Medical Science

Authors' Affiliation:
¹Professor Assistant of Radiology, College of Medicine, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia
²College of Medicine, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia

*Corresponding Author
College of Medicine, King Faisal University, Al-Ahsa, Kingdom of Saudi Arabia
Email: t.k.h2010@icloud.com

Contact List
Khalid Aljoqiman   Kaljoghaiman@kfu.edu.sa
Nora Alsultan   noraAlsultan1@outlook.com
Thamer Alhabdan   t.k.h2010@icloud.com
Latifah Aldhaif   m7-d@live.com
Mohammed Albesher   Aldhaif99@gmail.com
Nora Albaqshi   Norakhedr.2@gmail.com
Zainab Bu-Khamsin   ZainabBuKhamseen@gmail.com
Hussain Alali   h-alali2012@hotmail.com
Fatimah Alhabdan   Fatima.ahmed.1260@gmail.com

DISCOVERY
SCIENTIFIC SOCIETY

Knowledge, attitudes, and perceptions of medical students regarding Artificial intelligence in radiology in the Eastern Province of Saudi Arabia

Khalid Aljoqiman[1], **Nora Alsultan**[2], **Thamer Alhabdan**[2*], **Latifah Aldhaif**[2], **Mohammed Albesher**[2], **Nora Albaqshi**[2], **Zainab Bu-Khamsin**[2], **Hussain Alali**[2], **Fatimah Alhabdan**[2]

ABSTRACT

Background: Artificial intelligence (AI), particularly deep learning, is transforming radiology by enhancing diagnostic and imaging analysis capabilities. However, the integration of AI into clinical practice has sparked significant debate within the field. Research worldwide has shown that advancements in AI have negatively influenced medical students' interest in pursuing careers in diagnostic radiology. This study aims to evaluate the knowledge, attitudes, and perceptions of medical students toward AI in radiology in the Eastern Province of Saudi Arabia. *Methodology:* It is a cross-sectional study, conducted in Eastern Province medical students' knowledge, attitudes, and perceptions of AI in radiology using an online survey. *Results:* Our study included 393 medical students from the Eastern Province of Saudi Arabia. The respondents showed a good level of knowledge, with 31.7% of them having a high level of knowledge. A significant proportion of participants (63.8%) believed that AI would reduce the number of needed radiologists in the future, and a lesser proportion (37.3%) of them believed that AI would replace human radiologists in the foreseeable future. Moreover, the study revealed that participants with higher knowledge of AI in radiology tended to have more negative attitudes compared to those with less knowledge. As a result of these concerns, 31.8% of medical students were less likely to consider diagnostic radiology as a career option. In conclusion, medical students in the Eastern Province of Saudi Arabia demonstrate a strong understanding of AI and deep learning but express a more pessimistic perspective on the future of radiology as AI advances.

Keywords: Artificial Intelligence (AI), Radiology, Saudi Arabia, Al-Ahsa

1. INTRODUCTION

Artificial intelligence (AI) is an area of computer science that focuses on developing systems that can carry out activities that typically require human intelligence, using various methodologies (Pesapane et al., 2018). Machine learning (ML) is one branch of artificial intelligence that focuses on creating algorithms that can increase accuracy through data analysis and pattern identification. The healthcare sector has shown a great interest in deep learning (DL), a subdivision of machine learning (ML). DL uses artificial networks to analyze massive amounts of data, image analysis and even in robotic surgeries (Allam et al., 2024).

Research showed some applications of DL algorithms in the radiology field, including estimating pediatric bone age from hand radiographs, categorizing liver masses, and assessing the likelihood of malignant transformation for a lung nodule (Pesapane et al., 2018). In 2019, a study was conducted to evaluate the efficacy of AI in the diagnosis of COVID-19 and community-acquired pneumonia (CAP) using pulmonary CT scans. The results demonstrated high sensitivity and specificity. In the independent test set, the per-scan sensitivity and specificity for COVID-19 and CAP were 90% and 87%, respectively. This study provides an excellent example of the promising use of AI in radiology (Li et al., 2020).

The appearance of AI is associated with concerns among radiologists and medical students who have interest in diagnostic radiology as their future career about being replaced with AI. Although some radiologists consider AI as a threat, the common belief within the radiology community is that AI will positively impact the field by improving the efficiency of radiologists. Instead of replacing radiologists, AI may aid them with routine tasks, identify and describe abnormal imaging features to be reevaluated by radiologists, and assist in drafting radiology reports, thus decreasing their high workloads and giving them more time for collaboration with other medical professionals (Reeder and Lee, 2022). In recent years, the field of radiology has seen intense discussions about the potential clinical applications of AI (AA et al., 2021).

As a result, a diverse range of perspectives on AI's role in medicine has emerged due to these technological advancements. Surveys show that radiologists' views on AI range from ardent acceptance to anxiety and uncertainty, with their main concern being that they may be replaced by modern technology (Alelyani et al., 2021). Nonetheless, another recently published research suggests that radiologists do not have concerns that AI might substitute for them; rather, they have an optimistic view toward the application of AI (Khafaji et al., 2022). Another recently published research suggests that radiologists have an optimistic view toward the application of AI without having concerns that AI might substitute for them (Khafaji et al., 2022). Most radiologists in Saudi Arabia see AI and its role in radiology as advantageous.

Nevertheless, 17.0% of respondents reported worries that AI may replace their work, which is considerably lower than other occupations. In contrast, a higher percentage of respondents have expressed similar concerns, according to most prior investigations (Pinto-dos-Santos et al., 2018). Among Saudi radiology residents, a high proportion (nearly 72% of them) would like to have AI training as a part of their residency program (Pinto-dos-Santos et al., 2018). Although a study conducted by the European Society of Radiology concluded that AI will not displace radiologists, instead it will advance the field and boost the value and importance of radiologists (Neri et al., 2019). Many worldwide published studies assessed the perspectives of medical students toward these changes in radiology.

They concluded that medical students have misconceptions about the impact of AI in radiology and hold a negative attitude towards AI when considering a profession in the radiology field (Sit et al., 2020; Brandes et al., 2020; Gong et al., 2019). Similarly, a local study conducted in Riyadh reported similar findings. It concluded that the concerns about the effect of AI in radiology have negatively affected medical students' decisions to consider radiology as a possible career (Bin-Dahmash et al., 2020). The aim of our study is to address gaps in the existing literature by evaluating the perspectives of Saudi medical students from the Eastern Province regarding the application of AI in diagnostic radiology, and to consider our medical students' knowledge, attitudes, and perceptions of AI in radiology.

2. METHODOLOGY

A cross-sectional study was conducted between February 2024 and March 2024. It aims to assess the knowledge, attitudes, and perceptions of medical students towards artificial intelligence in radiology among medical students in Eastern Province, Saudi Arabia. An online survey was created using Google Forms for data collection. The online survey was shared and spread among medical students in Eastern Province, Saudi Arabia, and people were encouraged and invited to participate. Data was collected through an

online self-administered questionnaire where participants first consented to participate in the study before answering the questionnaire.

Questionnaire

The questionnaire was adapted from a broad multinational study conducted in Arab countries and published in the European Society of Radiology (Allam et al., 2024). The questionnaire was created using commonly asked questions from the previously published research in Canada, the UK, Croatia, and Germany. Each question was revised by experts in radiology and AI to ensure it was clear, comprehensive, and relevant (Allam et al., 2024). The first section included socio-demographic data: gender, country, residence, university, grade, and whether they are experts at using modern technology. The second section was about knowledge of AI and DL. It consists of ten questions about the basic concepts of AI, its limitations, and whether they are familiar with the terminology related to AI. Four of the ten questions were true or false to measure the participants' knowledge objectively.

The third section was about attitudes towards AI and DL and included eighteen questions targeting their feelings and perspectives towards AI and DL in medicine and radiology. The last section included questions about perceptions regarding AI. It consisted of four questions: one evaluating whether they accept working alongside AI in a specific clinical workflow, and three asking about AI's potential applications in radiology practice. The Arabic version of our questionnaire was adapted from the same multinational Arab study, as they have already validated the questionnaire by two bilingual translators, and then the questionnaire was translated back from Arabic into English by two different translators. A final version was decided upon after comparing the new English version with the original (Allam et al., 2024).

Study population

The study's subjects are all medical students in Eastern Province, Saudi Arabia, who consented to participate in this study during the period between February and March 2024 and met the inclusion criteria. The inclusion criteria consisted of medical students who are studying in the Eastern Province of Saudi Arabia and have consented to participate in the study. The exclusion criteria consisted of medical students who are not in the eastern province of Saudi Arabia, and who have not consented to participate in the survey.

The utilized sampling technique is convenient random sampling, where the questionnaire is disseminated via social media platforms. Then, inviting the medical students of the eastern province of Saudi Arabia to participate through an online link. The sample size is calculated using the formula n = z2pq\d 2. With a confidence level of 95%, an estimated proportion of 50%, and a 5% level of precision. The minimum sample size is calculated to be 336. However, more participants and candidates are included to ensure sufficiency.

Study procedure

According to the inclusion and exclusion criteria, certain participants who fulfilled the criteria and agreed to the given consent are enrolled. Each subject anonymously filled out the questionnaire. The results of the questionnaire were analyzed statistically using the IBM SPSS program. The study results were taken from the IBM SPSS program and interpreted accordingly. Interpretation of the collected data was done accordingly, and proposals of potential solutions, if any, were delivered.

Statistical Analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 29 (IBM Corp., Armonk, NY). Frequency and percentages were used to display categorical variables. Minimum, maximum, mean, and standard deviation will be used to present numerical variables. A chi-square test is used to measure the association and compare between variables. The level of significance was set at 0.05.

3. RESULT

Our study included 393 medical students from the Eastern Province of Saudi Arabia who were assessed for knowledge, attitudes, and perceptions of AI use in radiology (Table 1). Notably, there is a nearly equal gender distribution, with 48.3% female and 51.7% male. Regarding residency, the majority hail from Al-Ahsa (87.5%), while a smaller portion of participants resided in Dammam (12.5%).

Regarding university affiliation, 94.4% were enrolled at King Faisal University, while 5.6% attended Imam Abdulrahman bin Faisal University. The grade distribution varied, with the largest group in the fourth year (24.4%) and the smallest in the first year (5.1%). A notable percentage of participants considered themselves tech-savvy (56.4%).

Regarding the earliest medical specialty affected by AI, diagnostic radiology emerges as the most affected specialty, with 29.8% of respondents believing that diagnostic radiology is the earliest specialty impacted by modern AI. Following diagnostic radiology, surgery is perceived to be impacted early by 20.4% of participants. The respondents showed a good level of knowledge when answering the four true or false questions about AI and deep learning in radiology. Around 31.7% had a high level of knowledge, and 27% had a moderate level of knowledge. A higher level of knowledge was correlated with prior AI training, as 84% of those who had AI training had moderate or high knowledge compared to only 43% with no previous AI training.

Our respondents have a fair level of prior exposure, as 30.5% of them were engaged in radiology research involving AI, and 23.7% of respondents had courses on AI or machine learning. The attitudes of our participants toward the effects of AI in radiology were uneven, as most of them (84.7%) believe that AI will improve radiology and medicine in general (81.9%). However, these positive attitudes were integrated with some concerns about the negative impact of AI on the future of diagnostic radiology as their own carrier, as 63.8% of them agreed that AI would reduce the number of needed radiologists in the future. More pessimistic, 37.2% of participants believed that AI would replace human radiologists in the foreseeable future. Due to these concerns, 31.8% of medical students were less inclined to consider radiology as a potential career due to the advancements in AI.

Interestingly, medical students with high knowledge were more likely to have pessimistic attitudes toward the impact of AI on the future of diagnostic radiology careers compared to those with a lower level of knowledge; comparatively, they were more likely to believe that AI will result in a reduction in the number of radiologists (90% vs. 78.4%), that AI will replace them (45.2% vs. 24.1%). They were slightly more frightened of AI (36.3% vs. 25.9%). Regarding the perceptions of AI, the majority of medical students know the importance of AI at the current time; therefore, most of them (74.7%) agree that teaching AI would benefit their careers. As applications of AI in radiology, 66.7% of participants agree that AI can automatically identify pathologies; 57.5% believe that AI can make automatic diagnoses; and around 60% of them believe that AI can suggest the appropriate next imaging examination.

Table 1 Socio-demographic and other parameters of participants

		Frequency (n=393)	Percent
Gender	Female	190	48.3
	Male	203	51.7
Residency	Dammam	49	12.5
	Al-Ahsa	344	87.5
University	Imam Abdulrahman Bin Faisal University	22	5.6
	King Faisal University	371	94.4
Grade	Prep Year	61	15.5
	1st Year	20	5.1
	2nd Year	24	6.1
	3rd Year	47	12.0
	4th Year	96	24.4
	5th Year	69	17.6
	Intern	76	19.3
I consider myself tech-savvy (well-informed about or proficient in the use of modern technology, especially computers)	Strongly Disagree/Disagree	48	12.2
	Neutral	123	31.3
	Strongly Agree/Agree	222	56.4

Figure 1 shows the perceived earliest impacted specialties due to AI and modern technology according to the participants' perceptions. Diagnostic radiology emerges as the most affected specialty, with 29.8% of respondents indicating its early impact. Following diagnostic radiology, surgery is perceived to be impacted early by 20.4% of participants. Internal medicine, pathology, and oncology follow closely, with 12.5%, 12.1%, and 11.1%, respectively. Family practice and dermatology are also noted, though to a lesser degree, with 7.8% and 6.2%, respectively. Interestingly, ophthalmology is seen as the least affected, with only 0.1% of participants mentioning it.
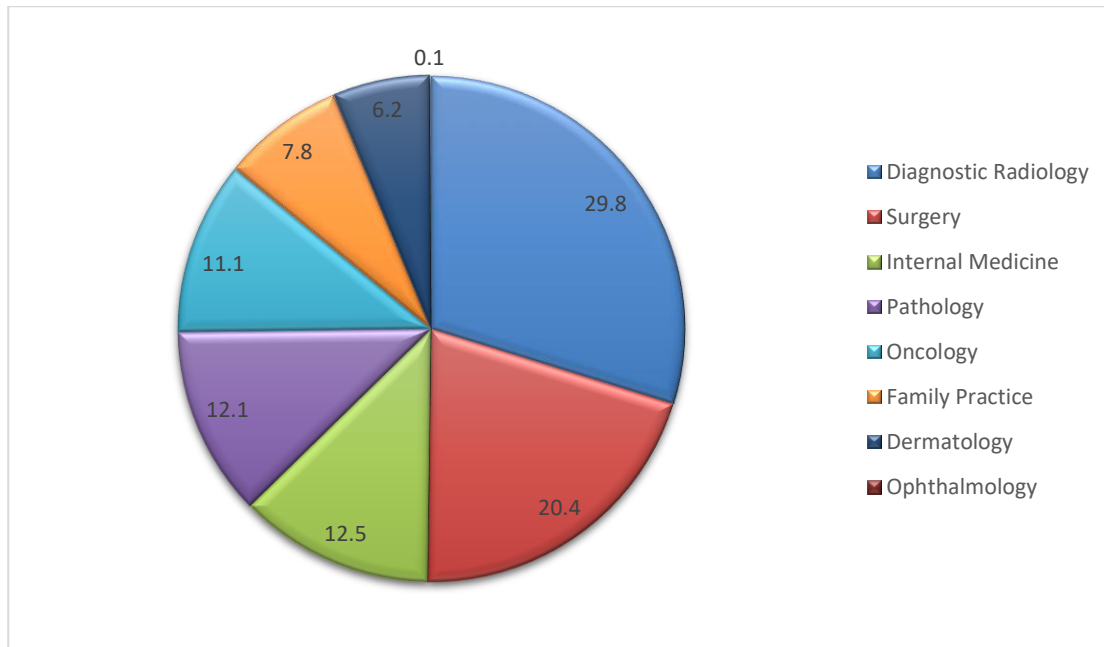

Figure 1 Specialties most affected by AI and modern technology based on participants' perceptions.

Table 2 shows the assessment of knowledge and understanding of deep learning in artificial intelligence (AI) within the field of radiology among the participants. Over half of the respondents (52.1%, n=205) agreed they understand the basic computational principles of AI. Similarly, 44.0% (n=173) agreed that they are comfortable with AI-related nomenclature. Regarding awareness, 63.1% (n=248) reported having prior knowledge of AI and deep learning topics in radiology. However, only 54.7% (n=215) stated they had a basic understanding of the technologies involved. In terms of exposure, 30.0% (n=118) were involved in radiology research related to AI, while 23.7% (n=93) had completed courses on AI or machine learning.

Regarding deep learning specifics, 52.2% (n=205) correctly identified it as a class of machine learning algorithms using multiple layers of neural networks, and 35.9% (n=141) recognized its ability to learn directly from data without manual feature extraction. Additionally, 53.7% (n=211) recognized the importance of large databases of labeled medical images for the application of deep learning in radiology. Furthermore, a significant portion (37.2%, n=146) acknowledged the lack of transparency in deep learning systems, while 42.0% (n=165) expressed uncertainty about this issue. The assessment of knowledge is based on the four objective questions about AI, we categorize the participants into low level (who answered only one question) moderate level (who answered two questions 50%) and high level (who answered three or four questions-75% and above) of knowledge based on their response.

Table 2 Assessment of Knowledge and Deep Learning in Artificial Intelligence in radiology

		Frequency (n=393)	Percent
I understand the basic computational principles of artificial intelligence	Disagree/Neutral	188	47.9
	Agree	205	52.1
I am comfortable with the nomenclature related to artificial intelligence	Disagree/Neutral	220	56.0
	Agree	173	44.0
I understand the limitations of artificial intelligence	Disagree/Neutral	193	49.2
	Agree	200	50.8
AI and Deep Learning as in Radiology			
'Deep Learning' and 'Artificial Intelligence' are currently being broadly discussed in the radiological community. Were you already aware of these topics in radiology?	No	145	36.9
	Yes	248	63.1
Do you personally have a basic understanding of the technologies used in these topics?	No	178	45.3
	Yes	215	54.7
Your exposure to artificial intelligence includes	None of the Above	180	45.8
	Courses on artificial intelligence/machine learning	93	23.7
	Computer science projects involving artificial intelligence of Radiology research involving artificial intelligence	120	30.5
Deep learning is a class of machine learning algorithms that use multiple layers of neural networks.	I Don't Know	148	37.6
	False	40	10.2
	True	205	52.2
Deep learning methods learn directly from data, without the need for manual feature extraction.	I Don't Know	151	38.4
	False	101	25.7
	True	141	35.9
The application of deep learning in radiology requires large databases of labeled medical images.	I Don't Know	112	28.5
	False	70	17.8
	True	211	53.7
Deep learning systems are often opaque: it can be difficult to delineate the underlying "thought process".	I Don't Know	165	42.0
	False	82	20.9
	True	146	37.1

Overall level of knowledge	Frequency (n)	Percentage
Low	162	41.2%
Moderate	107	27.2%
High	124	31.6%
Total	393	100%

Table 3 shows the assessment of attitudes toward artificial intelligence (AI) in radiology among the participants. Significantly, the majority (72.0%, n=283) agreed that AI will transform radiology. Similarly, 66.9% (n=263) believed that AI would revolutionize medicine as a whole. Regarding the replacement of human radiologists and physicians, a significant proportion disagreed, with 62.8% (n=247) and 63.9% (n=251) either disagreeing or remaining neutral, respectively. However, a notable minority (23.7%, n=93) believed that all physicians could be replaced in the near future. Despite these concerns, the majority (70.2%, n=276) were not fearful of these changes, while 29.8% (n=117) admitted to feeling anxious about this issue.

Moreover, nearly half (49.4%, n=194) found AI advancements in radiology exciting, along with 57.0 (n=224) finding them exciting in medicine in general. While a significant proportion (63.9%, n=251) agreed that AI would reduce the number of radiologists needed, 84.7% (n=333) believed it would improve radiology. Additionally, 81.9% (n=322) agreed that AI would enhance medicine overall. However, 31.8% (n=125) admitted they were less likely to consider a career in radiology due to AI advancements.

Table 3 Assessment of Attitudes towards Artificial Intelligence (AI) in Radiology

		Frequency (n=393)	Percent
Artificial intelligence will revolutionize radiology.	Disagree/Neutral	110	28.0
	Agree	283	72.0
Artificial intelligence will revolutionize medicine in general.	Disagree/Neutral	130	33.1
	Agree	263	66.9
The human radiologist will be replaced in the foreseeable future.	Disagree/Neutral	247	62.8
	Agree	146	37.2
The human (non-interventional) physician will be replaced in the foreseeable future.	Disagree/Neutral	251	63.9
	Agree	142	36.1
In the foreseeable future, all physicians will be replaced.	Disagree/Neutral	300	76.3
	Agree	93	23.7
These developments frighten me.	Disagree/Neutral	276	70.2
	Agree	117	29.8
These developments make radiology more exciting to me.	Disagree/Neutral	199	50.6
	Agree	194	49.4
These developments make medicine in general more exciting to me.	Disagree/Neutral	169	43.0
	Agree	224	57.0
Artificial intelligence will never make the human physician expendable.	Disagree/Neutral	232	59.0
	Agree	161	41.0
The impact of artificial intelligence alone will reduce the number of radiologists that are needed.	Disagree/Neutral	142	36.1
	Agree	251	63.9
Artificial intelligence will improve radiology.	Disagree/Neutral	60	15.3
	Agree	333	84.7
Artificial intelligence will improve medicine in general.	Disagree/Neutral	71	18.1
	Agree	322	81.9
I am LESS likely to consider a career in radiology, given the advancement of AI.	Disagree/Neutral	268	68.2
	Agree	125	31.8

Figure 2 shows participants' perceptions regarding the integration of artificial intelligence (AI) into the medical curriculum. The majority (69.5%) agree that all medical students should receive teaching in artificial intelligence. Similarly, a significant portion (74.5%) agree that such education would benefit their careers. However, there's some uncertainty remains about the impact of AI teaching in medical college on the understanding of healthcare AI algorithms and the ability to assess their performance, as only 46.6% of participants believe that they will develop a better understanding of performance assessments of AI algorithms that used in healthcare

system. Similar proportion (43% of participants) think that they will have the required knowledge to work with AI in daily clinic work at the end of their medical training.
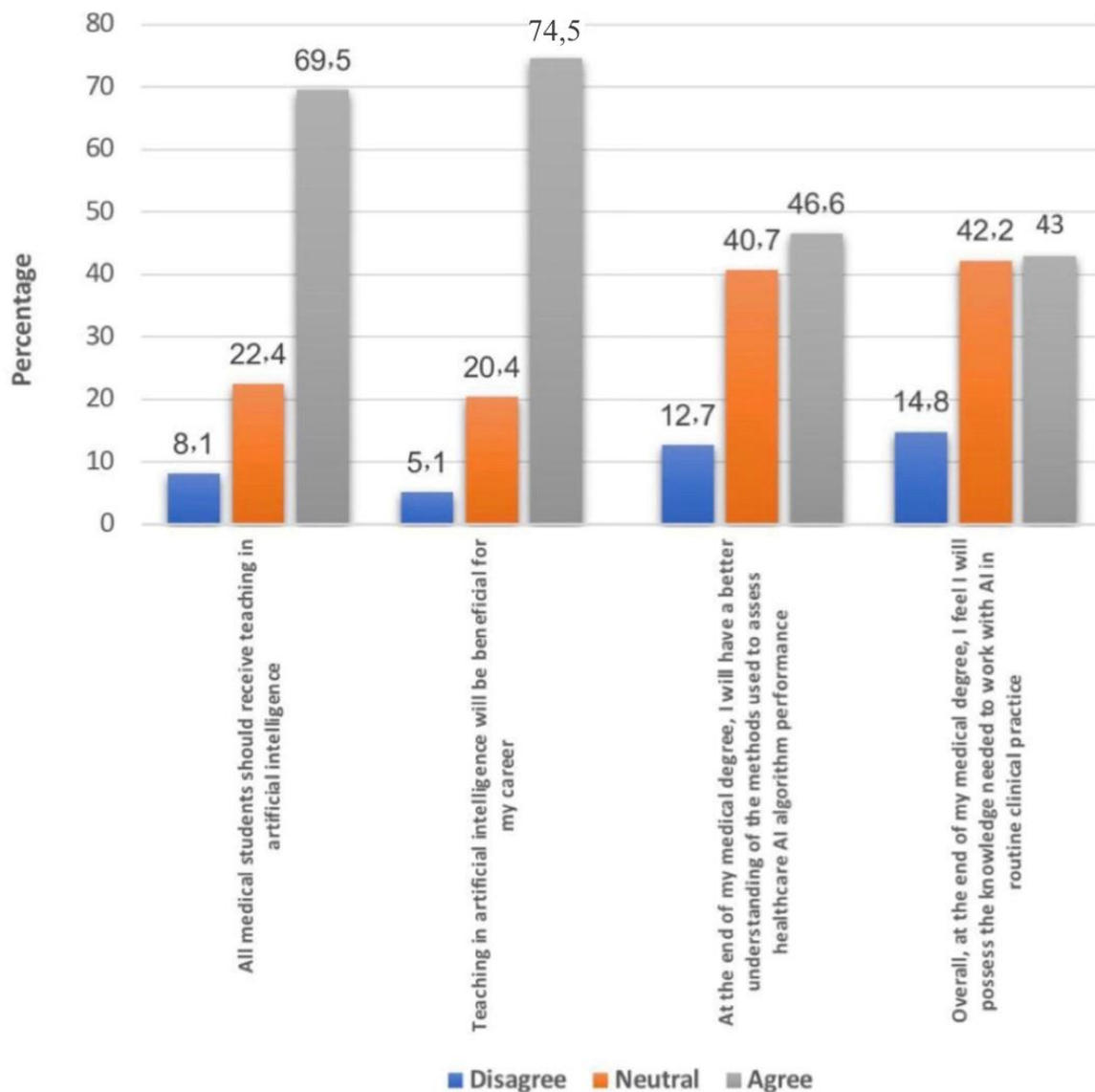

Figure 2 Perceptions of Participants about Addition of Artificial Intelligence in Curriculum

Table 4 shows the perceptions of participants regarding the applications of artificial intelligence (AI) in radiology among respondents. A majority (57.0%, n=224) expressed willingness to consider using a clinical workflow where patients' clinical images undergo AI analysis before review by a specialist. Regarding specific AI applications in radiology, most respondents (66.7%, n=262) strongly agreed with the automated detection of pathologies in imaging exams. Similarly, 57.5% (n=226) strongly agreed with automated diagnosis in imaging exams. Additionally, 59.8% (n=235) strongly agreed with automated indication of appropriate imaging exams. Regarding training in AI, 37.7% (n=148) of respondents had received teaching or training. Among those who received training, 83.1% (n=123) reported it as a compulsory part of their medical degree, while 16.9% (n=25) their training wasn't compulsory.

Figure 3 shows participants' perceptions regarding the usefulness of AI training. A small percentage (7.3%) of respondents view AI training as not useful at all, while a slightly higher proportion (6.9%) considers it not so useful. In contrast, a significant number (29.3%) perceive AI training as somewhat useful, indicating a moderate level of utility. Moreover, a notable portion (31.7%) believes AI training

to be very useful, suggesting a considerable level of perceived benefit. Additionally, a substantial proportion (24.8%) considers AI training extremely useful, highlighting a strong conviction regarding its utility in the medical domain.

Table 4 Perceptions of participants about Artificial Intelligence (AI) applications in Radiology

|		Frequency (n=393)	Percent
Would you consider using the following clinical workflow? Patients' clinical images undergo artificial intelligence analysis. A specialist subsequently reviews both the image and the artificial intelligence findings.	No	55	14.0
	Unsure	114	29.0
	Yes	224	57.0
Applications for AI in Radiology			
Automated detection of pathologies in imaging exams	Strongly Disagree	27	6.8
	Neutral	104	26.5
	Strongly Agree	262	66.7
Automated diagnosis in imaging exams	Strongly Disagree	50	12.7
	Neutral	117	29.8
	Strongly Agree	226	57.5
Automated indication of appropriate imaging exams	Strongly Disagree	42	10.7
	Neutral	116	29.5
	Strongly Agree	235	59.8
I have received teaching/training in artificial intelligence	No	245	62.3
	Yes	148	37.7
Was this teaching/training a compulsory part of your medical degree? (n=148)	No	25	16.9
	Yes	123	83.1
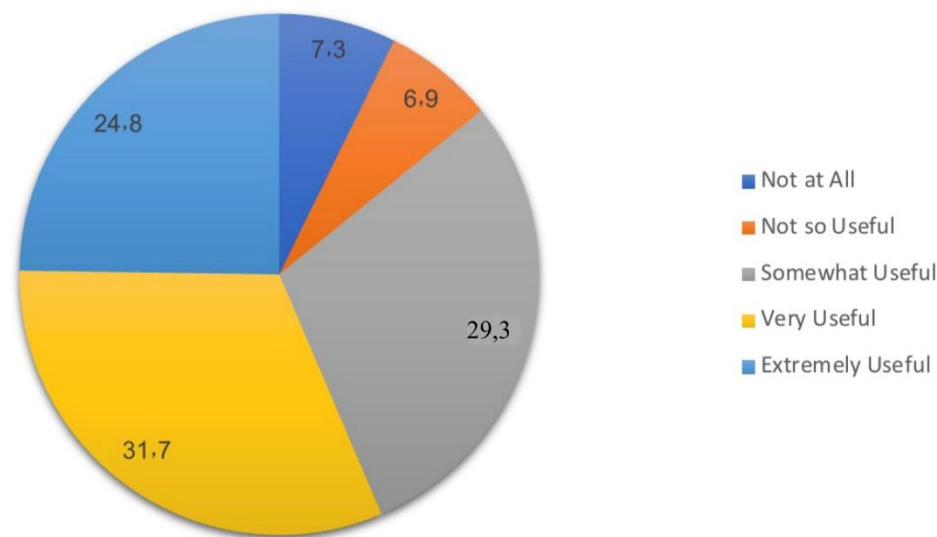
Figure 3 Perceptions about the usefulness of AI Training

Table 5 shows the association between knowledge levels about AI in radiology and various demographic and academic features among the participants. Gender distribution showed no significant association with knowledge levels (p=0.428), with 54.7% of females and 50.7% of males having a high level of knowledge. While residency location showed a trend (p=0.058), participants from Dammam were more likely to have a high knowledge level (65.3%) compared to those from Al-Ahsa (50.9%). Significant associations were observed between university affiliation (p<0.001), academic year (p=0.004), self-reported tech-savviness (p<0.001), and knowledge levels about AI in radiology. Notably, participants from Imam Abdulrahman Bin Faisal University (86.4%), higher academic years, and those strongly agreeing to being well-informed about modern technology (70.7%) were more likely to have a high level of knowledge.

Table 5 Association between Knowledge of AI in radiology and other features

			Knowledge Level about AI in Radiology		Sig. Value
			Low Level (< 50th Percentile)	Moderate/ High Level (> 50th Percentile)	
Gender	Female	N	86	104	0.428 *a*
		%	45.3%	54.7%	
	Male	N	100	103	
		%	49.3%	50.7%	
Where do you live?	Dammam	N	17	32	0.058 *a*
		%	34.7%	65.3%	
	Al-Ahsa	N	169	175	
		%	49.1%	50.9%	
University	Imam Abdulrahman Bin Faisal University	N	3	19	*<0.001 a*
		%	13.6%	86.4%	
	King Faisal University	N	183	188	
		%	49.3%	50.7%	

			N	31	30	
Grades/Academic Year	Prep Year		N	31	30	0.004 a
			%	50.8%	49.2%	
	1st Year		N	16	4	
			%	80.0%	20.0%	
	2nd Year		N	16	8	
			%	66.7%	33.3%	
	3rd Year		N	19	28	
			%	40.4%	59.6%	
	4th Year		N	38	58	
			%	39.6%	60.4%	
	5th Year		N	37	32	
			%	53.6%	46.4%	
	Intern		N	29	47	
			%	38.2%	61.8%	
Well Informed about Modern Technology	Strongly Disagree		N	39	9	<0.001 a
			%	81.3%	18.8%	
	Neutral		N	82	41	
			%	66.7%	33.3%	
	Strongly Agree		N	65	157	
			%	29.3%	70.7%	
I received AI training	Yes		N	23	125	0.000
			%	15.5%	84.5%	
	No		N	139	106	
			%	56.7%	43.4%	

(a) Chi-Square Test, (b) Fisher's Exact Test

Table 6 Presents the association between participants' knowledge level and attitudes toward AI in radiology. The belief that AI would reduce the number of needed radiologists was common among all participants with different levels of knowledge, as high knowledge represented the highest percentage (90% of them), and the low-level knowledge group also highly agreed (78.4% of them). In addition, participants with high knowledge (45.2%) were more likely to agree that radiologists would be replaced by AI compared to those with low knowledge (24.1%).

A statistically significant association (p = 0.000) was found between level of knowledge and being less likely to consider a profession in radiology because of AI, as 38.7% of the high knowledge group disagreed with being less likely to consider radiology as a career because of AI compared to only 17%. However, most people at all knowledge levels (41.2%) had a neutral opinion on this statement. Feelings of fear regarding AI developments were not significantly correlated with knowledge level (p = 0.090). However, participants with high knowledge showed a higher agreement rate (36.3%) that these developments frighten them compared to those with low knowledge (25.9%).

Table 6 Association between Attitudes towards AI and participants knowledge

AI will reduce the number of needed radiologists					
Level of knowledge	Agree	Disagree	Neutral	Total	Sig value
High	112	2	10	124	.025
	90.3%	1.6%	8.1%	100.0%	
Low	127	6	29	162	

	78.4%	3.7%	17.9%	100.0%	
Moderate	94	0	13	107	
	87.9%	0.0%	12.1%	100.0%	
Total	333	8	52	393	
	84.7%	2.0%	13.2%	100.0%	
Radiologists will be replaced with AI					
High	56	34	34	124	
	45.2%	27.4%	27.4%	100.0%	
Low	39	63	60	162	
	24.1%	38.9%	37.0%	100.0%	.000
Moderate	51	29	27	107	
	47.7%	27.1%	25.2%	100.0%	
Total	146	126	121	393	
	37.2%	32.1%	30.8%	100.0%	
I am LESS likely to consider radiology as a career, with the advancement of AI					
High	40	48	36	124	
	32.3%	38.7%	29.0%	100.0%	
Low	44	29	89	162	
	27.2%	17.9%	54.9%	100.0%	.000
Moderate	51	29	27	107	
	47.7%	27.1%	25.2%	100.0%	
Total	146	126	121	393	
	37.2%	32.1%	30.8%	100.0%	
These developments frighten me					
High	45	49	30	124	
	36.3%	39.5%	24.2%	100.0%	
Low	42	67	53	162	
	25.9%	41.4%	32.7%	100.0%	.090
Moderate	30	54	23	107	
	28.0%	50.5%	21.5%	100.0%	
Total	117	170	106	393	
	29.8%	43.3%	27.0%	100.0%	

4. DISCUSSION

This study investigated the knowledge, attitudes, and perceptions of medical students in Saudi Arabia's Eastern Province regarding the effects of artificial intelligence (AI) on the radiology field and how these views may influence their career choices. The current study revealed that 31.7% of participants had a high level of knowledge, and around 27% had a moderate level of knowledge, which indicates overall good knowledge. On the other hand, a multinational study conducted in nine Arab countries, which reported a much lower level of knowledge, with 87.1% of respondents having a low level of knowledge about AI and deep learning (Allam et al., 2024).

Similarly, another local study conducted in Riyadh concluded low levels of knowledge in AI when participants were tested objectively using five questions, as on average, only one of these five questions was answered correctly (Bin-Dahmash et al., 2020). Our study revealed that the high level of knowledge in AI and deep learning was strongly correlated with prior AI training, as 84% of those who had AI training had moderate or high knowledge compared to only 43% with no previous AI training. The difference in knowledge levels can be attributed to our lenient standards for knowledge assessment; in this study, participants who correctly answer

50% of knowledge questions are deemed to have moderate knowledge, whereas in the multinational study, participants who correctly answer 60% or fewer questions are classified as having low knowledge.

Furthermore, the current study had a higher proportion of students participating in AI/ML research (30.5%) and courses (23.7%) than the previous research, as 92.4% of participants did not receive any education or training in AI Allam et al., (2024), which contributed to a higher level of knowledge in our participants. As our results confirmed, prior AI training was strongly correlated with a higher level of knowledge, as 84% of those who had AI training had moderate or high knowledge compared to only 43% with no previous AI training. Most medical students believe that AI will improve radiology (84.7%), and medicine in general (81.9%). Similarly, participants in the multinational Arab study shared the same views that AI will improve radiology and medicine in general (74% and 79.9%), respectively (Allam et al., 2024).

When the respondents were asked about the effects of AI on the future of diagnostic radiology, 63.8% of them were convinced that AI would reduce the number of required radiologists. In contrast, many other studies reported less pessimistic results, as in the Bin-Dahmash et al., (2020) study, where only 44.8% of their participants agreed that AI would reduce the need for radiologists, and similarly, 48.9% in the multinational Arab study (Allam et al., 2024). Our results also reflected higher numbers than other studies. When our participants were asked if they thought that AI would replace human radiologists in our lifetime, 37% of them agreed, in comparison to 31% and 24% in Bin Dahmash and the multinational Arab study, respectively. Other worldwide studies reported lower percentages than ours, as only 15% of German and 29% of Canadian medical students thought AI would replace radiologists (Sit et al., 2020; Gong et al., 2019).

Even though the European Society of Radiology affirms that AI will not replace radiologists but instead emphasize their importance and advance the field Neri et al., (2019), the concerns about the influence of AI on the radiology field made 31.8% of our participants less likely to consider radiology as a future career given the advancement of AI in comparison to 28.6% in the multinational Arab study (Allam et al., 2024). These results reflect more negative perceptions of AI advancement in radiology when considering radiology as a future career among medical students in the eastern region of Saudi Arabia compared to their counterparts in other countries. Interestingly, our results revealed that the participants with high knowledge had more anxious feelings about AI in radiology than participants with lower knowledge, and they agreed more with the belief that AI would limit the number of needed radiologists or replace them.

Similar results were reported in the multinational Arab study, as they found that the high-knowledge group was more likely to believe that AI will decrease the number of needed radiologists or entirely replace them and were less likely to consider radiology as a career compared to those with low knowledge (Allam et al., 2024). A statistically significant number of our participants knew the importance of AI in the current time, as they (74.7%) agreed that teaching AI would benefit their careers. As applications of AI in radiology, 66.7 percent of participants agree that AI can automatically identify pathologies; 57.5% believe that AI can make automatic diagnoses; and around 60% of them think that AI can suggest the next appropriate imaging examination.

When our results were compared to the previous German study, we found higher optimistic predictions for AI applications in radiology among our participants, as in the German study, 42.2% agreed that AI would be able to automatically make diagnoses compared to 57.5% in ours (Gong et al., 2019). Although the difference was not extremely significant, our respondents were more likely to believe that AI can suggest the next imaging exam than those in the German study (60% vs. 56.7%), respectively. These results demonstrated that many of our respondents believed that AI could cover many human tasks in radiology, which may account for the increased belief that AI may eventually replace radiologists and lessen the need for them.

Limitations

While this study provides an informative overview of the knowledge, attitudes, and perceptions of AI in radiology in the Eastern region of Saudi Arabia, our study had some limitations that needed to be addressed. The preponderance of our sample was from King Faisal University (94%); therefore, the findings may not be precisely representative of all medical students in the eastern region, which may limit the generalizability of these data. Also, the current study was designed to assess the medical students' knowledge, attitudes, and perceptions toward AI; therefore, it could not assign the causes behind the participants' attitudes toward AI and radiology.

A published Canadian study pointed out that medical students who ranked radiology as their first choice as a future specialty were less likely to be worried about the possible impact of AI in radiology compared to those who ranked radiology as a second or third

choice. Therefore, we encourage future researchers to test more factors that could affect medical students' attitudes and perceptions towards AI and radiology (e.g., level of interest in radiology as a future career).

5. CONCLUSION

Medical students in the Eastern Province of Saudi Arabia showed an objectively good level of knowledge about AI and deep learning; nevertheless, they exhibited more pessimistic views about the future of radiology in the advancement of AI, and they tend to consider the impact of AI more than their counterparts in other countries. Interestingly, our data suggests that medical students with a higher level of knowledge tend to have more negative attitudes. Further research is needed to investigate the potential factors behind these negative attitudes

Author contributor

All authors contribute equally to the research and in writing the manuscript

Ethical approval

This study was approved by the research ethics committee at king Faisal university, Saudi Arabia, with letter number (KFU-REC-2024-MAR- ETHICS2037) on 6-3-2024.

Abbreviations

AI: Artificial intelligence, ML: Machine learning, DL: Deep learning.

Informed consent

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

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.

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