ORIGINAL PAPER

An extensive survey of radiographers from the Middle East and India on artificial intelligence integration in radiology practice

Mohamed M. Abuzaid[1] · Wiam Elshami[1] · Jonathan McConnell[2] · H. O. Tekin[1]

Abstract

Assessing the current Artificial intelligence (AI) situation is a crucial step towards its implementation into radiology practice. The study aimed to assess radiographer willingness to accept AI in radiology work practice and the impact of AI in work performance. An exploratory cross-sectional online survey conducted for radiographers working within the Middle East and India was conducted from May–August 2020. A previously validated survey used to obtain radiographer's demographics, knowledge, perceptions, organization readiness, and challenges of integrating AI into radiology. The survey was accessible for radiographers and distributed through the societies page. The survey was completed by 549 radiographers distributed as (77.6%, n = 426) from the Middle East while (22.4%, n = 123) from India. A majority (86%, n = 773) agreed that AI currently plays an important role in radiology and (88.0%, n = 483) expected that AI would play a role in radiology practice and image production. The challenges for AI implementation in practice were developing AI skills (42.8%, n = 235) and AI knowledge development (37.0%, n = 203). Participants showed high interest to integrate AI in under and postgraduate curriculum. There is excitement about what AI could offer, but education input is a requirement. Fears are expressed about job security and how radiology may work across all ages and educational backgrounds. Radiographers become aware of AI role and challenges, which can be improved by education and training.

Keywords Artificial Intelligence · Radiology · Radiography · Knowledge · Practice

1 Introduction

The radiographer's main job is to produce optimum diagnostic images exercising proper patient care, using as low as practicable ionizing radiation doses. Since the arrival of AI in healthcare systems and medical imaging, many radiographers questioned how it might affect their profession and the workforce [1]. The integration of AI in imaging production technology has influenced changes in radiographer roles for the patient's benefit. However, from a radiographic perspective, AI has been focused on integrating into equipment, image processing, radiation dose reduction while clear wider operation has not yet been identified [1].

Digitization and automation of image production improve acquisition efficiency and work performance [2]. Automatic Exposure Devices (AED) may be considered the first stage of automation, which directly relates to radiographer practice [3]. Consequently, the aims of achieving good image quality and reduced radiation dose and image repetition have been realized [4]. AI applications are growing and appear to be aligning with improving examination techniques, exposure reduction, controlling workflow to achieve the greatest efficiency of staff and equipment [5].

In terms of patient assessment before the procedure, AI could integrate patient identification and interrogate previous studies through the electronic health records and Picture Archiving and Communication System (PACS) [6] and apply this 'knowledge' to enable similar or higher quality image production across visits for imaging. In cross-sectional imaging modalities, AI can analyze patient examination information (centring, slice thickness, scan range, and the number of slices) [7] to reduce patient dose and scan time, particularly in MRI [8]. Automation of contrast media injection amounts, rates and injection timings

✉ Mohamed M. Abuzaid
  mabdelfatah@sharjah.ac.ae

1 Medical Diagnostic Imaging Department, College of Health Sciences, University of Sharjah, Sharjah, UAE

2 Radiology Department, NHS Greater Glasgow and Clyde, Glasgow, Scotland, UK

against prior patient parameters and image findings [9] has also been proposed for AI.

However, this assumes that Radiology Information Systems (RIS) or the PACS can provide this opportunity across a broad range of providers whose systems may not be linked to enable this communication to occur. An example is evident in Scotland. Even though there is a national PACS, the Radiology Information System (RIS) information cannot be shared. PACS does not collect all data that would be valuable for the suggested function [10].

Radiologists and radiographers share protocol selection responsibility radiographers are frequently positioned to determine a suitable protocol. Based on rapid image analysis, it is further suggested that AI can be integrated into equipment to suggest additional images such as different views in mammography [10] and scan sequences in CT and PET/CT [11]. Where operator dependence is common such as ultrasound, AI can play a major role via automated measurements such as fetal measurement and kidney function assessment/doppler ultrasound [12, 13].

The role of radiographers in image reporting is evolving globally, as it is recognized that radiographers can provide image reporting in various imaging modalities. The emergence of AI in the radiographer reporting role will improve patient care through fast image reporting, waiting for time and cost reduction [14, 15].

To move forward in terms of service delivery, radiographers, as the patient-facing equipment and technology users, need to correlate AI with career objectives, daily tasks and required knowledge and training for the future. This study aimed to assess radiographer willingness to accept AI in radiology work practice and the impact of AI on work performance. Understanding the end-users attitudes and behaviour towards the integration and the role of AI applications will shape the future needs for successful implementation.

2 Methods

An exploratory cross-sectional online survey of radiographers working within the Middle East and India (MENAIN) region was conducted. The eligibility to participate were diagnostic radiographers working across the (MENAIN) region during the study period. The responses received from Egypt, Sudan, Jordan, Saudi Arabia, United Arab Emirates, Bahrain, Oman, Turkey, and India. For this study, a previously validated research instrument was adapted by the research team [5]. The survey reviewed and modified demographic variable to add the working country. The survey was composed of three parts: the first part gathered the participant's demographic information, including age, gender, qualifications, and clinical experience. The radiographer's knowledge, perceptions, readiness, and challenges of integrating AI into radiology were captured using multiple response and attitudinal scale questions in parts two and three.

As there were no previous studies in this region, the population size was unidentified. The number of participants calculated based on a formula of cross-sectional studies to calculate the sample size with a 95% confidence level, the margin of error was set at 5%, and the population size was infinite [16]. A total of 549 participants were accepted for this study. The study used convenience sampling as it is an easy method to access participants in different geographical proximity.

The online survey used "Google Form" (Google, Mountain View, CA). The survey link shared via social media platforms using the professional bodies societies Facebook Page. The data collection duration was three months (May to August 2020), with regular reminders to maximize response. The participants read the survey cover letter, which included information about the study objectives and survey content. The participants were able to withdraw at any phase before submitting the survey without consequences. The respondent was able to see the recorded response at the end of the survey. The data were checked for any duplicate responses, filtered to remove any responses from areas rather than the Middle East and India.

2.1 Ethical approval

The study approved by the University of Sharjah Research Ethics Committee. The study protocol and methods were performed following the committee's guidelines (reference number REC-20–05–06–01).

Table 1 Demographic characteristic

		N (%)
Gender	Female	242 (44.1)
	Male	307 (55.9)
Qualification	Diploma	181 (33.0)
	BSc	296 (53.9)
	MSc	63 (11.5)
	PhD	9 (1.6)
Age	< 30 years	180 (32.8)
	30-39 years	213 (38.8)
	40-49 years	107 (19.5)
	=>50 years	49 (8.9)
I am currently a/an	Radiographer	491 (89.4)
	Sonographer	30 (5.5)
	MRI Technologist	28 (5.1)
I am currently working at	Hospital	540 (98.4)
	Academic Institute	9 (1.6)

Table 2 Perceptions of AI

	Strongly Disagree N (%)	Disagree	Neutral	Agree	Strongly Agree	All (n=549) M (SD)
AI play an important role in radiology	8 (1.5)	10 (1.8)	58 (10.6)	222 (40.4)	251 (45.7)	4.2 (0.8)
AI will take place in many applications and image production	4 (0.7)	12 (2.2)	50 (9.1)	232 (42.3)	251 (45.7)	4.3 (0.7)
AI will threaten/disrupt the radiology practice	30 (5.5)	79 (14.4)	204 (37.2)	137 (25)	99 (18)	3.3 (1.1)
AI will threaten/disrupt some radiology profession career.	33 (6.0)	74 (13.5)	126 (23)	204 (37.2)	112 (20.4)	3.5 (1.1)
AI has no limitations in my work	25 (4.6)	97 (17.7)	146 (26.6)	176 (32.1)	105 (19.1)	3.4 (1.1)

Attitudinal score: Strongly disagree = 1 and strongly agree = 5 *M* Mean of Attitudinal score

2.2 Statistical analysis

Data was collected, categorized, and processed using the Statistical Package for Social Sciences (SPSS), version 24®. The quantitative variables were expressed as percentages, mean and standard deviations. All graphs were created using Microsoft Office Excel 2013®.

3 Results

Out of 549 responses received, 55.9% (n = 307) were male, and 53.9% held a BSc degree. Eighty-nine percent (n = 491) indicated they were currently working as radiographers and 98.4% (n = 540) worked in hospitals (Table 1). The result of the study reveals that (77.6%, n = 426) of the respondents worked in the Middle East while (22.4%, n = 123) in India. The results revealed the countries were the participants obtained their terminal degree, were Turkey and India had the highest percentage with 16.6% (n = 91) each.

Eighty-six percent (n = 773) of participants agreed and strongly agreed that AI currently plays an important role in radiology and 88.0% (n = 483) agreed and strongly agreed that AI would be encountered in many applications for radiology practice and image production (Table 2). While 37.2% (n = 67) of participants aged less than 30 years agreed and

strongly agreed that AI would threaten/disrupt current radiology practice(s), in comparison to 53.1% (n = 26) of the participants aged over 50 years identified this would happen. A one-way ANOVA was conducted to assess the association of age and qualification with the perception. There was a significant difference between age groups and their perception that AI will threaten/disrupt the radiology practice (p 0.032.)

The results of alignment between participants demographic (age and qualifications) and understanding, knowledge and educational needs for AI use showed of participants, 31.7% (n = 174) and 53.9% (n = 197) were excited and aware of the challenges facing radiology, respectively. Only 12.2% (n = 76) were very comfortable working with AI, and 9.3% (n = 51) have no idea about AI. Of the participants, 51.0% were self-taught, and 22.4% attended courses designed to enable a greater understanding of AI.

Forty percent (n = 217) strongly agreed that AI should be taught in postgraduate programs, and 30.6% (n = 168) strongly agreed that AI should be taught in the undergraduate program (Table 3). Thirty-nine percent were unsure if someone was responsible for AI at their organizations, while 27.1% could identify with this role. Moreover, 33.7% have no idea if their organizations have a strategy for AI (Table 4). A one-way ANOVA test showed a significant association (p = 0.031) between age and the importance of teaching AI in the undergraduate program. Participants

Table 3 Participants agreement on knowledge

	Strongly Disagree N (%)	Disagree	Neutral	Agree	Strongly Agree	All (n=549) M (SD)
Radiology curriculum includes at least basic knowledge of AI.	10 (1.8)	26 (4.7)	91 (16.6)	267 (48.6)	155 (28.2)	3.9 (0.9)
AI should be taught in the undergraduate program	7 (1.3)	31 (5.6)	67 (12.2)	276 (50.3)	168 (30.6)	4.0 (0.9)
AI should be taught in the postgraduate program	6 (1.1)	21 (3.8)	61 (11.1)	244 (44.4)	217 (39.5)	4.2 (0.9)
I have a basic understanding of AI	6 (1.1)	18 (3.3)	146 (26.6)	287 (52.3)	92 (16.8)	3.8 (0.8)
I have a working knowledge of AI	19 (3.5)	120 (21.90	184 (33.5)	153 (27.9)	73 (13.3)	3.3 (1.1)
I have been trained and educated about AI	53 (9.7)	125 (22.8)	168 (30.6)	127 (23.1)	76 (13.8)	3.1 (1.1)

Attitudinal score: Strongly disagree = 1 and Strongly agree = 5

Table 4 Willingness status of AI

		N (%)
At my organization there is someone responsible for AI?	Yes	149 (27.1)
	No	188 (34.2)
	Not sure	212 (38.6)
For my work AI is:	A big part of what we do	105 (19.1)
	We are beginners	81 (14.8)
	I have no idea	95 (17.3)
	A small part	53 (9.7)
	It is a future plan	155 (28.2)
	We are not looking at or planning for	60 (10.9)
Does your work organization have a strategy for AI?	Yes	143 (26)
	No	144 (26.2)
	I have no idea	185 (33.7)
	We are developing one	77 (14)

aged "30–50 years old" agreed that teaching AI should start at undergraduate rather than postgraduate and continuous education. The Post hoc multiple comparisons showed a significant difference between groups for participants aged 40–49 years old (p = 0.016). The biggest challenges for AI implementation in the workplace was the development of skills (42.8%, n = 235) and knowledge about AI (37.0%, n = 203) (Fig. 1). A one-way ANOVA revealed a significant relationship between age groups, qualifications, and the difficulty of training current employees. With p-values of .031 and .027 for age and education, participants believed that AI technology education and training would be difficult for existing workers. The result of Post hoc multiple comparisons showed a significant difference between groups of participants who aged > 50 years (p = 0.04) and hold diploma degree (p = 0.031). Similarly, the one-way ANOVA test showed a significant association between age and working knowledge of AI (p = 0.023). Still, the post-hoc test did
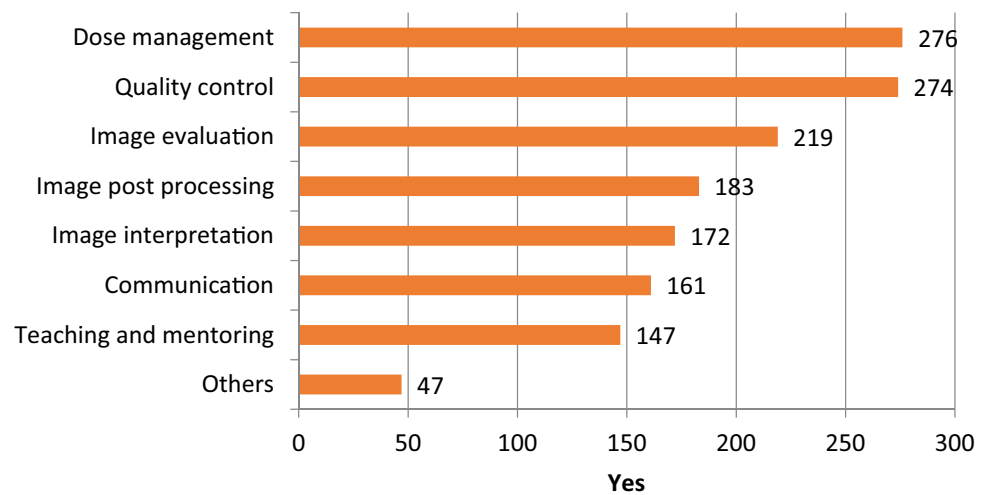
not show any difference among age groups. The highest AI application identified as necessary for the workplace was dose management (50.3%, n = 276), followed by quality control (49.9%, n = 274) and image evaluation (39.9%, n = 219) (Fig. 2). Multiple responses were allowed for this question.

4 Discussion

The introduction of this paper indicated possible applications of AI in radiology, which has caused some disquiet among some radiographers. [17]. Across the respondents, a wide variation of educational background represented the 'generational' range from Diploma to Doctoral levels. This ensured there was representation reflecting wide practice variation that may be experienced across the sample geography. However, there is a noticeable increase in the number of radiographers with postgraduate qualification in the middle east recently. Elshami et al., reported that 36% of the radiographers obtained their postgraduate in 2020 and afterward [18].

The findings revealed that radiographers have difficulties in acquiring AI-related education and training. This is made worse by the fact that the radiographer mentioned a lack of education courses to assist post-qualification training. Causes for this have been highlighted within educating for new clinical practices and include faculty resistance, the complexity of use, quality of supporting evidence and costs [19]. Most respondents see AI as having an important and wide role, with slightly more mixed feelings about the negative or positive impact on careers and service change. Addressing appropriate education will be a key development that is required of AI.

The final argument is that AI education should be included in both undergraduate and continuing education courses. This is not surprising as relatively few systems are available currently, such as aiding the radiologists

Fig. 1 AI implementation challenges

Fig. 2 AI recommended application

Application	Yes
Dose management	276
Quality control	274
Image evaluation	219
Image post processing	183
Image interpretation	172
Communication	161
Teaching and mentoring	147
Others	47

reporting role [1]. Other areas include patient appointing functions to enhance workflow, dose evaluation and clinical decision making. As a result of the radiographers' limited exposure to AI, there was an even split between excitement and fear of AI.

Perhaps the slightly greater male to female response rate (55.9%:44.1%) reflects the potential gender-based interest in computing seen elsewhere within computer science discussions [20]. Although there are small differences in attitudes about practice and career impacts between males and females, the mean attitudinal values of recognition of the importance AI may have in influencing operating approaches within radiology are high. It is suggested that there is a gender difference in perceptions about whether AI should be taught to higher degrees qualified course content. However, male perceptions are higher than female perceptions. A variation between genders is evident for these latter areas reinforcing previously identified gender differences concerning computer and information science subjects as being valued more by males [21].

There is a large variation between participants concerning engagement with AI at the workplace. Some replies suggest work has progressed and departments are initiating AI use with a plan being devised, and personnel has given responsibility for this aspect of clinical working. Overall, however, the general message is unprepared for AI or lack of information about this reaching a wider staff base. Perhaps, as the questions were not asked, this is more reflective of AI still, relatively speaking, being in its infancy with significant risk to adoption being the main barrier to uptake. Extensive research needs to continue with clinical applications being shown to be effective, safe and costs to be saved relative to the expense of initiating AI within a department of radiology. Many far more affluent countries than some of those represented in this sample have not progressed as rapidly as envisaged, suggesting this is more difficult than

first thought [18]. The global Covid-19 pandemic affected the radiology workforce [22] and has delayed much research and resulted in the resource being redirected. However, on the AI positive side, it has been useful in helping develop more AI algorithms to use across imaging modalities and in information handling.

5 Strength and limitation

A part of the study limitation is the restricted sample, survey length and awareness about the study importance. Although cross-sectional surveys are associated with uncertainty being driven on a voluntary response basis, it could be argued that there may be bias within the sample population representing those with interest in AI. Nevertheless, the cross-sectional survey is quick, easy to conduct, multiple outcomes can be studied and good for descriptive analyses. The paper's strength is that it may raise awareness and attention of the importance of AI in radiology practice and education.

6 Conclusion

As a generalization, there is excitement about what AI could offer but a recognition that education needs to catch up. Much needs to be done to ensure all who will begin to work with AI can feel secure they are doing it well and have a good education base to achieve this. Fears are expressed about job security and how radiology may work, however this is across all ages and educational backgrounds. This is also thought to be caused by the lack of coherent direction amongst leaders (radiology managers, clinicians, and politicians) with respect to a direction for AI use. If this can be achieved on the back of good foundational research, then new ways of working are feasible that may lead to a whole

new approach to healthcare. AI will then be used as a tool to aid efficiency rather than take jobs. After all, the example of the autopilot within aircraft is a good one to demonstrate machines cannot replace humans completely. In conclusion, there is strong support for AI integration in radiology work practice among radiographers. The radiographers' aware of the challenges of AI implementation and indicated the knowledge gap as the main concern. Based on the survey results, education institutes and professional societies should integrate AI into the curriculum and education program.

Declarations

IRB statement Study approved by institutional review board.

Conflict of interest The authors declare that they have no conflict of interest.

References

1. Kulkarni S, Seneviratne N, Baig MS, Khan AHA. Artificial Intelligence in Medicine: Where Are We Now? Acad Radiol. 2020;27(1):62–70.
2. Hutton D, Beardmore C, Patel I, Massey J, Wong H, Probst H. Audit of the job satisfaction levels of the UK radiography and physics workforce in UK radiotherapy centres 2012. Br J Radiol. 2014;87(1039):20130742.
3. Lohikoski K, Roos M, Suominen T. Workplace culture assessed by radiographers in Finland. Radiography. 2019;25(4):e113–8.
4. Uffmann M, Schaefer-Prokop C. Digital radiography: The balance between image quality and required radiation dose. Eur J Radiol. 2009;72(2):202–8.
5. Abuzaid MM, Elshami W, Tekin H, Issa B. Assessment of the Willingness of Radiologists and Radiographers to Accept the Integration of Artificial Intelligence Into Radiology Practice. Acad Radiol. 2020 Oct.
6. Davenport T, Kalakota R. The potential for artificial intelligence in healthcare. Futur Healthc J. 2019;6(2):94–8.
7. Sun Y, Zhu Z, Pang S. Learning models for acquisition planning of CT projections (Conference Presentation). In: spiedigitallibrary.org. 2019. p. 11.
8. Wang S, Su Z, Ying L, Peng X. SZ-2016 I 13th, 2016 U. Accelerating magnetic resonance imaging via deep learning. ieeexplore.ieee.org. 2016.
9. Santini G, Zumbo LM, Martini N, Valvano G, Leo A, Ripoli A, et al. Synthetic contrast enhancement in cardiac CT with Deep Learning. arxiv.org. 2018.
10. Zarshenas A, Liu J, Fajardo LL, Suzuki K. Radiation dose reduction in digital breast tomosynthesis (DBT) by means of neural network convolution (NNC) deep learning. spiedigitallibrary.org. 2018.
11. Ahn CK, Heo C, Kim JH. Combined low-dose simulation and deep learning for CT denoising: application in ultra-low-dose chest CT. In: spiedigitallibrary.org. 2019. p. 43.
12. Looney P, Stevenson GN, Nicolaides KH, Plasencia W, Molloholli M, Natsis S, et al. Fully automated, real-time 3D ultrasound segmentation to estimate first trimester placental volume using deep learning. JCI insight. 2018 Jun;3(11).
13. Kuo C-C, Chang C-M, Liu K-T, Lin W-K, Chiang H-Y, Chung C-W, et al. automation of the kidney function prediction and classification through ultrasound-based kidney imaging using deep learning. npj Digit Med. 2019;2(1).
14. Woznitza N, Piper K, Rowe S, West C. Optimizing patient care in radiology through team-working: A case study from the United Kingdom. Radiography. 2014;20(3):258–63.
15. Howard ML. An exploratory study of radiographer's perceptions of radiographer commenting on musculo-skeletal trauma images in rural community based hospitals. Radiography. 2013;19(2):137–41.
16. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? Indian J Psychol Med. 2013;35(2):121–6.
17. Gallix B, Chong J. Artificial intelligence in radiology: who's afraid of the big bad wolf? Vol. 29, European Radiology. Springer Verlag; 2019. p. 1637–9.
18. Elshami W, McConnell J, Abuzaid M, Noorajan Z. Radiography doctorates in Arabia: Current position and opportunities to transform research practice in the Middle East. Radiography. 2020.
19. Pitts NB, Drummond J, Guggenberger R, Ferrillo P, Johnston S. Incorporating new materials and techniques into clinical practice. Adv Dent Res. 2013;25(1):33–40.
20. Rosson MB, Carroll JM, Sinha H. Orientation of Undergraduates Toward Careers in the Computer and Information Sciences: Gender, Self-Efficacy and Social Support. ACM Trans Comput Educ. 2011;11(3):14.
21. Dang Y, Zhang Y, Ravindran S, Osmonbekov T. Examining student satisfaction and gender differences in technology-supported, blended learning. J Inf Syst Educ. 2016;27(2):119–30.
22. Elshami W, Akudjedu TN, Abuzaid M, David LR, Tekin HO, Cavli B, et al. The radiology workforce's response to the COVID-19 pandemic in the Middle East, North Africa and India. Radiography. 2020.