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Citation: Arkoh, S., Akudjedu, T. N., Amedu, C., Antwi, W. K., Elshami, W. & Ohene-Botwe, B. (2025). Current Radiology workforce perspective on the integration of artificial intelligence in clinical practice: A systematic review. *Journal of Medical Imaging and Radiation Sciences*, 56(1), 101769. doi: 10.1016/j.jmir.2024.101769

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Link to published version: <https://doi.org/10.1016/j.jmir.2024.101769>

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Current Radiology workforce perspective on the integration of artificial intelligence in clinical practice: A systematic review

Abstract

Introduction: Artificial Intelligence (AI) represents the application of computer systems to tasks traditionally performed by humans. The medical imaging profession has experienced a transformative shift through the integration of AI. While there have been several independent primary studies describing various aspects of AI, the current review employs a systematic approach towards describing the perspectives of radiologists and radiographers about the integration of AI in clinical practice. This review provides a holistic view from a professional standpoint towards understanding how the broad spectrum of AI tools is perceived as a unit in medical imaging practice.

Methods: The study utilised a systematic review approach to collect data from quantitative, qualitative, and mixed-methods studies. Inclusion criteria encompassed articles concentrating on the viewpoints of either radiographers or radiologists regarding the incorporation of AI in medical imaging practice. A stepwise approach was employed in the systematic search across various databases. The included studies underwent quality assessment using the Quality Assessment Tool for Studies with Diverse Designs (QATSSD) checklist. A parallel-result convergent synthesis approach was employed to independently synthesise qualitative and quantitative evidence and to integrate the findings during the discussion phase.

Results: Forty-one articles were included, all of which employed a cross-sectional study design. The main findings were themed around considerations and perspectives relating to AI education, impact on image quality and radiation dose, ethical and medico-legal implications for the use of AI, patient considerations and their perceived significance of AI for their care, and factors that influence development, implementation and job security. Despite varying emphasis, these themes collectively provide a global perspective on AI in medical imaging practice.

Conclusion: While expertise levels are varied and different, both radiographers and radiologists were generally optimistic about incorporation of AI in medical imaging practice. However, low levels of AI education and knowledge remain a critical barrier. Furthermore, equipment errors, cost, data security and operational difficulties, ethical constraints, job displacement concerns and insufficient implementation efforts are integration challenges that should merit the attention of stakeholders.

Keywords: Artificial Intelligence; radiology workforce; perspective; radiographers; radiologists

Introduction

Artificial Intelligence (AI) represents the application of computer systems in tasks traditionally performed by humans, encompassing aspects like learning, problem-solving, and visual perception.¹ In healthcare, AI is not designed to replace human roles but to complement human intelligence, particularly in sectors like medical imaging and radiotherapy. The integration of AI in these fields has shown significant progress, improving quality assurance through the production of regular reports on image quality and radiation dosage, auto-populating reports with imaging data across all modalities, automatic lesion detection, auto-segmenting of tumours, and tailoring radiation dosage in radiotherapy, to name a few, with expectations of future revolutions.²⁻⁷

While AI holds the promise of improving diagnostic accuracy and efficiency in radiology, it is not without challenges. Concerns such as data privacy, ethical considerations, and the rigorous validation of AI models persist as areas of critical focus.⁴ These concerns, along with the advantages of AI tools, continue to shape the perspectives of the radiology workforce overtime.^{7,8} Regular research activities become indispensable for understanding how professionals feel and perceive AI in their practice.

Although there are many publications¹⁻⁸ addressing the perspectives of radiologists (including trainees) and radiographers (including trainees, sonographers, nuclear imaging professionals, diagnostic and therapy radiographers) regarding AI, most of these studies have examined the views of these professionals in isolation. Works which assessed the views of both professionals have done so on a limited scope, mainly in local or national studies, without comprehensively assessing the global perspectives of these two professions to present a common view as the key stakeholders the radiology department. The lack of a comprehensive study creates a gap in knowledge about the collective perspective of this clinical workforce. The collective perspective is necessary for the implementation and integration initiatives of AI into the clinical practice operations within radiology departments.

As researchers in medical imaging practice, our role as professionals is to ensure the community stays informed about these updates, acting as a bridge between developers (various manufacturers) and end users (radiographers and radiologists). Consequently, this work was undertaken with the anticipation that such a systematic review will provide a holistic view of current professional standpoints to understand how AI tools are perceived as a unit in medical imaging practice.

Method

The study utilised a systematic review approach to collect data from quantitative, qualitative, and mixed-methods studies, adhering to the guidelines of the Cochrane Collaboration⁹. Unlike studies that collect deeply personal or confidential information from participants, systematic review studies do not necessitate institutional ethics approval, as highlighted by Suri.¹⁰

Eligibility Criteria

Inclusion criteria encompassed articles concentrating on the viewpoints of either radiographers or radiologists regarding the incorporation of artificial intelligence in medical imaging practice. Non-English studies, along with review articles, letters to the editor, opinion pieces, and case reports, were excluded. All selected studies had to fall within the scope of medical imaging. Publication date restrictions were not imposed, and two authors independently screened all titles and abstracts to identify studies meeting the eligibility criteria.

Search Strategy

Two researchers independently conducted a systematic search across various databases. The initial screening and selection of eligible studies were overseen by one researcher using appropriate keywords adapted from the Medical Subject Heading (MeSH). The search utilised Boolean operators (AND, "OR" and "NOT"), and MeSH keywords ('radiographers,' 'radiologists,' 'artificial intelligence,' 'perspectives,' 'medical imaging' and 'medical imaging technologists'). Search combinations were adjusted to include abbreviations, truncated syntax, and subject headings per each database's requirements. PubMed, Science Direct, and Scopus were used as the databases to systematically explore to incorporate all studies aligning with the review's objective. The databases from which the articles were selected are widely used, easily accessible to the review team, and were considered sufficient to comprehensively capture a broad range of relevant biomedical literature. Google Scholar was additionally utilised for a manual search using the previously mentioned keywords. Given the robust nature of these databases, it was determined that including additional databases would likely result in redundancy without significantly enhancing the scope of the review. Key Journals with medical imaging focus (*Radiography*, *Journal of Medical Imaging & Radiation Sciences (JMIRS)*, *Journal of Medical Radiation Sciences (JMRS)*, *Radiologic Technology*, and *Radiology: Artificial Intelligence*, *European Journal of Radiology*) were examined for relevant articles. Microsoft Excel 2016 was employed to organise and sort all search outputs during the screening process.

Subsequently, the second researcher confirmed the eligibility of the identified studies using an adapted PICOS (Population, Interest or Aim of study, Context, and Study Design) framework form.¹¹ The PICOS model is an effective method for grouping and narrowing down the subject of a study into a searchable query, and splitting the PICOS components helps identify search terms/concepts to employ in systematic review search strategies.¹¹ Therefore, studies were included or excluded based on which professionals were recruited, the aims of respective studies, the perspectives on relevant subjects, and the relevant study designs. The final search was conducted on 11/3/2024.

Table A: Article selection criteria using the PICOS format.

| Topic | Inclusion | Exclusion |
|--------------|---|--|
| Population | Diagnostic radiographers, Therapeutic radiographers, Radiologists, Nuclear medicine radiographers, Student radiographers, resident radiologists | All other medical imaging support staff e.g., Biomedical engineers, imaging support workers, |

| | | |
|--------------------------|---|--|
| | | PACS officers, medical physicists etc. |
| Interest or Aim of Study | Assessment of perspectives of the population, that is radiologists (including trainees) and radiographers (including trainees, sonographers, nuclear medicine radiographers, diagnostic and therapy radiographers) on the integration of Artificial Intelligence in medical imaging | Opinion studies or commentaries of authors on Artificial Intelligence in medical imaging |
| Context | Survey or Interview based Perspective studies on the desired population | Non survey or Interview based studies |
| Study Design | Cross-sectional (one-time point) quantitative (Descriptive) and qualitative (phenomenological) studies with at least descriptive analysis, inferential analysis or thematic analysis. | All other forms of quantitative and qualitative study designs. |

Study selection and data extraction

Utilising the predetermined search strategy, the selected studies underwent quality assessment using the Quality Assessment Tool for Studies with Diverse Designs (QATSSD)¹² checklist framework for cross-sectional studies in Table C (See *Supplementary document C*). QATSSD evaluates both qualitative and quantitative components of research and has strong inter-rater reliability.¹² The research team members collectively reviewed the results. The primary investigator conducted an additional review of selected studies to eliminate potential ambiguity in applying eligibility criteria throughout the screening process. Discrepancies in quality assessment scores were deliberated by the review team until a consensus was reached. Based on best practice, studies were categorised as 'high quality,' 'moderate quality,' and 'low quality' if they achieved aggregate scores of at least 70%, 50%-69%, and less than 50%, respectively. This was done to check the quality of the studies; however, all the papers recorded values above 50 to indicate satisfactory quality levels. Data from all studies were extracted and tabulated using a template, capturing details such as the study reference and journal, geographical area of study, study site characteristics, study design and analysis approach, study period, study aims, and key outcomes.

Data Synthesis Approach

A parallel-result convergent synthesis approach¹³ was employed to independently synthesise qualitative and quantitative evidence and to integrate the findings during the discussion phase. Independent syntheses of respective studies are presented in Table B. The findings were further analysed, utilising the synergistic advantages of both textual narrative synthesis and thematic synthesis methods.¹⁴ Lucas et al.¹⁴ indicate that textual narratives are useful in synthesising evidence of various kinds and making the heterogeneity in studies apparent. Textual narrative synthesis elucidated the context and distinctive characteristics of each study in this review, and this allowed for the grouping of qualitative and quantitative research into a more homogeneous category by qualiting

quantitative aspects of studies. On the contrary, thematic synthesis was employed to organise the findings into structured themes and subheadings¹⁵ for ease of presentation and clarity.

Results

The initial search produced 14,468 articles. These articles were extracted from Google Scholar (n=13,800), PubMed (n=383), Science Direct (n=92), websites from Google cross-search (n=55), and others (i.e., Scopus, CINAHL) (n=138). Articles were preliminarily screened for duplicates, which resulted in the exclusion of 5,305 articles with a remainder of 9,163 articles. These articles were then passed through two stages of screening by title and abstract. 2876 articles were found not to have a title or abstract that sought to assess the perspectives of radiographers or radiologists on artificial intelligence. The remaining 6,287 articles were further screened with common keywords such as artificial intelligence, perspectives, opinions, machine learning (ML), survey, radiologic technologists, radiographers, radiologists, radiation therapists, radiology residents, medical imaging, radiology, diagnostic imaging, integrations etc. 137 articles were included, having passed the eligibility phase; they were, however, passed through further scrutiny to eliminate review articles (n=23), unacceptable study designs (n=20), multi-disciplinary studies that did not involve radiologists and/or radiographers (n=13), book chapters (n=10), and commentaries/blogs for websites (n=6), among others (n=12). The resulting 53 articles underwent a final step in the eligibility phase before ultimate inclusion. 12 articles were found to be duplicate studies obtained by both researchers by manually screening through all 53 studies independently and reaching a consensus on duplicates. Independent manual screening for duplicates significantly left little to no room for oversight errors. Finally, forty-one (n=41) articles were exhaustively read and were considered to meet the inclusion criteria of this review. Figure 1 shows the PRISMA chart of various stages of screening identified articles (*See Supplementary Document A*). Table B shows various articles that met inclusion criteria after a thorough screening of identified articles (*See Supplementary Document B*). Table C shows quality assessments for all 41 articles (*See Supplementary Document C*).

All forty-one (n=41) articles employed a one-time point cross-sectional study design. Thirty-four (n=34) articles utilised convenience sampling methods, disseminating questionnaires predominantly through online platforms such as SurveyMonkey, Google Docs, and Qualtrics. In contrast, seven (n=7) studies, Edzie et al.²⁶; Akudjedu et al.³⁰; Abuzaid et al.³⁴; Ng et al.⁴⁶; Stogianos et al.⁴⁸; Rawashdeh et al.³¹; and Champendal et al.⁵⁵—adopted purposive sampling targeting a broader audience of radiographers and/or radiologists.

Thirty-three (n=33) studies generated quantitative responses, while five (n=5) studies, Akudjedu et al.³⁰; Rainey et al.²⁰; Ryan et al.¹⁸; Stogiannos et al.⁴⁸; Champendal et al.⁵⁵, produced both quantitative and qualitative data. Only three (n=3) studies, Antwi et al.¹⁷; Chivandire et al.⁵⁰; and Ng et al.⁴⁶, exclusively collected qualitative responses. Concerning statistical analysis methods, twenty-nine (n=29) employed both descriptive and inferential analysis, seven (n=7) articles employed descriptive data analysis, three (n=3) employed thematic analysis, one (n=1) had both descriptive and thematic analysis, and one (n=1) had descriptive, inferential, and content analysis methods.

Discussion

The fields of radiology have embraced technological advancements, including the shift from film-screen analogue systems to digital imaging, computer-aided diagnosis, and quantitative analysis. This evolution, along with the integration of AI, significantly impacts the field and requires educators and practitioners to stay informed and explore seamless integration of these emerging tools into the profession globally.

This review analysed 41 studies conducted worldwide from 2018 to 2024, focusing on the perspectives of radiographers and radiologists on AI integration into clinical practice. The studies included diagnostic and therapeutic radiographers, nuclear medicine professionals, and residents/practising radiologists, enabling a comprehensive comparison. Common themes developed, covering general knowledge, AI education, impact on image quality and radiation dose, ethical and medico-legal aspects, patient considerations, perceived significance, factors influencing implementation, job security, and overall thoughts on development. Despite varying emphasis, these themes collectively provide a global perspective on AI in the field.

General knowledge and reception of AI

Participants' general knowledge and acceptance of AI were common themes across all studies.^{2,16,17,18,19,20,21,22,23,24,25,26,27,28,29} While there were varying levels of knowledge, both radiographers and radiologists generally showed a positive reception to AI integration in medical imaging. For instance, Akudjedu et al.³⁰ reported that over 70% of respondents were confident in adopting AI in daily practice. American imaging technologists and United Arab Emirates (UAE) radiographers described themselves as technology enthusiasts, indicating their daily use of AI applications and grasp of AI concepts.^{19,31} Studies in Africa, Canada, , the UAE, Saudi Arabia, Ireland, Australia, and the Nordic region consistently highlighted a positive attitude towards AI integration, with professionals expressing optimism about its future role in diagnostic imaging and patient care.^{2,3,18,19,25,30,32,33,34,35,36,37,38,39,40,41}

The radiology communities displayed high optimism and familiarity with the integration of AI.^{27,42,43} Italian, Chinese and French radiologists viewed AI as an aid to daily working practice.^{25,38,44} In the UK, 83% of trainee radiologists cited the use of AI applications such as Brainomix, RAPID software, and CT polyp finder in their work.⁴⁰ Swiss radiologists also expressed a favourable view of the futuristic use of AI tools.³⁹ Studies by Huisman et al.³ and Hashmi et al.⁴⁰ among UK radiologists supported the opinion that AI will improve diagnostic efficiency and bring significant changes to the field within the next decade.

Despite widespread acceptance of AI integration in medical imaging, several studies highlight a notable lack of knowledge.^{2,16,17,18,19,21,22,23,24,,25,26,27,28,29,45,46} Radiologists and radiographers in the USA, Saudi Arabia, Ireland, and the UK displayed varying levels of familiarity with AI concepts, exhibiting limited understanding of its principles and terminology.^{18,19,20,23,27,45} Usage rates of AI applications were relatively low among radiologists in Ghana, the USA, Saudi Arabia, and France, with only 45%, 29%, 8%, and 7%, respectively, reporting daily use.^{24,25,26,29} Singaporean radiographers lacked knowledge of machine learning concepts, and African radiographers expressed discomfort with AI tools.^{2,46} Gaps in knowledge were evident among Singaporean radiologists, highlighting a significant disparity between technology reception and

understanding.⁴⁶ Media influence could be a contributing factor to this knowledge-reception gap, with professionals forming impressions based on mainstream media rather than scientific literature.^{23,27,33,38,47} This discrepancy raises concerns about the potential for erroneous AI use, emphasising the need for accurate knowledge acquisition among medical professionals to gauge genuine AI acceptance. Many authors stressed the importance of meticulous knowledge acquisition for accurate AI acceptance assessment.^{23,27,31,33,47}

The gaps between AI reception and knowledge in radiography and radiology modalities also arise from varying AI applications. Abuzaid et al.³³ suggest a limited understanding beyond abnormality detection on x-ray images. The absence of dedicated AI officers in institutions³³ may contribute to this gap, prompting the emergence of AI specialisations to address the need for expertise.⁴⁶ Radiologists propose AI imaging informatics as a radiology subspecialty.³ Radiographers specialising in AI, equipped with computer science skills, can control, create, audit AI systems, and troubleshoot, offering potential solutions.⁴⁶ The integration of AI-augmented systems is expected to attract technologically adept doctors to radiology.²³ Malamateniou et al.¹⁵ highlight ongoing radiography-led studies exploring the attitudes, perceptions, and expectations of radiographers under ASRT, ISRRT, and SCoR guidelines, aiming to establish foundational data for addressing AI preferences and challenges.

Perspectives on education in AI integration

Literature suggests that AI-based education positively influences professionals' attitudes toward AI utilisation and broader medical education aspects.⁶ Radiologists, including residents and BSc holders, express a desire to enhance their AI/ML knowledge for practice improvement.^{23,25,28} AI education has shown to increase positive acceptance and involvement in the radiography workforce,³⁰ while Saudi PhD radiographers believe in AI's potential to minimise radiation exposure.³⁶

However, challenges exist in addressing the low level of AI education among participants. UK radiography workforce reported lack of knowledge and confidence for full AI integration^{45,48} with some ASRT imaging technologists receiving no AI training.¹⁹ French radiologists and a significant proportion of radiography professionals in the UK express insufficient prior AI knowledge^{24,25}, attributed to the absence of AI modules in undergraduate or residency programmes.²⁹ However, the integration of AI content in curricula is gaining ground. For example, the Health and Care Professions Council (HCPC) in the UK in their latest standard of proficiency requires radiographers to have AI awareness. While a small cohort in the UAE, ASRT, and Saudi Arabia have structured AI training,^{19,29,47} UAE MRI technologists lack ongoing AI medical education.³³ The radiology community in Jordan are challenged by a lack of mentorship from AI experts in the field.⁴⁹

Responses regarding professionals' eagerness to pursue continuing professional education in AI vary. Some professionals show reluctance to participate in conferences and courses related to AI in radiology.^{41,46} Rainey et al.⁴⁵ reported a significant cohort agreeing on lacking skills for robust AI implementation. On the contrary, Waymel et al.²⁵, Ampofo et al.²² and Rawashdeh et al.³¹ found that virtually all French radiologists, Ghanaian radiographers, and UAE radiographers would attend AI workshops, especially advanced ones, and individuals with prior AI knowledge or tech-savvy tendencies are more inclined to seek education.^{23,25} Notably, a majority of Saudi Arabian, Nordic, and

Zimbabwean radiography and radiology workforce expressed interest in AI education^{29,46,50} and most UK radiologists wanted to be involved in AI-centred research.⁴⁰ Comprehensive training programmes and implementation are essential prior to AI use.^{28,36} The ISRRT/EFRS joint statement in 2020 emphasised the need for education in "AI advancements".⁵³ Professionals in this review acknowledged the need for educational tools and training opportunities to acclimate to AI, with the Saudi Arabian and Zimbabwean radiology and radiography workforce advocating for AI inclusion in medical and allied health college curricula.^{41,50} Similarly, Ghanaian and French radiologists emphasised the importance of teaching AI foundations in medical schools.^{25,26} Huisman et al.³ and Salastekar et al.⁵² both underlined the widespread opinion of AI education in residency programs.

Despite some African radiographers indicating having some coding abilities², education packages for radiographers may be limited to understanding how AI works rather than extensive coding.⁵³ Many radiography professionals resort to self-training for basic AI education.^{18,45,49} Informal learning through clinical placements and continuing professional development is common in the evolving field of radiography.^{15,45} AI-dedicated courses are lacking in radiology residency programmes in Ghana and Saudi Arabia.^{26,27} A structured education framework is needed to bridge global knowledge levels and manage functional and ethical facets of AI for patient care and safety.¹⁵

Web-based programmes from highly resourced institutions or renowned faculty are suggested as a sustainable way to infuse AI knowledge.⁵³ The Topol Review recommends integrating computer sciences and digital technologies into the undergraduate curricula for all healthcare practitioners.^{30,54} Singaporean radiologists call for the introduction of data science education in residency programmes.²³ While participants express interest in AI education, challenges arise in integrating AI into packed curricula across institutions, leading to high drop-out rates.²³

Prospective research should prioritise effective education on AI for professionals and students.⁴⁹ UK radiology trainees express a desire for AI instruction at the deanery level, through methods such as webinars, local training programmes, and certified qualifications.⁴⁰ Continuing professional development opportunities, including local training sessions and webinars, have also been reported as ways that can address specific AI topics.^{23,46} AI/ML education highly recommended to be structured in a way that would enable professionals to comprehend algorithm principles, collaborate with data scientists, and recognise technology drawbacks and safety concerns.²³

Engagement from radiography researchers with AI integration is increasing, with the EFRS leading a landmark AI competency development.¹⁵ However, it is suggested that further research should explore overhauling the undergraduate curricula to replace outdated imaging methods with modern practices, ensuring graduates are trained in AI principles.^{55,56} Meanwhile, participants in some studies^{2,30,41} have also called for the inclusion of AI in allied health and medical college curricula. Interestingly, there are already tailored postgraduate courses related to AI in some institutions⁵⁷, which is great. Moreover, medical Imaging and radiotherapy conferences have been including AI CPD sessions to promote AI awareness.¹⁵ It is suggested that professional bodies should mandate members to take introductory AI courses.^{30,36}

There was a positive acceptance of AI among radiographers and radiologists with varying education levels to suggest that there is enthusiasm for rapid integration of AI education at all levels of radiography and radiology education.^{42,57} Academic institutes are therefore encouraged to incorporate AI elements into undergraduate⁵⁵ or

postgraduate courses.⁵⁷ It also suggested that each country should strive to equip its workforce with the knowledge, skills, and attitudes needed for the digital present and future of healthcare.^{2,30}

Impact of AI on image quality and radiation dose

This section presents opinions on AI's impact on image quality and radiation doses. Radiologists in Alelyani et al.'s⁴¹ study anticipate AI improving image quality and diagnostic efficiency, while Ghanaian and Saudi Arabian radiographers expect reduced radiation doses and maintained image quality.^{2,36,43} Dose management and image evaluation are key AI features for Arabian technologists.³⁴ Efforts to enhance image quality in medical imaging often face challenges in ionizing radiation modalities, and balancing image quality with high radiation doses.⁵⁸ The principle of 'as low as reasonably achievable/practicable' guides this balance.⁵⁸

AI, particularly in image processing, proves beneficial in overcoming challenges posed by traditional methods. It enables reduced dose parameters without compromising image quality.^{1,5,58,59,60} Arabian radiographers prioritise AI's role in dose management.³⁴ Deep Learning Image Reconstruction (DLIR) algorithms, like those discussed by Sun et al.⁵ could reduce dose by 85%. ASRT technologists and Singaporean radiographers also foresee AI tools reducing radiation exposure and addressing motion artifacts.^{19,46}

Studies highlight AI's capacity to rectify motion blurring artefacts, eliminate streak artefacts in MRI scans, and remove banding artefacts, maintaining a high signal-to-noise ratio.^{61,62} AI methods provide avenues to enhance contrast-based examinations by delivering small contrast volumes and extrapolating MRI sequences using neural networks.^{62,63}

European radiographers, per Coakley et al.⁵⁷, believe AI will influence exposure factor selection and quality assessment, addressing the image quality perception gap between radiologists and technologists.^{4,64} Some AI software offer real-time image quality assessment, aiding radiographers in identifying errors and improving image quality.⁴ Singaporean radiographers also foresee AI assisting in procedures and reducing patient radiation exposure.⁴⁶

Ethical and medico-legal considerations on the use of AI

UK radiologists emphasise ethical concerns as a top priority in AI education.⁴⁰ Huisman et al.'s³ intercontinental study revealed ethical concerns raised by non-European radiologists and those with advanced AI knowledge. Moreover, African and European radiographers express concerns about AI-related errors and ethical issues, highlighting worries about AI trustworthiness.^{16,41,43,57} ASRT technologists are also cautious, with only 1.8% expressing complete trust in AI tools, emphasising data privacy and security concerns.¹⁹ Australian radiographers echo heightened concerns about the ethical facet of AI algorithm development.³⁵

Singaporean radiographers stress that AI systems' credibility relies on algorithm context, highlighting potential biases.⁴⁶ In another study³, radiologists note ethical concerns tied to the lack of annotated datasets and software generalisation issues. Concerns about AI's vulnerability to bias and discrimination led some Saudi Arabian radiographers and Swiss radiologists to doubt AI's role in diagnostic decision-making.^{29,36,39,43} A general

scepticism about AI results, especially among participants with at least BSc. Degrees indicate widespread concerns about reliability.⁴¹

To address these concerns, comprehensive, widely accepted regulatory approvals for AI packages are proposed.¹⁵ Open scientific methods like dataset sharing and source code sharing are suggested solutions to optimise algorithms for diverse populations.⁴⁶ Australian nuclear medicine and radiography professionals advocate for stringent implementation guidelines shared among professional bodies.³⁵ UK reporting radiographers also advocated for explainable AI solutions to boost trust even when there is an inadvertent AI error.²⁰

Moreover, radiographers expressed incredulity about responsibility for AI-related errors, with varied opinions on whether radiologists, vendors, or governing organisations should bear liability.^{16,25,31,33,41} Swiss radiologists emphasise avoiding patient consequences in AI errors but cannot reach a consensus on liability attribution.³⁹ African radiographers also had diverse views on potential blame targets in AI errors.¹⁶

Saudi Arabia radiology community perceive AI as causing stress and anxiety among patients due to medicolegal issues.⁴¹ Ghana radiologists share concerns about adverse effects on patient outcomes²⁶, while a minority in Akudjedu et al.'s³⁰ study believe patients will accept AI without concerns. Potential patient dissatisfaction arises from reduced human interaction due to AI's perceived independence and discrepancies between AI and radiologist reports.^{30,41} The participants highlight the need for studies assessing patient perceptions of AI-empowered medical imaging examinations to bridge the gap between technical predictions and subjective patient feelings.³⁰

Professionals express concerns about over-reliance on digital results over patient considerations.³⁰ Globally, many radiologists envision AI as a second reader in the long run, emphasising its supportive role rather than autonomy.^{3,40} Disparities, however, exist in staff attitudes toward obtaining patient consent for AI deployment, with varying views on patient awareness and involvement in decisions.^{18,41} Ethical considerations regarding patient consent and the potential misuse of data for commercial purposes are prominent.³⁶ Radiographers and radiologists diverge on whether AI makes medical services inhumane, with concerns about the need for legislative frameworks and ethical regulations.^{18,41} Patient trust, governmental involvement, and collaboration with relevant stakeholders are proposed solutions to address ethical complications and boost confidence in AI technology.^{26,46} The role of equipment vendors in defining ethical regulations is debated, emphasising the importance of human supervision and auditing AI solutions.¹⁸ It is suggested that healthcare organisations must balance the potential benefits of AI in radiology with a comprehensive understanding and management of associated risks and liabilities.⁶⁵

Perceived potential of AI on image reporting, workflow, quality assurance and enhanced performance

AI is poised to revolutionise radiologic practice, impacting various facets from examination planning to image reporting, and workflow optimisation.⁶⁵ Professionals globally anticipate AI's potential to reduce radiographers' workload significantly, with expectations of improved efficiency and competent diagnosis.^{20,36,44,50} Radiologists envision fundamental changes in practice, foreseeing AI's role as a second reader, allowing them to focus on value-added patient care.^{3,23} Italian radiologists believe AI can

enhance diagnosis accuracy and therapy individualisation by providing quantitative data in reports.³⁸

The impact on workflow management is evident, with expectations of AI optimising worklists, automating pre-imaging patient management, and transforming patient scheduling aspects.^{46,57,66} AI's assistance in patient preparatory processes and examination planning is also highlighted, promising increased speed and throughput.³⁰ Additionally, AI chatbots are thought to offer guidance to referrers on relevant imaging modalities, contributing to clinical decision support.⁶⁷

Literature supports AI's role in improving isocentre alignment, automatic protocol selection, and contrast optimisation.^{18,68} Moreover, AI's influence is thought to extend to image acquisition processes in MRI, CT, and ultrasound, offering possibilities for procedure automation and efficiency enhancement.^{18,29,33,65} Regarding image post-processing, AI is recognised for its potential in automated image reconstruction, with radiographers and radiologists expressing optimism about its impact.^{19,25} The automation of CT, MR, and nuclear medicine post-processing has been considered a possibility for enhancing examination efficiency and patient modality throughput.⁶⁹ Early research into synthetic modality transfer further explores the potential for AI to extract CT images from MRI data or vice versa, eliminating the need for double studies.⁶⁹

AI holds substantial promise in revolutionising image reporting and interpretation across radiography. European radiographers recognise its potential, with UK counterparts anticipating significant impacts on areas such as screening for abdominal aortic aneurysm and stroke recognition.^{20,57} Automatic lesion detection, vessel measurements, and identification of incidental findings are highlighted as areas where AI could transform radiology practice.^{19,25,67.}

UK radiographers believe that AI will have a positive effect on reporting radiographers' decision making in the future.²¹ It is indicated that AI applications, such as those utilising Natural Language Processing (NLP), may expedite report generation by auto-populating reports with imaging data, reducing radiologists' reporting time.⁷⁰ Implementing AI-supported reporting services, involving both radiographers and radiologists, is also seen as a cost-effective and accurate alternative to traditional image interpretation services.^{65,71} The potential for addressing reporting backlogs and workforce concerns is emphasised, promoting straightforward adoption strategies.

In radiotherapy, Wong et al.³² and Rainey et al.²⁰ also highlighted AI's positive impact, particularly in treatment planning. Deep learning algorithms show promise in auto-segmenting tumours and individualising radiation dosage, potentially accelerating effective patient care.⁷²

Furthermore, radiographers globally anticipate AI's role in improving radiography practice, quality assurance, and clinical care.^{2,36,41} Larson & Boland⁷³ emphasise AI tools' ability to produce regular reports on image quality and radiation dosage, enabling professionals to validate equipment efficiency and enhance performance over time.

AI's impact on research output in medical imaging is also acknowledged, reflecting the dynamic evolution of the field.³⁶ In all, it was anticipated that the rapid integration of AI necessitates professionals to embrace new roles and opportunities while upholding core values.

Factors that potentially affect AI implementation

Several challenges have been identified in the literature that impede the successful integration of artificial intelligence (AI) in medical imaging and radiology, including equipment errors, costs, data security, operational pitfalls, and inadequate implementation efforts. Ghanaian and Saudi Arabian radiographers expressed explicit concerns about AI-related errors,^{16,36} and there is a global lack of trust, especially among non-European radiologists.³ Radiologists also express concerns about digital infrastructure limitations with AI systems³, and some within the Dutch healthcare community perceive inconsistent technical performance of AI applications.⁷⁴

Some AI-related errors often stem from sensitivity and specificity issues, leading to false positives or false negatives, respectively.⁷⁴ Concerns were raised about the potential burden on radiologists who may need to double-check AI interpretations.²⁹ To mitigate errors, stakeholders are urged to develop automated tools dependent on human validation, emphasising the need for radiographers and radiologists to own the validation process.⁶⁷

Cost concerns were widespread, with radiographers and radiologists worrying about both equipment and maintenance expenses.^{16,19,26,36,57,38,48} The projected \$36 billion expenditure on AI in healthcare by 2025 poses a financial challenge, especially in low-resource settings.^{75,76} While Ghanaian radiologists advocate for government cost subsidisation, the financing landscape involves contributions from both private and public sectors.^{26,77}

Concerns about cybersecurity threats were also highlighted, with Saudi Arabian radiographers and African radiographers identifying potential breaches as major worries.^{16,17,36,43} The calls for an internationally binding, large-scale cybersecurity regulatory framework underscore the need for enhanced data security and resilience across borders.⁷⁸

While AI's limitations in patient interaction and creativity are acknowledged,^{19,46,57} professionals across studies anticipate an expansion of their roles with AI integration.^{18,19,30,46}

Furthermore, the lack of concerted efforts to introduce professionals to AI, coupled, with low education levels on AI tools, poses a challenge.^{35,50} Many diagnostic radiographers and nuclear medicine professionals feel unprepared for AI implementation.^{35,48} Some of the challenges have been that some institutions often lack dedicated officers to guide AI implementation, relying on self-taught or vendor-provided education, creating a need for appropriate educational channels.^{3,33,47}

Impact of AI on job security and job description

It also reported that professionals in medical imaging and radiology are apprehensive about the potential labour displacement caused by AI, attracting significant attention.^{18,36,22,41,49,79} Job security concerns were prevalent among these professionals, with Irish radiographers anticipating staffing reductions due to AI implementation.¹⁸ In Ghana, a notable fraction of radiographers feared job insecurity and salary reduction,^{16,22} a finding seen in a larger group of African radiographers.² Thematic analyses by Antwi et al.¹⁷ support these concerns, revealing that most medical imaging professionals in Africa foresee job losses and role revisions due to AI. Similarly, Saudi Arabian⁴¹ and Jordan⁴⁹ radiographers express anxiety about AI replacing them in their career path, echoing sentiments from Aldhafeeri³⁶ in an earlier study.

French radiologists anticipate a reduced need for radiologists in the next decade due to AI integration²⁵, and job loss is a top grievance among UK radiologists and some Swiss radiologists.^{40,55} Concerns about the inevitable deskilling of the global workforce due to excessive reliance on AI are shared worldwide.³⁰ Despite widespread anxiety about AI replacing human workers, there is limited evidence supporting this theory.^{36,80.}

Job security concerns regarding AI in radiography are particularly pronounced among African radiographers despite their limited exposure to AI's practical impacts or knowledge.⁸¹ However, Edzie et al.²⁶ argue that AI cannot replace professionals in Africa and similar low-resource settings. While job automation is plausible, external factors like technology costs, legislative approval, and the inherent advantage of human labour in executing care skills may mitigate job loss.⁸² ASRT technologists, especially the younger cohort, anticipate expanded roles with AI tools and believe AI will not significantly alter their practice scope.¹⁹ UK radiographers express no job security concerns with AI.²⁰

In contrast to reports of potential job displacement among African radiographers, a substantial number of UAE MRI technologists believe AI integration will not alter their work practices.³³ Similarly, UAE MRI technologists and most European radiographers believe AI cannot perform tasks related to patient care.^{47,57} While AI may be deficient in soft care skills,¹⁸ it is, however, considered proficient in basic technical roles by Aldhafeeri.³⁶ Concerns among diagnostic radiographers, as highlighted by Ryan et al.¹⁸ and Akudjedu et al.³⁰, centre on potential loss of technical skills with the advent of smart technological tools. Participants fear becoming rusty, negatively impacting employment prospects, as AI could eliminate the need for certain technical roles³⁶, such as patient positioning⁷⁴, contrast volume estimation⁸³, or radiographer/radiologist reporting.⁷⁹

Despite concerns over job security, professionals hold varied views on AI's impact on job roles. Some Italian and UK radiologists anticipate reduced role extension and learning opportunities.^{38,40} Canadian and French radiologists express pessimism or uncertainty, considering a shift from diagnostic to interventional radiology.^{25,39} French radiologists perceive interventional radiography as less likely to be affected by AI²⁵. Radiographers, however, foresee role development opportunities with AI integration.^{18,46} In Aldhafeeri³⁶ and Sharip et al.⁸⁴, most radiographers anticipate modifications in their responsibilities amid AI integration, with potential changes in daily clinical practice noted globally.³⁰ The European Federation of Radiographer Societies advocates AI's role in relieving radiographers of non-essential tasks⁵¹. Singaporean radiographers predict an 'AI Specialisation' role, where they are trained in computer science to manage and troubleshoot AI systems, calibrate data, and contribute to algorithm development.⁴⁶

Concerns about job displacement for reporting radiographers and radiologists exist, but it's essential to recognise that their work extends beyond image analysis, and AI tools currently perform specific automation tasks.^{38,79,85} As many AI applications are needed for comprehensive diagnoses, reporting radiographers play a crucial role in applying relevant tools to imaging data. Ng et al.⁴⁶ highlight the widely held view among Singaporean radiographers that AI complements rather than replaces their role.

Several studies^{23,24,25,27,39} emphasise the enduring appeal of radiology for professionals in Singapore, Saudi Arabia, Canada, France, and the USA. Despite Rainey et al.⁴⁵ suggesting no cause for concern, the prevalent indifferent responses regarding recruitment and job appeal in radiography and radiology demand attention^{20,38} Trainees, per Collado-Mesa et al.²⁴ and van Hoek et al.³⁹ studies express more reservations about pursuing diagnostic radiology considering AI's potential impact, contrasting with Waymel et al.²⁵ and Hashmi et al.⁴⁰ characterising residents as more drawn to the profession.

Participants, as reported by Akudjedu et al.³⁰, hold mixed feelings about AI's futuristic impact on the profession's appeal. Italian radiologists anticipate challenges with AI, particularly concerns about professional reputation.³⁸ Saudi Arabia radiographers diverge on whether AI as an assistive tool would negatively impact their earnings.³⁶ Akudjedu et al.³⁰ attribute these uncertainties to pre-conceived notions from 'technology influencers' and acknowledge the role of digital literacy and AI work experience in shaping perspectives. Rainey et al.⁴⁵ recommend focusing on professionals' learning needs based on demographic characteristics to foster AI acceptance.

Irish professionals, following Ryan et al.¹⁸ findings, stress the importance of involving the general medical imaging workforce in AI tool development to establish a symbiotic relationship with AI technology. This collaboration aims to create standardised processes aligning machine-recommended procedures with technologist judgment. ASRT technologists and Malaysian radiographers express concern about the lack of standardisation but firmly agree that AI will not adversely affect their professional prospects.^{19,84.}

Consideration of general thoughts and areas to be developed

Key considerations for successful AI integration in medical imaging, emphasising global professionals' perspectives have been suggested. Cybersecurity threats are a primary concern for African radiographers, urging stakeholders to enhance awareness and infrastructure.^{2,17} Particularly, Ghanaian radiologists emphasise the need for improved internet connectivity and IT infrastructure.²⁶

A global study by Rainey et al.²⁰ identifies MRI, CT, and X-ray as major AI application areas in radiography. However, attention must shift to accelerate AI development for other modalities like ultrasound, PET scan, mammography, dental imaging, and nuclear medicine. UK respondents foresee "reporting" as a future development area.²²

Active professional involvement in AI model development is also thought to be crucial for adoption preparedness.⁴⁶ Tech-savvy students may be drawn to radiology due to AI prospects.³⁹ Evidence shows that, radiologists and radiographers are ready to learn AI applications^{26,46}, and professionals can contribute to data collection and cleansing for algorithm development.⁴⁶

Strengths and limitations

This review effectively analysed the perspectives of radiographers and radiologists in studies in different jurisdictions using scientific and predetermined analysis to produce robust worldwide evidence. Additionally, a detailed, replicable and robust methodological approach was employed for the conduct of the review including study selection and quality assessment. This strategy reduced selection bias and guaranteed that only appropriate studies were included to inform the evidence base presented.

Notwithstanding the inclusion of most of the expected articles, it might have been more robust to use a recognised platform such as RefWorks to organise hits and to remove duplicates. The study was also limited by a lack of data inclusion from South America, potentially due to English being a key criterion for considering the articles which may have restricted the review by inadvertently excluding relevant studies published in other

languages. Notwithstanding, the studies included in this analysis are diverse, encompassing low, middle, and high resource contexts, as well as a variety of healthcare systems.

Conclusion

AI has the potential to revolutionise and improve clinical radiology practice. While expertise levels varied, both radiographers and radiologists were generally optimistic about AI incorporation in medical imaging practice. However, there are barriers in addressing individuals' low levels of AI education. Prospective research should prioritise effective AI teaching for both professionals and students. Some studies expressed fears regarding the ethical and medico-legal implications of utilising AI-enabled products. Therefore, healthcare organisations must carefully weigh the potential advantages of AI in radiology versus the management of the related ethical risks and liabilities. Equipment mistakes, prices, data security, operational difficulties, and insufficient implementation efforts were some issues stated by studies to hinder the successful integration of artificial intelligence (AI) in medical imaging and radiology. Professionals in medical imaging and radiology, particularly those from low-resource regions, were also concerned about the possible job displacement generated by AI.

It is vital that medical imaging and radiology educators, as well as practitioners, analyse current developments in artificial intelligence in medical imaging, particularly how it might be seamlessly integrated into the profession on a global level. While this will inform stakeholders about the workforce's level of knowledge of AI, it will also reveal knowledge gaps worldwide and other relevant issues to shape future research and provide foundational evidence to guide stakeholders in making well-informed decisions.

Funding

None.

Conflict of Interest

None.

Ethical Approval

This study did not require an ethical approval.

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