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RESEARCH

Ethical issues identified by analyzing the attitudes of Swedish radiologists and screening participants toward the use of AI in mammography screening

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Abstract
The debate about the use of artificial intelligence (AI) in medicine has intensified among different stakeholders, including academics, developers, patients associations, regulators, and the general public. This debate is driven by the development of a number of AI-based technologies designed for different medical applications, including diagnosis, prognosis, patient management, and healthcare delivery. Building on previous research examining Swedish radiologists' and screening participants' perception of AI use in mammography exams, this paper aims at identifying the ethical issues raised by these two populations. The ultimate goal is elaborating a structured set of key considerations and a map of ethical priorities that may inform the discussion regarding the use of AI in medical practice, particularly in ethical and regulatory debates on the use of AI in radiology.

Keywords AI Ethics · Medical Ethics · Medicine · Radiology · Mammography Screening · Breast Cancer Screening · AI and Medicine

1 Introduction

The use of AI in medicine is a multifaceted issue that has attracted growing attention from regulatory, ethical, political, and sociological perspectives [8, 10, 19, 30]. The number of applications relying on, or informed by, AI is already impressive and its expansion very likely. The form of AI that is increasingly impacting medical practice is machine-learning (ML) technology, particularly Deep-Learning (DL) applications.

The range of potential medical applications of such technologies is extensive. Examples include the automatic transcription of dictated medical advice, the generation of medical notes from patients' interviews and laboratory test results, support for decisions regarding health insurance coverage, assistance in interpreting medical images and other patient-derived data, analysis and interpretation of large research databases, and contribution to diagnostic and prognostic processes [10].

More specifically, AI applications in medicine include the selection of patients for supplemental cancer screening [31, 38], assistance in cancer diagnosis trough the interpretation of medical images [44], the use of Large Language Models (LLM) to automatically generate medical documentation [39], the identification and classification of orthopedic issues from plain radiographs [3, 32], and the prediction of the outcome of medical interventions, including cognitive behavioral therapy [25]. The impact of AI on medicine is reflected in the rapidly increasing number of relevant publications on the topic and the launch of specialized journals, such as the New England Medical Journal AI (https://ai.nejm.org/).

To maximize the positive impact of AI on medical practice, technological optimization must be accompanied by careful reflection on the ethical issues arising from its use. These challenges include issues related to equity, fairness, explainability, and generalizability of AI models, and more generally the implications of AI for personalized and

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precision medicine (e.g., assuring equal opportunities to get access to AI-based medical applications) [40].

Radiology emerges as a medical field particularly in need of further reflection about the ethical and legal implications of the use of AI, as confirmed by both institutional statements and population-based studies [11, 22, 26]. In fact, the analysis of the use of AI in radiology has identified many ethical issues in recent years, including privacy, bias, trust, transparency, and explainability [12, 13, 15, 23, 24, 28, 35], the risk of increasing healthcare inequity [2, 23, 24, 28, 29], responsibility and accountability [15, 35, 43], data security and ownership [1, 18, 43], among others. Importantly, analyses of stakeholders' opinions (e.g., radiologists and screening participants) have complemented and informed theoretical reflections [4–6, 9, 26, 27, 33, 36].

Against this background, the present paper aims at contributing to this ethical reflection through the identification of the ethical issues that are indicated by the attitudes of Swedish radiologists and screening participants toward the use of AI in mammography screening. Since AI catalyzes several interests, expectations, hypes, concerns, and worries by different stakeholders, its development and use are very challenging issues. For this reason, a balanced ethical analysis is very important, and it requires two fundamental conditions: a clear method for the identification of the issues that arise from AI, including their different kinds and specific impact; an empirically-informed approach, which consists in starting from actual opinions of relevant stakeholders to eventually elaborate an ethical reflection on their basis. In fact, if not informed by empirical data that reveal the state-of-the-art of medical practice, including the priorities and most urgent needs to address, ethical reflection risks to be detached from reality and eventually not effective (i.e., not really impacting ordinary practice).

In what follows, I first describe a method that has been recently introduced for the identification of the ethical issues emerging from AI; then, I summarize the results from two empirical studies on the opinions of radiologists and patients concerning the use of AI in radiology; finally, I identify the ethical issues emerging from these two groups through the application of the abovementioned method. While the elaboration of specific recommendations for solving the emerging issues lies beyond the scope of this paper, its final goal is providing a case study that may possibly contribute to further clarifying and mapping the priorities for future work in ethical reflection and regulation.

1.1 A method for the ethical analysis of AI

There is a wide variety of approaches to AI ethics, which covers very different topics [14, 16, 20, 37]. For instance, Dignum elaborated the ART framework, which is a principle-based approach that identifies the ethical issues arising from AI through the application of three principles: accountability, responsibility, and transparency [17]. Morley and co-authors identified three content-related kinds of ethical issues (i.e., epistemic, normative, and related to traceability) and six levels of abstraction those issues may arise at (i.e., individual, interpersonal, group, institutional, and societal or sectorial [34]). Ashok and co-authors proposed the distinction of four ontological frameworks, where ontology is conceived not in the philosophical sense of "nature of reality" but as "shared taxonomy of entities or concepts", consistent with the concept elaborated in information science. They identified the physical, the cognitive, the information, and the governance domains, which can help us to clarify emerging ethical issues and relevant concrete and effective strategies [7]. These are just selected illustrations of approaches and frameworks that have been proposed for facilitating the ethical reflection about AI. While a comprehensive analysis of these models lies beyond the scope of this paper, two criticisms that have been raised about them are relevant to the present analysis: the risk of principlism (i.e., to rely on taken-for-granted principles, and to eventually propose a model of ethical reflection similar to the traditional medical ethics) and the risk of limiting the analysis to a few issues of applied ethics (e.g., transparency, data ownership, accountability) [37].

To avoid these two risks, and taking brain-inspired or neuro-AI as a case study, a recent paper introduced a two-tier method conceived to be heuristic in nature (i.e., to provide a framework that in principle is applicable also to other forms of AI in order to identify the emerging ethical issues) [21]. This method relies on a preliminary distinction between fundamental/foundational and practical/applied ethical issues: it is necessary to justify moral choices with both relevant values and principles, and the clarification of key notions, including moral subject, moral reasoning, and moral action, analyzed with a focus on their implications for decision making. Accordingly, two main kinds of ethical issues emerge from AI: fundamental/foundational (i.e., concerning both the justification of AI and its impact on how we think about key moral notions) and practical/applied (i.e., concerning the impact and implications of AI on different sectors of our daily life). The first kind of issues involves theoretical analysis, while the second kind involves mainly applied analysis, that is, the use of ethical theory to identify and address the practical issues regarding the use of AI.

More specifically, Farisco and co-authors propose to classify the practical/applied issues that emerge from AI in relation to (at least) the following main levels [21]:

- *Operational*, related to how AI functions. For instance, because of limited training data, some AI applications

may process personal data in a biased way, and they may eventually provide unreliable information.
- *Instrumental*, related to how people make use of AI systems. For instance, people may use AI tools for complementing and/or facilitating their decision-making process, or alternatively they may completely delegate the decision to AI.
- *Relational*, related to how people perceive AI and to the resulting psychological and metaphysical human-AI relationship. For instance, especially, but not exclusively lay people may overrate the reliability of AI systems, and inappropriately trust their results.
- *Societal*, related to the social and economic costs and consequences of the development and use of AI. For instance, AI may challenge the present job system, making some professional figures redundant or raising the need for re-allocating some workers in other fields.

Also, Farisco and co-authors identify two main categories of fundamental/foundational ethical issues [21]:

- Those related to goals, which refer to questions like: What is the driver of AI? What do we want to achieve by it? For instance, AI may be inspired by the goal of making human job easier and more productive, or rather by the goal of making more money through the commercialization of AI tools.
- Those related to concepts, which include issues like implicit assumptions and biases about AI, and considerations about the historical, cultural, and societal contexts of AI. For instance, we may see AI only as a tool that complements human experience and competence, or rather as a reliable source of information that can replace human activity altogether.

I propose to use this two-tier method to identify the ethical issues arising from the answers of radiologists and screening participants, because I think that it is sufficiently flexible to avoid the two abovementioned criticisms: being tied to specific principles and covering only a limited number of applied issues that emerge from AI. The reason I chose these two specific studies is contingent: within the same research project, which examines the challenges on Swedish healthcare regulation posed by AI, the present analysis aims to complement the empirical data of these studies with ethical reflection. In addition, these two studies can serve as case-studies for a more general reflection about the impact of AI on medical practice.

1.2 Results from radiologists and screening participants

As mentioned above, for maximizing the effectiveness and impact of the ethical reflection on AI, and for avoiding an analysis informed by too abstract principles that are eventually disconnected from reality, it is imperative to start from the actual experience and opinions of involved stakeholders. Accordingly, I here summarize the results from two recently conducted studies, which involved readiologists and screening participants during a clinical trial on the use of AI in mammographic radiology (ScreenTrustCAD, NCT04778670) at Capio S: t Görans Hospital, Sweden, between 2021 and 2023 [41, 42].

The paper by Johansson and co-authors [41] is an exploration with professionals, including 7 semi-structured interviews, whose transcripts were analyzed using inductive thematic content analysis. Emerging results were grouped into three main categories: AI in society, AI and human interaction, and AI as a tool.

Table 1 reports the main responses from radiologists and screening participants about potential positive effects, uncertainties and ambivalences, and potential negative effects of using AI as a diagnostic tool in radiology. In addition to this, Table 1 reports also other ethically salient points emerging from the two studies. These data raises a number of ethical issues, as specified below.

1.3 Emerging ethical issues

Tables 2 and 3 summarize the results emerging from both radiologists' and screening participants' responses, analyzed through the application of the two-tier AI ethics method described above. In what follows, I report the emerging issues in the same order as introduced before: first practical/applied ethical issues, then fundamental/foundational ethical issues. I report the participants' responses, trying to remain neutral about the reliability and the generalizability of their perceptions. Both points would require further analyses, including a comparison with previous studies and reviews, like those mentioned in the introduction and in the discussion. Nevertheless, these declared perceptions are also relevant in themselves, because they are indicative of the attitudes of relevant stakeholders, which should inform an empirically-grounded ethical assessment of the use of AI in radiology.

1.4 Practical/applied ethical issues

As discussed above, the practical or applied ethical issues that emerge from AI can be classified into four analytical categories: operational, instrumental, relational, and

Table 1 Radiologists' and screening participants' opinions about potential positive, negative and uncertain effects of the use of AI in radiology

Shared view	AI may be an excellent complementary decision tool, but it cannot replace human professionals
Potential positive effects of AI according to	
Radiologists	AI may improve well-being (of both patients and professionals, e.g. through the creation of a more attractive workplace, the reduction of queues, the mitigation of the workload) AI may increase efficiency (e.g., through the facilitation of better diagnosis, the development of multifactorial risk models, the implementation of tailored approach) AI may reduce costs (e.g., through the reduction of the number of needed radiologists) AI fits well in work routine AI may gave the radiologists an added reason, a sense of security, to trust their own judgment
Screening participants	There are several potential ways in which AI may improve the screening process AI may also be used as an independent reader of the mammograms to reduce the workload for the breast radiologists and assisting the triage of patients in first-line care
Uncertainties/ambivalences on AI according to	
Radiologists	The effect that AI will have on the relationship between professionals and patients Whether to disclose or not disclose the use of AI: the risk of "overinforming" is contrasted by the need to be transparent The distribution of responsibility when AI is used as a form of support for decision-making Difficulty in interpreting/understanding AI results, which may be stressful or exciting
Screening participants	Limited understanding of the underlying mechanisms of AI Prevailing skepticism regarding the current capabilities of AI was evident among many participants Concerns about the long-term sustainability of AI effectiveness Uncertainty regarding AI diagnostic capacity, especially with certain more uncommon conditions Uncertainty regarding the specific areas in which AI demonstrates the highest performance
Potential negative effects of AI according to	
Radiologists	AI may generate a bigger sense of responsibility for possible errors AI may reduce the competence of radiologists AI may generate false-positive, with more work in the second review and possible disproportionate worries by patients and excessive costs
Screening participants	AI lacks the holistic perspective that humans have and qualities like intuition, empathy, and contextual understanding An excessive use of AI may hinder the development of certain skills of radiologists
Requests by screening participants	Thorough evaluation Transparency about the use of AI (This connects to the uncertainty by radiologists whether to disclose the use of AI) Involvement of radiologists in the assessment of AI (This connects to the willingness of radiologists to be involved) Effective communication regarding the role and limitations of AI Need to evaluate AI diagnostic performance relative to that of radiologists Necessity to control AI for preventing it from learning incorrect patterns
Salient points from screening participants	They preferred increased worry, due to being recalled more often, over missed cancer cases (This connects to the risk of generating false-positives and disproportionate worries by patients highlighted by radiologists) Less tolerance towards errors if generated by AI rather than by humans (This may be connected to the perceived increased sense of responsibility by radiologists when using AI) If AI generates an error, it would be the responsibility of humans, as AI is viewed as a tool that cannot be held accountable for decisions (This may be related to the concern regarding the distribution of responsibility expressed by radiologists) Willingness to share health information within the health care system setting
Salient point by radiologists	Willingness to be involved in the assessment/development of AI

Table 2 Practical/applied ethical issues arising from interviewed radiologists and screening participants

Operational	Instrumental	Relational	Societal
Limited understanding of how AI works	AI is complemental to humans	Humans cannot be replaced	AI may improve well-being (of both clinicians and patients)
Uncertainty regarding the specific areas in which AI excels	AI may increase efficiency of medical practice	AI may support medical staff self-trust	AI may reduce costs
	AI fits well in work routine	Uncertainty about the need for disclosing the use of AI (avoiding over-informing vs. need for transparency)	AI may reduce workload
	AI may generate disproportionate worries by patients and excessive costs	Uncertainty about distribution of responsibility when AI is used as decision support	AI may help in triaging patients in first-line care
	AI may cause the decline of learning skill development for the radiologist	Skepticism towards current capabilities of AI	Uncertainty about the impact of AI on the relationship between professionals and patients
		Uncertainty regarding AI diagnostic ability	Difficulty in interpreting/understanding AI may be stressful or exciting
		AI may raise a bigger sense of responsibility for possible mistakes	Concerns about the sustainability of AI's effectiveness in the long run
		AI lacks the holistic perspective that humans have (e.g., thinking about consequences, conducting investigative work, and demonstrating greater imagination), as well as qualities like intuition, empathy, and contextual understanding	AI may decrease the competence of radiologists
		Radiologists should be involved in the development of AI	
		Effective communication regarding the role and limitations of AI	
		The need to evaluate AI's cancer detection performance compared to radiologists and the overall integration process	
		The necessity of control and monitoring to prevent AI from learning incorrect behaviors, recognizing the constant evolution of AI	
		Less tolerance towards errors if made by AI than humans	
		If AI were to make a mistake, it would be the responsibility of humans, as AI is viewed as a tool	

societal. This categorization is intended primarily as a heuristic device to facilitate analysis, while in reality these categories are interrelated and may often overlap.

In the following, I assign the participants' perceptions to the category deemed most relevant, based on the following definitions. Operational issues arise from the functioning and technical characteristics of AI. Instrumental issues arise from how individuals employ AI systems. Relational issues arise from how individuals perceive AI and conceptualize their relationship with it. Finally, societal issues arise from the broader impact of AI on society.

At the operational level, results from the studies above highlight two main issues: a limited understanding of the underlying mechanisms of AI and uncertainty regarding the specific domains in which AI demonstrates the highest performance. These operational challenges may have ethical implications. For example, radiologists may reach incorrect conclusions if they rely on AI outputs without fully recognizing the limitation of the technology and its reliability. Moreover, insufficient understanding of the contexts where AI performs optimally may prevent radiologists from appropriately identifying specific applications for which AI may be an excellent support tool.

At the instrumental level, results from the studies above indicate different issues. Both radiologists and screening participants tended to view AI as complementary to human expertise rather than a replacement of human professionals. In this perspective, participants thought that AI may increase the efficiency of medical practice. For instance, AI may allow radiologists to reduce or avoid too repetitive (e.g., procedural) tasks and instead focus on more urgent clinical needs. Participants also reported that the fact that AI integrates well in routine workflow may facilitate the use of AI as a complement or integration to healthcare professionals. On a negative side, participants indicated that AI could generate disproportionate anxiety among patients and might

Table 3 Fundamental/foundational ethical issues arising from interviewed radiologists and screening participants

Goals	Concepts
Better healthcare provision, at different levels (e.g., financial, working condition, quality of diagnosis, better patients' management)	Transparency
Increase medical doctors' self-confidence	Understanding (difficult and stressful)
Involve professionals and patients in the assessment/development of AI	Uncertainty (e.g., where AI excels? what its impact on human professionals? should its use be disclosed? …)
Improve/streamline decision-making in healthcare	Human-technology relationship
	Clinicians-patients relationship
	Right to be informed (avoiding over-informing vs. preferring increased worry)
	Responsibility (distribution of): human vs. AI; AI may increase the human sense of responsibility; less tolerance towards errors made by AI
	Trust vs. skepticism
	Competence (increased or decreased?)
	Holistic perspective (e.g., thinking about consequences, conducting investigative work, and demonstrating greater imagination), as well as qualities like intuition, empathy, and contextual understanding and related human irreplaceability
	Supervision (need to evaluate AI's cancer detection performance compared to radiologists and the overall integration process)
	Control and monitoring to prevent AI from learning incorrect performance, recognizing the constant evolution of AI
	Privacy and confidentiality: the participants consistently expressed their willingness to share their health information within the health care system setting.

involve excessive costs associated with its operation. Additionally, disproportionate reliance on AI may also hinder the development of radiologists' diagnostic skills if certain tasks or competences are eventually delegated to automated systems.

The relational level is the domain where participants thought that the most ethical issues arise. Consistent with observation at the instrumental level, participants agreed that AI cannot replace human professionals and should instead function as a supportive tool, thereby reinforcing professional self-confidence among medical staff. This perception may derive from the recognition that AI lacks the holistic perspective that humans typically have, such as thinking about consequences, conducting investigative work, and demonstrating greater imagination. Similarly, participants perceived AI as lacking qualities like intuition, empathy, and contextual understanding. Participants also reported skepticism toward current capabilities of AI and uncertainty regarding the actual AI diagnostic accuracy. Furthermore, there is wide uncertainty about the necessity of disclosing the use of AI, reflecting a tension between the concern of over-informing patients and the need for transparency. The issue of responsibility also emerges as particularly controversial. Participants were uncertain regarding the distribution of responsibility when AI is used as decision–support system. Some respondents thought that AI may increase the sense of responsibility in professionals for potential errors, while others declare that they would personally have less tolerance for errors produced by AI than for those made by humans. Conversely, other participants thought that if AI were to cause an error, responsibility should remain with humans, since AI is eventually considered only as a tool. Participants also emphasized the importance of involving radiologists in the development of AI. In fact, there is a convergence between professionals and screening participants regarding the need to evaluate the AI performance in cancer detection relative to that of radiologists, as well as the need to carefully monitor the integration of AI into clinical practice in order to prevent AI from learning incorrect patterns, particularly given the evolving nature of AI. Finally, participants invoked a clear and effective communication regarding the role and limitations of AI in cancer diagnosis.

At the societal level, the following issues emerged. As noted in relation to the instrumental level, AI may contribute to improved well-being of both professionals and patients. For instance, it may reduce clinical workload and assist in triaging patients in the first-line care. Moreover, AI may contribute to reduce costs potentially improving the overall quality of healthcare and facilitating the access to care. Nevertheless, participants also reported uncertainty regarding the impact of AI on the relationship between professionals and patients, as well as concerns about the long-term sustainability of AI effectiveness. Finally, professionals reported that the difficulty in interpreting and understanding AI, already outlined at the operational level, may be stressful or exciting, and AI might reduce the competence of radiologists with a negative impact on their professional relationship with patients.

1.5 Fundamental/foundational ethical issues

With regard to goals, participants converged in considering the improvement of healthcare provision as a primary goal of the adoption of AI in radiology. Such improvement may occur at different levels, including financial efficacy, working condition, diagnostic quality, and better patients´ management. Additional goals of the use of AI in radiology identified by participants are enhancing physicians' self-confidence, promoting the involvement of both professionals and patients in the assessment and development of AI, and improving or streamlining decision-making processes in healthcare.

With regard to concepts, participants tended to assess the impact of the diagnostic use of AI in relation to the following fundamental ethically salient concepts: transparency, understanding, uncertainty, the human-technology relationship, the clinician-patient relationship, the right to be informed, responsibility, trust and skepticism toward AI systems, professional competence, holistic perspective, humanness, human irreplaceability, supervision, control and monitoring of AI, privacy and confidentiality.

2 Discussion

As outlined above, the analytical framework that I used in this paper to identify and classify the ethical issues arising from Swedish radiologists' and screening participants' attitudes toward the use of AI in mammography screening is based on a two-tier model of ethical reflection. This model aims to distinguish between fundamental/foundational ethical issues and applied/practical ethical issues. Although this is only one possible methodological approach among many alternatives, I think that this two-tier model is very useful because it focuses not on content-specific concerns or particular normative principles in the first place, but rather on the underlying types of ethical issues that may emerge from the implementation of AI. For this reason, this approach may help avoid or at least mitigate two criticisms frequently raised in the AI ethics literature: excessive reliance on principlism and too much emphasis on narrowly defined applied ethical issues.

Overall, the findings from the two Swedish studies considered in this paper are consistent with those from other similar studies, particularly with regard to the generally positive attitude toward the use of AI combined with the awareness of its limitation, the potential risks and ethical issues arising from it. Confirmed points include the tendency to trust AI, especially when medical professionals are involved in its development [26, 27]; the perception of AI as a tool intended to complement rather than replace human professionals [36]; the potential benefit associated with reducing the time radiologists spend interpreting medical images [33].

The present paper complements the two studies empirical with an ethical analysis that they do not include. The added value of the specific ethical analysis elaborated in this paper is contributing to better identify the value of the studies' findings, their potential contribution to the discussion about the medical use of AI, and their societal relevance. The application of the two-tier ethical model to the results of the two studies reveals that also the identified ethical issues are broadly consistent with relevant scientific literature, policy, and regulation. Although the identification of specific strategies for addressing these issues is beyond the scope of this paper, it is noteworthy that most of them revolve around the need of "keeping humans in control" (i.e., maintaining central human involvement in AI-supported medical practice). Among the practical/applied ethical issues, this necessity is reflected at different levels. At the operational level, it is evident in concerns about the limited understanding of how AI functions, as expressed also in [12, 15]. At the instrumental level, it manifests in the opinion that AI should complement human expertise, with its major potential benefit being the enhancement of the efficiency of medical practice, as expressed also by [23]. At the relational level, it is reflected by the widely reported opinion that human professional cannot be replaced (see also [22]). Finally, at the societal level, it is associated with the expectation that AI may ultimately improve the well-being of both clinicians and patients, a view shared also by [36]. In other words, the background framework of the ethical assessment indicated by the results of the two studies can be characterized as fundamentally anthropocentric, a view widely shared in the literature [17]. This characteristic is clearly reflected in two central fundamental/foundational ethical issues. First, AI is perceived as lacking the holistic perspective that human practitioners have – namely, their capacity to really understand the case in question, identifying contextual causes, anticipating potential consequences of taken actions, and combining technical, quantitative information with human qualities like intuition and empathy. Second, the development and use of AI are widely regarded as requiring continuous oversight by radiologists and other medical professionals. Despite some uncertainties regarding the allocation of responsibility, the prevailing view is that accountability for possible errors ultimately remains with humans, since AI is eventually only an instrument in their hands.

The necessity of "keeping humans in control" does not offer a specific solution to emerging ethical challenges. Rather, it functions as a basic strategy or conceptual framework for identifying and addressing such challenges. For example, screening participants expressed a prevailing

skepticism regarding the current capabilities of AI, which may contribute to forms of algorithmic aversion. This skepticism also appears to stem from the "black-box" nature of AI systems, a recurrent concern in the ethical reflection about AI: since we eventually do not understand the underlying mechanisms of these systems, and particularly the reasons and modalities through which they operate, we often remain reluctant to trust them. The participants in both studies confirmed this tendency, ultimately emphasizing the necessity of maintaining an anthropocentric system architecture in which humans retain control.

A similar tendency emerged with regard to the distribution of responsibility, another central issue in AI ethics. The prevailing opinion is that responsibility and accountability ultimately remain with human actors, including developers and medical professionals, since AI functions as a tool employed in their decision-making processes. Although this position may appear intuitive, it contrasts with perspectives advanced by some scholars who conceptualize AI systems as agents or evaluators, thereby attributing to them a degree of responsibility and accountability. The "pragmatic" stance expressed by the participants considered here may therefore provide useful insights for informing the theoretical and ethical debate about the nature of AI systems, in particular the possibility of attributing them characteristics typically associated with human agents, like responsibility.

2.1 Limitations

Different limitations affect this paper. First, as already mentioned above, I used an analytical framework —a two-tier model distinguishing between fundamental/foundational and applied/practical ethical issues— that is only one of several possible approaches to ethical analysis. I choose this model for its conceptual clarity and its capacity to avoid an overreliance on principlism, but its use inevitably shapes the interpretation of the empirical data.

Second, this analysis is based on findings from two Swedish studies, which limits its geographical and cultural scope. Therefore, the generalizability of the findings beyond the Swedish context should be approached with caution.

Third, previously published studies are the primary empirical basis of this paper, which therefore depends on the methodological choices, sampling strategies, and potential biases (e.g., sample size, participant selection, or data collection methods) of those original studies.

Fourth, as mentioned above, the paper provides an ethical interpretation of the findings but it does not aim to propose concrete policy recommendations or implementation strategies for addressing the identified ethical issues. As a result, the discussion remains at a conceptual level, with limited immediate practical applicability.

Fifth, the ethical analysis is primarily qualitative and interpretive in nature. This introduces a degree of subjectivity in the identification and classification of ethical issues.

Finally, the paper focuses only on the perspective of radiologists and screening participants, while it does not include other relevant stakeholders (e.g., AI developers, hospital administrators, or policymakers).

Despite these limitations, the study provides a structured ethical interpretation of existing empirical findings and contributes to the broader discussion on the integration of AI in medical practice.

3 Conclusion

The application of the two-tier ethical method described above resulted in the identification of some practical/applied and fundamental/foundational ethical issues. Overall, both radiologists and screening participants largely agree that AI is a potential useful tool, but they do not perceive it as capable of replacing human professionals. Participants report a number of potential positive effects associated with the integration of AI into radiology.

In addition to these potential benefits, participants report also several potential negative effects. Among these, uncertainty emerges as a particularly salient theme. Respondents declare to be uncertain regarding different aspects, including how AI functions, the extent to which it can actually improve medical diagnostics, its consequences for doctor-patient relationship, and its impact on the attribution of responsibility in clinical practice.

Both the perceived negative and positive effects of AI in medical contexts, as well as the uncertainty surrounding its use, deserve specific consideration within ethical and regulatory debates. Such analysis is necessary to eventually maximize the positive impact of AI on healthcare, which both radiologists and screening participants indicate as the final objective of diagnostic AI applications. Finally, the fundamental ethical concepts highlighted above (e.g., transparency, understanding, uncertainty, and human irreplaceability) and the emerging need of "keeping humans in control" may provide useful points of reference for ongoing ethical and regulatory reflection on the use of AI in radiology and in medicine more broadly.

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Declarations

Conflict of interest The authors declare no competing interests.

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