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Radiographers' knowledge, attitudes and expectations of artificial intelligence in medical imaging

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ABSTRACT

Introduction: Artificial intelligence (AI) is increasingly utilised in medical imaging systems and processes, and radiographers must embrace this advancement. This study aimed to investigate perceptions, knowledge, and expectations towards integrating AI into medical imaging amongst a sample of radiographers and determine the current state of AI education within the community.

Methods: A cross-sectional online quantitative study targeting radiographers based in Europe was conducted over ten weeks. Captured data included demographical information, participants' perceptions and understanding of AI, expectations of AI and AI-related educational backgrounds. Both descriptive and inferential statistical techniques were used to analyse the obtained data.

Results: A total of 96 valid responses were collected. Of these, 64% correctly identified the true definition of AI from a range of options, but fewer (37%) fully understood the difference between AI, machine learning and deep learning. The majority of participants (83%) agreed they were excited about the advancement of AI, though a level of apprehensiveness remained amongst 29%. A severe lack of education on AI was noted, with only 8% of participants having received AI teachings in their pre-registration qualification.

Conclusion: Overall positive attitudes towards AI implementation were observed. The slight apprehension may stem from the lack of technical understanding of AI technologies and AI training within the community. Greater educational programs focusing on AI principles are required to help increase European radiography workforce engagement and involvement in AI technologies.

Implications for practice: This study offers insight into the current perspectives of European based radiographers on AI in radiography to help facilitate the embracement of AI technology and convey the need for AI-focused education within the profession.

Introduction

The central driver of emerging technologies has been artificial intelligence (AI). Its evolution began in 1950 when Alan Turing proposed the possibility of engineering machines that possess human-level intelligence, capable of learning from experience.[1] From this idea, the humble algorithm was developed. Sets of algorithms, or coded instructions, have then been grouped together in recent years to form the foundations of AI and the computerised driven systems that have permeated countless sectors, including healthcare. Due to its reliance on technology, the medical imaging domain has begun to feel AI's dominating presence and influence. Diagnostic companies, such as Siemens and GE, have started integrating AI capabilities within their machinery, with algorithms currently being used to optimise CT radiation dose, reduce image noise and carry out automated detector alignment.[2] With the increasing development of AI algorithms that allow for more automated actions, uncertainty has begun to circulate concerning the future roles of medical imaging professionals. Although exploration has already started into how AI may affect radiologists' roles,[3,4] there is limited literature analysing how radiographers feel about this new wave of AI-driven technology.

Studies focusing on radiologists' views about the rise of AI by the European Society of Radiology (ESR) and Waymel et al. found there

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to be a generally favourable attitude towards AI.[3,5] In both studies, this positivity was accompanied by a heavy desire for more education on AI's potential applications. Contrastingly, when medical students across various countries were questioned about their future speciality career choices, AI was considered a negative impact.[6–9] In these studies, participants exposed to AI showed far more positive viewpoints regarding the future of radiology as a speciality. There is also some apprehension/fear/cynical viewpoint likely attributable to "fear of the unknown" more than anything else. Some students were discounting a career in radiology due to a fear of AI displacing radiologists in the future. According to the various authors, this perception of AI was heavily influenced by the lack of education on AI within the medical school curriculum. By studying the views of current and prospective radiologists, a need for education on AI was highlighted, along with an insight into potential recommendations for increasing the embracement of AI technology. For the European radiography workforce, no similar studies on AI perspectives or educational needs, to date, have been carried out, despite the growing presence of AI in the medical imaging domain.

The integration of AI into radiography practice has already begun, an example of this being automated positioning gaining an accepted place in the performance of CT scanning. Yet, the question remains if radiographers are familiar with the concept of AI and its future potential impact upon their professional roles.[10] Recent early studies on radiographers' understanding and attitudes towards AI implementation have been carried out in the United States, United Arab Emirates (UAE) and Africa.[11–14] All studies noted positive attitudes towards AI, yet these affirmations were accompanied by concerns surrounding role displacement or demise. The study in the UAE, by Abuzaid et al., delved further into the radiographer's understanding of AI concepts and found a significant lack of knowledge regarding the subject of AI integration into radiographic practice.[12] The findings were similar to those reported by the studies on prospective and current radiologists, suggesting a definite need to implement AI educational programmes throughout the medical imaging domain in the researched continents.

In Europe, there is a current lack of insight into radiographers' attitudes towards integrating AI into their roles and their levels of understanding of AI concepts. The recent joint statement by the International Society of Radiographers and Radiological Technologists (ISRRT) and the European Federation of Radiographer Societies (EFRS), which sets out the positions of both organisations in terms of AI within radiography, has pushed for an "embrace, adopt and adapt" attitude towards AI technology.[15] Yet, to date, there has been no research that focuses primarily on European-based radiographers' knowledge of and views of AI. The emergence of such a guideline statement demonstrates the progressive reach of AI into European radiography, which was further corroborated by the focal shift, during the 2021 European Congress of Radiology (ECR 2021), towards the subject of AI within the medical imaging sector. Representatives for the radiographic community during ECR 2021 voiced an intense desire among radiographers for education on AI, but there is currently no research evidence backing up this desire.

AI is on the cusp of potentially revolutionising radiography. Still, there remains an ambiguity around how radiographers perceive the technology and if educational needs, underpinning the embracement and appropriate uptake of AI by radiographers, are being met. As critical stakeholders in the integration of AI in medical imaging, radiographers must be aware, prepared and supported to take full advantage of AI. It is anticipated that this will be a dynamic process which will ultimately help ensure that implementation improves radiographic efficiencies, prioritizing patient care and experience.

We, therefore, undertook this study with the following aims:

1. Investigate the attitudes, perceptions, knowledge, and expectations of a sample of radiographers towards the surge of AI within the radiography field.
2. To use the above information to determine a consensus regarding European-based radiographers' perceptions of AI and to explore how AI is perceived based on demographics including gender, age, and educational background.
3. Determine whether the state of education relating to AI is currently deemed adequate and, gather information on AI training within the radiography community.

Methods

Ethical approval

Ethical approval of the research was granted by The Clinical Therapies Social Research and Ethical Committee of the University College Cork (CT-SREC-2020-37).

Study type

A cross-sectional quantitative online survey was conducted.

Data collection tool

The survey was constructed with reference to previous assessments of radiologists', medical students', and radiographers' views on AI.[3–14] Internal piloting among senior and doctoral radiographers (MME, AE, RY) with over ten years' of experience was conducted.

The final survey was composed of six sections. The first section was a demographics section and included gender, age, country/highest level of radiography qualification, number of years post-qualification and the total number of qualifications. The second section used multiple-choice questions with a single correct answer to establish a participant's baseline understanding of AI.

The subsequent four sections each included several 5-point Likert-item style questions (strongly disagree, disagree, neutral, agree, strongly agree) relating to a unifying sectional theme. Analysed themes included establishing a participant's familiarity with AI, opinions on AI, perceptions on the effect of AI on their roles and finally, the education of AI within the radiography field (see Supplementary Material).

Data collection

The survey was hosted online using the Google Forms (Google Inc., Mountain View, CA) web-based application. Informed consent was required before the survey commenced, and an anonymous response feature on the application was enabled. The study was accepted to be part of the EFRS/European Congress of Radiology (ECR) 2021 Research Hub, whereby the survey would be promoted throughout the length of the congress. The survey went live on March 2nd, 2021 and remained open for ten weeks. The link was shared with emailed contacts and was advertised on social media platforms (Facebook, LinkedIn, Twitter) by the EFRS and the research team.

Data analysis

Anonymised data were imported from Google Forms into Microsoft Excel 2011 (Microsoft Corp., Redmond, WA). Frequency tables were generated for responses to the Likert-item questions. These were summarised and displayed using diverging stacked bar charts.

Statistical analysis

Data were imported to the Statistical Package for Social Sciences Version 28 (IBM Inc., Armonk, NY). The responses from the Likert scale items were converted to continuous data by assigning the following values: strongly disagree = 1, disagree = 2, neutral = 3, agree = 4, strongly agree = 5. Reverse scoring was applied depending on the manner of the question. Higher scores were indicative of those with a favourable viewpoint of AI in radiography and vice versa.

The Kolmogorov–Smirnov test was used to assess the distribution of study data. When an approximately normal distribution existed and compared two or more variables occurred for scaled data, the *t*-test or analysis of variance (ANOVA) was used. Mann–Whitney or Kruskal Wallis Ranks testing was employed when analysing an appropriately non-normal distribution for two or more scaled variables. The Pearson Correlation Coefficient was used to correlate continuous scaled variables and either Chi-squared or Fishers Exact Test for nominal/ordinal associations. Statistical significance was set at $p < 0.05$.

Results

Demographics (Section 1)

A total of 96 valid responses were collected, of which 55.2% of participants identified as females and 44.8% as males. The largest percentage of participants (32.3%) were in the 30–39 age range, though this was closely followed by the 40–49 age group (30.2%) and 20–29 age group (25%). As this was primarily a European-based study, participants were asked where they had gained their primary qualification in radiography. Over 50% of participants had received their qualifications from Ireland and the UK. Radiographers of all experience levels (years, number, and level of degree) were included. See Table 1 for a demographic summary.

Objective understanding of AI (Section 2)

Thirty-eight participants incorrectly answered the index question designed to establish a baseline understanding of AI. Seventy-one per cent of the incorrect answers were female ($n = 26$, $p = 0.035$). A statistically significant association between age range and response existed ($p = 0.042$). Participants aged 20–29 years (42%) and 40–49 years (59%) had higher incorrect rates. There was no association between qualification demographics such as origin ($p = 0.228$), experience ($p = 0.132$), number ($p = 0.608$) and highest level achieved ($p = 0.492$). See Table 2 for a summary of demographics related to the objective AI understanding question.

Survey response data (Section 3–6)

Familiarity with AI

Most participants believed that radiographers should embrace, adopt, and adapt to technology (85/96). Only 41 viewed auto-positioning and 40 automatic exposure control, however, as a type of AI. Forty participants did not understand the difference between machine learning (ML), deep learning (DL) and AI (Fig. 1).

Opinions on AI

Seventy-eight participants believed it was unlikely that AI would replace radiographers. Most participants believed AI had an essential role in the sector (61/96) and were excited about AI (79/96). Only 28 participants were apprehensive about introducing AI, but 55 were concerned about ethical issues surrounding its integration (Fig. 2).

Perceptions on the effects of AI on future role

Table 1
Summary of participants' demographics.

Demographics	$n = 96$	%
Gender		
Male	43	44.8
Female	53	55.2
Age range		
20–29	24	25
30–39	31	32.3
40–49	29	30.2
50–59	8	8.3
60+	4	4.2
Origin of qualification		
Ireland	26	27.1
UK	30	31.3
Portugal	9	9.4
Italy	5	5.2
Malta	5	5.2
Spain	3	3.1
Other (Europe)	7	7.3
Other (Outside Europe)	11	11.5
Years qualified		
Mean (Std. Dev.)	14 (±9.9)	
Range		
<5 years	18	18.8
5–9 years	19	19.8
10–14 years	15	15.6
15–19 years	19	19.8
≥20 years	25	26
Number of qualifications		
0	5	5.2
1	25	26
2	37	38.5
3	15	15.6
4	11	11.5
5	2	2.1
Highest level of qualification		
Bachelors	42	43.8
Masters	38	39.6
PhD	12	12.5
N/A	3	3.1

Table 2
Demographic associations with objective AI understanding.

Demographics $n = 96$	Definition of AI		
	Correct	Incorrect	*p*-Value
Gender	58	38	
Male	31	12	0.035
Female	27	26	
Age range			
20–29	14	10	0.042
30–39	23	8	
40–49	12	17	
50–59	7	1	
60+	2	2	
Origin of qualification			
Ireland	19	7	0.228
UK	13	17	
Portugal	6	3	
Italy	3	2	
Malta	4	1	
Spain	3	0	
Other (Europe)	5	2	
Other (Outside Europe)	5	6	
Years qualified			
Mean (Std. Dev.)	12.8 (9.5)	15.9 (10.3)	0.132
Number of higher-level qualifications			
Mean (Std. Dev.)	2.04 (1.16)	2.16 (1.10)	0.608
Highest level of qualification			
Bachelors	22	20	0.492
Masters	24	14	
PhD	9	3	
N/A	2	1	

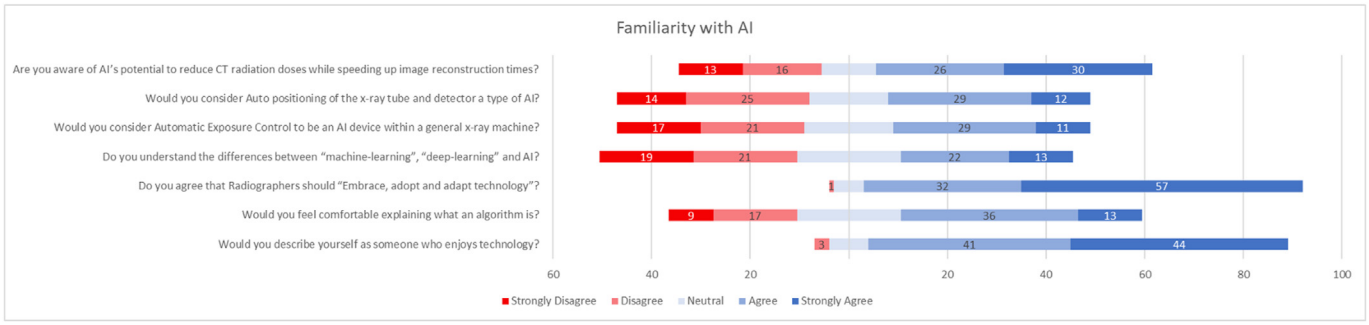

Figure 1. Likert scale bar chart summary of the participants' familiarity with AI ($n = 96$).

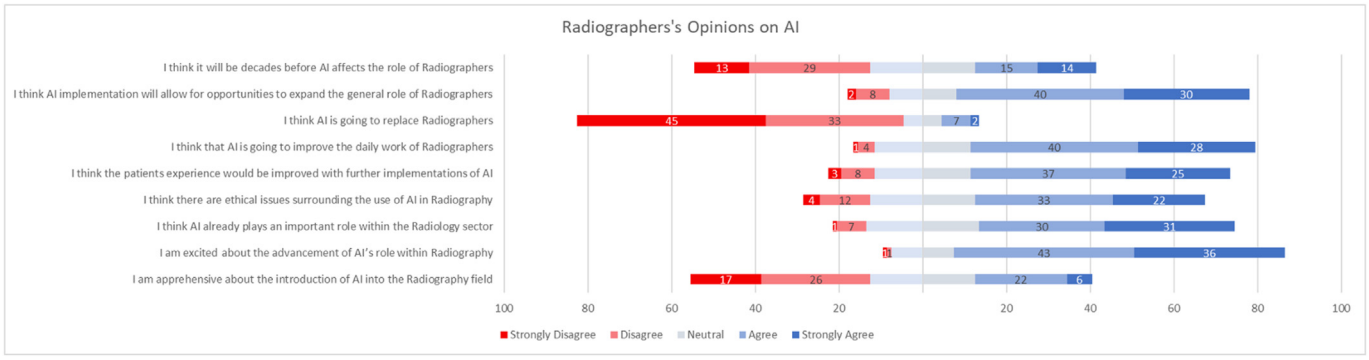

Figure 2. Likert scale bar chart summary of the participants' opinions of AI ($n = 96$).

Most radiographers felt that AI would affect the interpretation of images (69/96), radiographic quality assessment (58/96), selection of exposure factors (68/96) and patient scheduling (57/96) aspects of the radiographer's role. Fifty-three participants believed that AI would not affect radiography's communication and patient care aspect (Fig. 3).

AI education within radiography

Seventy-four participants received no formal education regarding AI in their undergraduate studies, and 64 received no AI education in the workplace. The majority of participants (82/96) were interested in further continuous professional development (CPD) accredited educational courses in AI (Fig. 4).

Inter-thematic correlation analysis

Familiarity with AI correlated with radiographers' opinions ($p < 0.001$, $r = 0.363$), effects of AI on the radiographer ($p < 0.001$, $r = 0.356$) and educational exposure within radiography training and post-graduate ($p < 0.001$, $r = 0.532$). Previous AI education correlated with radiographers' opinions on AI ($p < 0.05$, $r = 0.212$; Table 3).

Demographic–thematic relationship analysis

While both males and females indicated high levels of familiarity with AI, males were more positive in their responses to questions within this theme ($p < 0.05$), their opinions towards AI were also slightly more favourable ($p < 0.05$). There was no significant difference for gender and responses to the effects of AI on the role of radiography ($p = 0.06$) and previous AI educational exposure within radiography ($p = 0.06$). Responses to each theme did not significantly differ between age groups. Radiographers from Ireland and the UK indicated lower familiarity with AI ($p < 0.05$) than other international colleagues. However, no significant difference existed between opinions on AI ($p = 0.09$) and the effects of AI on the radiographer's role ($p = 0.95$). Participants from Ireland,

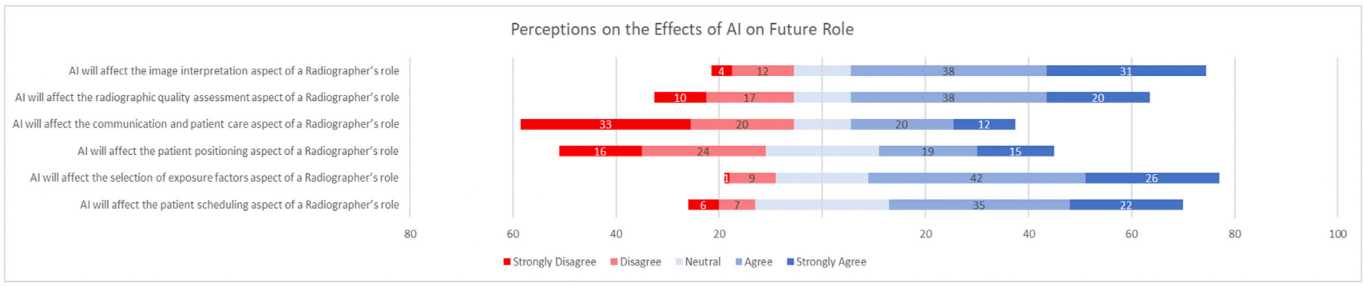

Figure 3. Likert scale bar chart summary of the participants' perceptions on the effects of AI on future roles ($n = 96$).

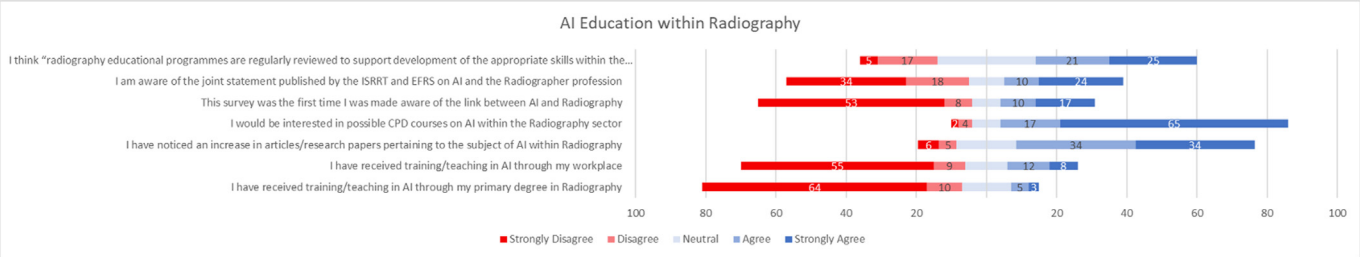

Figure 4. Likert scale bar chart summary of the participants perceptions of AI education within radiography ($n = 96$).

Table 3
Correlation matrix for themed responses.

		Familiarity	Opinion	Effects	Education
Familiarity	*R*		0.363	0.356	0.532
	p-Value		<0.001	<0.001	<0.001
Opinion	*R*	0.363		0.063	0.212
	p-Value	<0.001		0.544	0.038
Effects	*R*	0.356	0.063		0.180
	p-Value	<0.001	0.544		0.079
Education	*R*	0.532	0.212	0.180	
	p-Value	<0.001	0.038	0.079	

the UK, and Malta reported low exposure to education on AI ($p < 0.001$). The range of years qualified and the highest level of qualification did not result in significantly different responses across each theme (see Supplementary Material).

Discussion

AI's increasingly dominating presence in the medical imaging domain has led to an acknowledgement by the radiography profession that AI's existence brings opportunities for radiographers.[12] The current study was designed to capture the views and attitudes of international radiographers towards AI to help facilitate the embracement of AI technology in the profession. Furthermore, with every new technological advancement, education must be updated. The study results could potentially be used as an evidential foundation to argue for the development of AI elements within radiography training courses. Encouragingly, an overall positive embracement of AI technologies was displayed, but differences were observed in terms of technical understanding and awareness of AI concepts among subgroups of radiographers. The desire for AI education within the radiography community was evident.

The initial question of the study's survey, where participants were asked to choose the correct AI definition from four options, was included to gain an insight into radiographers' foundational understanding of AI. The correct selection by 64% of participants suggested some knowledge of AI by most respondents, later propagated by respondents' awareness of AI's role in CT dose reduction and auto-positioning. However, there was a 20% notable drop in participants' understanding of the more technical components of AI when they were later questioned more specifically about machine learning and algorithms. This indicated that radiographers recognise general AI concepts and are aware of some of AI's functional roles within the field but are unfamiliar with the more technical components of the technology. The UAE study of radiographers similarly found that 31% of their respondents had a working knowledge of AI, yet only 4% understood AI basics.[13] Regarding algorithmic bias, 58% of respondents felt it could occur during AI development. When compared with the American Society of Radiologic Technologists (ASRT) (US) study,[14] there is almost a 20% increase in awareness of potential bias within AI systems. This may reflect a growing recognition of such bias within the scientific community or relate to geographical awareness of AI-algorithmic bias.

Studies on radiologists' opinions of AI within radiology displayed a generally positive attitude towards AI, yet when surveyed, medical students have been noted to discount radiology as a possible career due to AI.[3–9] A study of African radiographers found 82% of respondents were excited about AI integration, which correlates with the 83% of radiographers in the current study who expressed excitement about AI advancement.[15] This positive reception of the technology is potentially related to the general agreement (71%) that AI will improve the daily work of radiographers and help to expand the role (73%). However, there remains a level of apprehensiveness amongst 29% of participants, which may be due to similar fears of role reduction noted by the ASRT 2020 study.[14] Further education around AI's potential role and its limitations within the radiography field may help quell this concern and also address the anxiety felt by 9% of respondents who believe AI will replace radiographers in the future. Although there is no evidence to suggest that this would ever be the case, it was also a belief held by 61.3% of respondents in the study carried out on African radiographers.[15,16] The general population is progressively becoming more comfortable with the idea of AI. Still, as Ongena et al.'s 2020 study identified, there is, and always will be, a strong need by patients for human interaction and communication in imaging departments.[17]

Most respondents agreed that AI will impact and enhance patient scheduling, image interpretation, selection of exposure factors and radiographic quality assessment aspects of the role. The belief that AI could alter such a sizeable portion of the radiographer practice potentially relates to the conviction held by the majority of participants (73%) that AI will expand the role of radiographers. Role expansion may be necessary if AI could significantly reduce the workload relating to such elements. It is encouraging to

discover that 92% of respondents agree with the ISRRT/EFRS joint statement[18] quote of "embrace, adopt and adapt technology" radiographers are also actively focusing on how AI implementation can positively enhance the profession.

The 2020 joint statement on AI and radiography released by the ISRRT/EFRS stipulated a need for education "in AI advancements going forward".[18] However, a noticeable lack of AI subject matter was found amongst participants' educational backgrounds. Over 75% had not received teaching in AI during their primary degree, despite the study including participants from over 14 different countries, and 28% of respondents were completely unaware that AI is already integrated into everyday radiographer practice. Positively though, 86% of survey participants expressed interest in CPD courses on AI, whilst 88% agreed that AI fundamentals should be taught to prospective radiographers. The City University of London has begun to address this fundamental need by radiographers by introducing an AI course tailored for radiographers. However, this solo course will not address the deficiency of AI teachings within current undergraduate and graduate radiography courses. Publications on how best to introduce AI into medical-related curricula are now available,[19,20] suggesting that educational institutions are awakening to the necessity of such knowledge in the medical field. Possible initial recommendations to institutes would include applying AI elements into postgraduate courses where it appropriately suited, for example, an aspect on 'the use of AI in image interpretation/reporting' in radiographer reporting postgrad courses.

Limitations in the current study existed in time constraints and finite distribution sources. A risk of over-sampling academic radiographers and an under-sampling of clinically based radiographers may have occurred due to limited access to the ECR, which acted as a primary source for survey distribution. The timing of the study during the Covid-19 pandemic may have been attributed to the lower than anticipated sample number procured. A follow-up study, post-pandemic, with a longer sample time and more significant sampling of radiographers in clinical settings across Europe, are suggested to combat the noted limitations of the study. Recommendations for follow-up work would include using a focus group to determine aspects of AI that radiographers wish to learn more about to help establish AI competencies that should be included in radiography course curriculums.

Conclusion

This study observed relatively positive attitudes to AI among radiographers, despite limited understanding of some of the specific technical aspects of AI systems. There is an immediate requirement for incorporation of AI education into undergraduate and postgraduate radiographer education to allow the wider radiography community to embrace AI in daily practice and engage in future AI developments.

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Conflict of interest statement

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2022.06.020.

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