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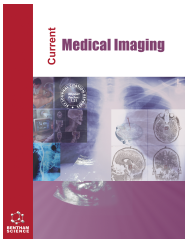

RESEARCH ARTICLE

Radiologists' and Radiographers' Perspectives on Artificial Intelligence in Medical Imaging in Saudi Arabia

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Abstract:

Introduction:

Artificial intelligence (AI) in medical imaging rapidly expands regarding image processing and interpretation. Therefore, the aim was to explore radiographers' and radiologists' perceptions and attitudes towards AI use in medical imaging technologies in Saudi Arabia.

Methods:

The survey was distributed online, and responses were collected from 173 participants nationwide. Data analysis was performed using SPSS Statistics (version 27).

Results:

The participants scored an average of 1.7, 1.6, and 1.8 on a scale of 1–3 for attitudinal perspectives on clinical application and the positive and negative impact of integrating AI technology in diagnostic radiology. Lack of knowledge (43.9%) and perceived cyber threats (37.7%) were the most cited factors hindering AI implementation in Saudi Arabia.

Conclusion:

The radiographers and radiologists in this study had a favorable attitude toward AI integration in diagnostic radiology; nonetheless, concerns were raised about data protection, cyber security, AI-related errors, and decision-making challenges.

Keywords: Artificial intelligence, Diagnostic radiology, Radiographer, Radiologists, CT, US.

Article History	Received: April 10, 2023	Revised: October 7, 2023	Accepted: October 16, 2023

1. INTRODUCTION

Medical imaging (MI) modalities, including computed tomography (CT), ultrasound (US), single photon emission tomography/positron emission tomography (SPECT/PET), and magnetic resonance imaging (MRI), play a critical role in the detection or diagnosis of several diseases [1]. Human experts are responsible for analyzing and interpreting medical images in clinical work. Physicians have recently started to benefit from computer-aided diagnoses [2]. Advances in machine learning methods have resulted in powerful learning algorithms, referred to as artificial intelligence (AI) [3], defined as computer systems that can perform tasks that would typically require human intelligence, such as decision-making, visual perception, and speech recognition [4]. AI is widely used in medical fields, especially for domains requesting imaging data analysis, such as diagnostic imaging and pathology [5, 6]. This approach has the potential to change physicians' clinical practice in MI. Although the vast majority of applications have been focused on assisting and augmenting radiologists, there is an increase in applications that are directly appropriate to radiography practice [6, 7]. AI is recognized for providing unique benefits in MI, such as reduced workplace-related stress and providing clinical decision support to radiographers and radiologists [8, 9].

The radiographers' and radiologists' perspectives on AI integration into MI must be better understood. Whether AI will

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support radiographers' decisions in radiation dose selection is unclear. Healthcare professionals must be able to predict AI's professional requirements and potential unknowns to ensure its safe, continuous, and effective integration into MI practice [10, 11]. This has sparked debates about the responsibilities and roles of imaging professionals, especially radiologists and radiographers, who will use this technology [10].

During the COVID-19 pandemic, radiologists have used AI to diagnose and progress COVID-19, utilizing a variety of imaging evidence [12 - 14]. One study found that using AI to interpret radiological data improved COVID-19 diagnosis compared to a radiologist-only approach without the aid of AI [15]. Another study found that AI can enhance image interpretations in accurately distinguishing COVID-19 from other pneumonia infections [16].

Radiographers are in charge of image post-processing, such as 3D image formation or multiplanar reconstruction, which is mostly automated and can be improved with AI integration [17]. Some radiographers may have exciting or scary views of AI, suggesting that these scary views may be heightened by the thought of having an "AI colleague" in the medical imaging department [18]. Using AI in MI practice as a strategic plan will increase the possibility of its successful implementation. For AI applications to be well-integrated in the clinical radiology department, radiographers must support the integration process. However, there are only a few studies involving radiographers and AI systems. Few studies have been conducted to understand radiographers' perspectives and readiness to use AI in MI practice. These studies identified factors that could improve the implementation process in Africa and Ghana [19, 20]. Recently, two studies on this topic were conducted in Saudi Arabia [21, 22]. These studies included students who lacked experience in the real-life practice of a radiology department, which might have affected the results. However, this study explores only radiologists' and radiographers' perspectives on AI in MI practice in Saudi Arabia because they are at the forefront of this technological leap with real-life experience and adequate practice. Understanding their views, in particular, is critical for the optimal development and implementation of AI in MI. Therefore, this study aimed to explore the Saudi Arabian radiologists and radiographers' perspectives on integrating AI into MI practice to support policy development and enhance the AI implementation strategy for Saudi Arabia.

2. METHODS

2.1. Study Design, Sample Size, and Ethical Considerations

The study was designed as a self-administered survey that was distributed electronically between March 2021 and November 2021 to reveal the perspectives of radiographers and radiologists on AI in Saudi Arabia's radiology departments. The Standing Committee for Scientific Research - Jazan University approved the current REC-43/10/229 study.

G*Power version 3 was used to compute the required sample size for this study. The sample size needed to achieve 80% power for detecting a medium effect, at a significance criterion of $\alpha = .05$, was N = 150 for the Independent Sample T-Test. The survey was administered electronically using Google Forms as the data collection procedure. Participants were mainly approached using social media platforms such as WhatsApp, Facebook, and Twitter. The survey's first page included an introduction information sheet that detailed the study's objective, duration, benefit, risk, what AI was for radiographers and radiologists, and the option to withdraw at any time. In addition, on the first page of the survey, each radiographer was requested to consent to their participation to access the survey electronically.

2.2. Instrument

The cross-sectional survey used in the current study was previously validated and tested by a panel of academics with 7–10 years of experience in radiography research and practice [19]. The survey consists of several sections: (a) questions regarding demographic data, (b) attitudinal perspective items (five Likert scale statements) towards AI in MI, (c) perspective items (ten Likert scale statements) on the positive impact of AI on MI, (d) perspective items (eight Likert scale statements) on the negative impact of AI on MI, (e) perspective items on factors affecting AI in MI (four Likert scale statements) and decision-making of AI (three Likert scale statements) and (f) one open-ended question (free-text comment) at the end of the questionnaire. The questionnaire had 36 items, including closed-ended questions and 5-point Likert scale statements (1 = strongly disagree to 5 = strongly agree).

2.3. Data Analysis

The current study used the Statistical Package for the Social Sciences (SPSS version 27) to analyze the data. Descriptive statistics (frequencies, percentages, and means) and inferential statistics (correlation coefficients and *P*-values) were obtained. The responses to a five-point Likert scale were assigned scores (1–5), ranging from strongly agree = 5 to strongly disagree = 1. As shown in the tables, the responses, including strongly disagree and disagree, were grouped (coded in one number) to present the results easily. The aggregate mean scores (overall mean) were obtained for each study component. The relationship between participants' perspectives on AI and participants' demographic characteristics was assessed using Spearman's correlation. For non-parametric data variables, the Mann-Whitney U test was used. A P-value of less than 0.05 was defined as the statistical significance.

3. RESULTS

3.1. Demographics

One hundred seventy-three participants (74.1% males, 25.3% females, 77% radiographers, and 23% radiologists, with a mean age of 31.4 ± 5.3 years) working in radiology departments in Saudi Arabia responded to the current cross-sectional survey. Summarize the participants' demographic characteristics (Fig. **1** and Table **1**).

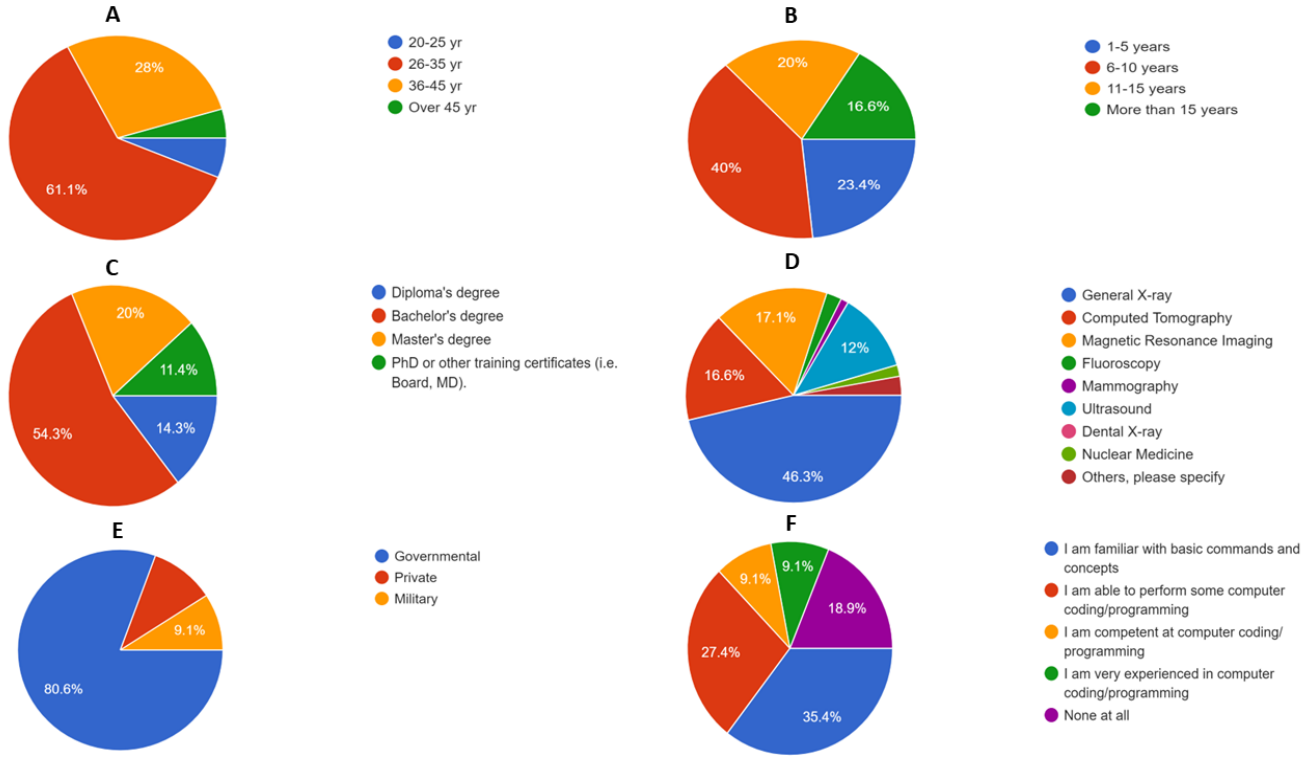

Fig. (1). Distribution of demographics. (**A**) shows percentages of age range. (**B**) shows percentages of work experience in years. (**C**) shows percentages of qualifications (educational levels). (**D**) shows percentages of participants working on different imaging modalities. (**E**) shows percentages of participants working in different hospitals. (**F**) shows percentages of participants having an experience in programming.

Table 1. Summary of demographic characteristics.

Demographic characteristics	Number	%
Gender	-	-
Female	44	25.3%
Male	129	74.1%
Age	-	-
20–25 yrs.	11	6.3%
26–35 yrs.	107	61.8%
36–45 yrs.	47	27.2%
Over 45 yrs.	8	4.6%
Qualification level	-	-
Bachelor's degree	94	54.0%
Diploma degree	25	14.4%
Master's degree	34	19.5%
PhD or other training certificates (*i.e.*, board, MD).	20	11.5%
Years of working experience	-	-
1–5 years	41	23.6%
11–15 years	34	19.5%
6–10 years	70	40.2%
More than 15 years	28	16.1%
Type of Modality	-	-

(Table 1) contd.....

Computed tomography	28	16.1%
Fluoroscopy	4	2.3%
General X-ray	81	46.6%
Magnetic resonance imaging	29	16.7%
Mammography	2	1.1%
Nuclear medicine	3	1.7%
For others, please specify	5	2.9%
Ultrasound	21	12.1%
Type of hospital	-	-
Public	140	80.5%
Military	15	8.6%
Private	18	10.3%
Job title	-	-
Radiologists	40	23%
Radiographers	133	77%
Previous computer programming code experience	-	-
I can perform some computer coding/programming.	47	27.2%
I am competent in computer coding/programming.	16	9.2%
I am familiar with basic commands and concepts.	61	35.1%
I am very experienced in computer coding/programming.	16	9.2%
None at all.	33	19.0%

3.2. Participants' Perspectives on AI in MI

The findings regarding the participants' attitudinal perspectives on the implementation of AI in MI are described in Table **2**. More than 56% of participants were aware of AI as an emerging trend in MI, thrilled about its rise in MI, and embraced AI technology as the future of MI. Participants gave AI an average score of 1.7 on a scale of 1–3, indicating a favorable attitude toward AI integration in MI.

The participants' perspectives on AI's positive and negative impacts on MI are described in Tables **3** and **4**. More than half of the participants (55.5%) indicated that AI would positively impact MI practice. The participants indicated that AI could be an assistive tool to ease radiographers' work, increase patient care access, and improve decision-making, quality assurance, research productivity, and accuracy levels in diagnosing diseases and education (Table **3**). Furthermore, 63% of the participants indicated that AI would decrease radiation doses while maintaining optimal image quality. On the other hand, the majority of participants (nearly 60%) expressed fears of the possibility of machine errors while using AI-integrated equipment in radiography practice (n = 102) (Table **4**). On a scale of 1–3, the participants scored the positive and negative impacts of AI at an average of 1.6 and 1.8, respectively.

The findings of participants' perspectives on factors that may influence AI implementation and decision-making in MI are described in Tables **5** and **6**. Some of the obstacles to AI implementation in Saudi Arabia were identified as a lack of knowledge (43.9%) and perceived cyber threats (37.7%) (Table 5). In terms of AI decision-making, nearly half of the participants indicated that diagnostic decision-making should remain a human task and should not be handled through an AI algorithm (Table **6**).

3.3. Associations between Participants' Perspectives and Demographic Characteristics

There was a significant negative correlation between participants' perspectives on the positive impact of AI implementation and education or qualification level (p = 0.02) (Table **7**). In addition, there were significant positive associations between participants' perspectives on the negative impact of AI implementation and age and job title (radiographer or radiologist) (p = 0.04) for all. There were no significant correlations between any participants' perspectives and the type of hospital where they worked (governmental, private, or military), kind of modality, and previous experience in computer coding (p > 0.05).

Table 2. Radiographers and radiologists' attitudinal perspectives.

S.No.	-	Agreement	Neutral	Disagreement	Overall Mean
1	I am aware of AI as an emerging trend in medical imaging.	100 (57.8%)	37 (21.4%)	36 (20.8%)	1.70 ± 0.59
2	I am concerned about the integration of AI into medical imaging.	69 (39.9%)	46 (26.6%)	58 (33.5%)	
3	I am excited about the emergence of AI in medical imaging.	102 (59%)	31 (17.9%)	40 (23.1%)	
4	Most patients would be excited about using AI technology in their care.	81 (46.8%)	49 (28.3%)	43 (24.9%)	
5	I embrace AI technology as the future of medical imaging.	98 (56.6%)	33 (19.1%)	42 (24.3%)	

Table 3. Radiographers and radiologists' views on AI's benefits to medical imaging.

-		Agreement	Neutral	Disagreement	Overall mean
1	AI would have an overall positive impact on medical imaging.	96 (55.5%)	34 (19.7%)	43 (24.9%)	1.61 ± 0.55
2	AI would be an assistive tool to ease my work as a radiographer.	**104 (60.1%)**	29 (26.8%)	40 (23.1%)	
3	AI would increase access to care in places where radiologists are inaccessible.	90 (52%)	33 (19.1%)	50 (28.9%)	
4	AI would improve decision-making on the diagnostic results of patients.	94 (54.3%)	34 (19.7%)	45 (26%)	
5	AI technology would improve quality assurance through its efficiency in diagnosis.	108 (62.4%)	24 (13.9%)	41 (23.7%)	
6	The introduction of AI in medical imaging provides an avenue for more research productivity in radiology.	101 (58.4)	30 (17.3%)	42 (24.3%)	
7	AI would help to reduce radiation dose levels while maintaining optimal image quality in medical imaging.	**109 (63%)**	31 (17.9%)	33 (19.1%)	
8	AI would improve education in medical imaging.	102 (59%)	26 (15%)	45 (26%)	
9	AI would have increased levels of accuracy in detecting and diagnosing diseases.	97 (56.1%)	34 (19.7%)	42 (24.3%)	
10	AI would affect a change in the role of radiographers in the radiography unit.	74 (42.8%)	39 (22.5%)	60 (34.7%)	

Table 4. Radiographers and radiologists' views on AI's effects on medical imaging.

S.No.	-	Agreement	Neutral	Disagreement	Overall mean
1	The integration of AI would limit the radiographer's work in the unit.	69 (39.9%)	35 (20.2%)	69 (39.9%)	1.86 ± 0.52
2	Most radiologists will be negatively affected by the introduction of AI in diagnostic image interpretation.	47 (27.2%)	46 (26.6%)	80 (46.2%)	
3	I have a concern that AI will displace me from my job someday.	53 (30.6%)	36 (20.8%)	84 (48.6%)	
4	AI, as an assistive tool, could cause a reduction in my basic salary.	55 (31.8%)	40 (23.1%)	78 (45.1%)	
5	I acknowledge the possibility of machine errors associated with AI-induced equipment in the radiography unit.	**102 (59%)**	34 (19.7%)	37 (21.4%)	
6	AI might curtail patients' rights to privacy and confidentiality by storing personal information alongside clinical data.	62 (35.8%)	46 (26.6%)	65 (37.6%)	
7	AI tools could lead to the unethical use of patient data for unwarranted commercial quests.	54 (31.2%)	45 (26%)	74 (42.8%)	
8	AI would affect a change in the role of radiographers in the radiography unit.	74 (42.8%)	39 (22.5%)	60 (34.7%)	-

Table 5. Radiographers and radiologists' views on AI in medical imaging implementation factors.

S.No.	-	Agreement	Neutral	Disagreement
1	AI implementation in Saudi Arabia will be hindered by its high implementation costs.	54 (31.2%)	50 (28.9%)	69 (39.6%)
2	I acknowledge that the need for knowledge on the emergence of AI technology poses a significant barrier to AI implementation.	76 (43.9%)	48 (27.7%)	49 (28.3%)
3	The implementation of AI can easily be affected by a cyber threat.	65 (37.6%)	51 (29.5%)	57 (32.9%)
4	In an environment with a lack of robust cyber security measures, AI can be manipulated by cybercriminals.	63 (36.4%)	58 (33.5%)	52 (30.1%)

Table 6. Radiographers and radiologists' AI-affected decision-making.

S.No.	-	Agreement	Neutral	Disagreement
1	Diagnostic decision-making should remain a human task.	86 (49.7%)	45 (26%)	42 (24.3%)
2	Diagnostic decision-making should be shared equally with an AI algorithm.	72 (41.6%)	50 (28.9%)	51 (29.5%)
3	AI algorithms should handle diagnostic decision-making.	52 (30.1%)	53 (30.6%)	68 (39.3%)

Table 7. Correlations between respondents' demographics and their AI-related perspectives.

S.No.	-	Age		Gender		Education		Years of experience		Job title	
-	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	

(Table 7) contd.....

1	Perspectives on attitudes towards AI.	0.06	0.39	0.08	0.28	-0.11	0.15	0.03	0.65	0.03	0.63
2	Perspectives on the positive impact of AI.	0.04	0.58	0.09	0.23	-0.17	**0.02**	0.10	0.89	0.14	0.06
3	Perspectives on the negative impact of AI.	0.15	**0.04**	0.06	0.40	-0.01	0.96	0.10	0.18	0.15	**0.04**
4	Perspectives on factors affecting the implementation of AI.	0.01	0.92	0.02	0.73	0.01	0.83	0.01	0.89	-0.03	0.62
5	Perspectives on decision-making on the presence of AI.	0.01	0.93	0.14	0.05	0.03	0.66	-0.02	0.78	0.07	0.31

3.4. Differences in Participants' Perspectives Related to Gender, Age, and Employment Title

There was a statistically significant difference between radiographers and radiologists regarding their perspectives on the negative impact of AI (p = 0.048). There were no significant differences between males and females or those aged above or below 40 years in terms of their attitudinal perspectives towards AI, perspectives on the positive impact of AI implementation, and perspectives on the factors affecting AI implementation or diagnostic decision-making (p = > 0.05).

3.5. Open Question (Free-text Comments)

The open-ended question resulted in thematic free-text comments about AI in MI practice. Some participants favored using AI in MI, whereas others commented on a lack of knowledge about AI and the need for further training. One of the participants commented on the need for AI in mammography.

4. DISCUSSION

This survey was developed to begin gauging the radiographers' and radiologists' perceptions, level of understanding, concerns, and opinions on the emerging use of AI in MI practice, research, and training. Even though AI has only recently been introduced in the field of MI [23], this study revealed that most participants had at least basic computer programming or coding experience (81%).

More than half of the participants (57%) were aware of and excited about the rising trend in MI, with 56.6% considering that to be the discipline's future. This is by the findings of previous studies [19, 24]. On a scale of 1–3, the participants gave AI a mean score of 1.7, indicating a fairly favorable attitude toward AI in radiology. However, no statistically significant relationship was found between participants' attitudinal perspectives and demographic variables such as the level of education (P = 0.15) and years of work experience (P = 0.65).

Understanding the implications of AI is critical for medical practitioners, particularly the technology's meaning and contribution to the radiology profession. According to experts, AI-based applications will alter MI's ethical, scientific, economic, and clinical future [24]. More than half of the participants in this study reported that AI could be an assistive tool to ease their work (60.1%), optimize radiation dose levels (63%), improve quality assurance (62%), increase research productivity and, in general, have an overall positive impact on MI, which is consistent with several other previous studies [10, 18, 19]. Not only does AI have a positive effect in clinical practice from the participants' perspectives, but also in the academic field. According to Sarwar *et al*., AI tools are thought to improve MI education and promote radiology research output in the educational field [25].

Regarding AI's negative impact, participants scored the technology with a mean of 1.86 on a negative impact scale ranging from 1–3, indicating they do not have concerns about AI. For example, 48.6% of participants did not believe that AI would eventually displace them in a clinical environment. This was consistent with a survey conducted among medical students, who largely refuted the perception that radiologists would be replaced in the future [26]. This may be because a majority of the participants had a basic knowledge of computer coding. Furthermore, more than half of the participants were aware of this technology. These findings contrast with a previous study [19]. However, most participants (n = 102) were concerned about the possibility of machine errors associated with AI-induced equipment in the radiography unit, and 42.8% believed that AI might change their role in the unit. This aligns with other studies' findings [19, 25, 27]. An explanation for this belief could be a lack of sufficient and in-depth understanding of how AI is implemented and what it can achieve beyond implementation. Furthermore, there was no statistically significant correlation between participants' perspectives on AI's negative influence and their demographic characteristics (p > 0.05), except for age and job title (p = 0.04), respectively, implying that all participants, regardless of gender, would require similar training to ease some of their negative views about AI.

In terms of the factors that could affect AI implementation in MI, the majority of participants agreed that a lack of robust cyber security measures (63%) is a significant barrier to AI implementation in Saudi Arabia when compared to the other participants' opinions and knowledge on the emergence of AI technology (44%). This study's results align with several other studies [19, 28]. Only 31.2% of the participants stated that the high cost of AI systems would impact their implementation in Saudi Arabia. A previous study in Ghana reported that 78.1% of the participants stated that high equipment cost was a significant factor in hindering AI implementation [19].

In terms of who should make decisions about the use of AI tools, nearly half of the participants (n = 72) believed that radiology errors made in cases with AI-platform contributions, participants and vendors should be held equally liable, and a small minority even believed that the AI-algorithm should handle the vendor alone. The remaining half stated that making diagnostic decisions should remain a human task, which is in line with the conclusions of the Sarwar *et al*. study [28]. This could be because 60% of the participants stated that AI systems merely support tools.

There are several limitations to this study. The main limitation of the current study was the relatively small sample size, and the number of study participants who used AI in their clinical practice should have been reported. Therefore, additional studies with more participants are required to

validate these findings. However, it is essential to acknowledge that the limited sample size in our study, due to the challenges in participant response despite multiple survey attempts, may impact the generalizability of our findings. Another limitation of this study is a bias in sample data between males and females and between radiographers and radiologists. This may be because the number of radiologists in any hospital is always less than that of radiographers. Furthermore, radiologists are usually busy and need more time to complete any survey. Moreover, the percentage of male radiographers is more significant than that of female radiographers in Saudi Arabia. This caused the 1:3 gender ratio in our study. Therefore, a more extensive study is required to address these limitations.

CONCLUSION

In this study, radiographers and radiologists in Saudi Arabia revealed a positive attitude toward integrating AI into MI. However, concerns regarding AI-related errors, data protection, cyber security, and decision-making issues were recognized. Understanding radiologists' and radiographers' perspectives on AI in MI in Saudi Arabia has significant implications for practice, ensuring optimal technology development, implementation, training, and planning for prospective role changes.

AUTHORS' CONTRIBUTION

A.S.A. wrote the manuscript, co-designed the study, and assisted with study interpretation and manuscript preparation. N.A.M. analyzed and interpreted the data and wrote some parts of the manuscript. N.AS. Assisted with the data interpretation and manuscript preparation.

LIST OF ABBREVIATIONS

CT	=	Computed Tomography
AI	=	Artificial Intelligence
MRI	=	Magnetic Resonance Imaging

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The Standing Committee for Scientific Research - Jazan University approved the current REC-43/10/229 study.

HUMAN AND ANIMAL RIGHTS

No animals were used that are the basis of this study. All procedures performed in studies involving human participants were by the ethical standards of institutional and/or research committees and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from all participants of this study.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

STANDARDS OF REPORTING

STROBE guidelines were followed.

FUNDING

The Deputyship funded this research for Research& Innovation, Ministry of Education in Saudi Arabia through project number RUP3-2.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

The authors thank the Deputyship for Research& Innovation, Ministry of Education in Saudi Arabia, for funding this research work through project number RUP3-2.

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