doi: 10.1148/radiol.2019182742
19. Kanal E, Barkovich AJ, Bell C, Borgstede JP, Bradley WG, Froelich JWJ, Gimbel JR, Gosbee JW, Kuhni-Kaminski E, Larson PA, Lester JW, Nyenhuis JJ, Schaefer DJ, Sebek EA, Weinreb J, Wilkoff BL, Woods TO, Lucey L, Hernandez D. ACR guidance document on MR safe practices 2013. J Magn Reson Imaging 2013; 37:501-30. doi: 10.1002/jmri.24011
20. Kim BG, Kim JW, Park JJ, Kim SH, Kim HN, Choi JY. Adverse events and discomfort during magnetic resonance imaging in cochlear implant recipients. JAMA Otolaryngol Head Neck Surg 2015; 141:45-52. doi: 10.1001/jamaoto.2014.2926
21. Muranaka H, Horiguchi T, Ueda Y, Tanki N. Evaluation of RF heating due to various implants during MR procedures. Magn Reson Med Sci 2011; 10:11-9. doi: 10.2463/mrms.10.11
22. Prezzia C, Vorona G, Greenspan R. Fourth year medical student opinions and basic knowledge regarding the field of radiology. Acad Radiol 2013; 20:272-83. doi: 10.1016/j.acra.2012.10.004
23. Qutbi HAS, Taher TMJ, Mahdi SA. Knowledge about risk and protective measures related to diagnostic radiation among medical staff in teaching hospitals (Wasit Province). Wiad Lek 2021; 74:2345-51
24. Sadigh G, Khan R, Kassin MT, Applegate KE. Radiation safety knowledge and perceptions among residents: A potential improvement opportunity for graduate medical education in the United States. Acad Radiol 2014; 21:869-78. doi: 10.1016/j.acra.2014.01.016
25. Sammet S. Magnetic resonance safety. Abdom Radiol (NY) 2016; 41:444-51. doi: 10.1007/s00261-016-0680-4
26. Shu H, Ma Q, Li A, Wang P, Gao Y, Yao Q, Hu Y, Ye X. Diagnostic performance of US and MRI in predicting malignancy of soft tissue masses: Using a scoring system. Front Oncol 2022; 12:853232. doi: 10.3389/fonc.2022.853232
27. Stafford RJ. The physics of magnetic resonance imaging safety. Magn Reson Imaging Clin N Am 2020; 28:517-36. doi: 10.1016/j.mric.2020.08.002
28. Tsai LL, Grant AK, Mortele KJ, Kung JW, Smith MP. A practical guide to MR imaging safety: What radiologists need to know? Radiographics 2015; 35:1722-37. doi: 10.1148/rg.2015150108