**Artificial Intelligence in Healthcare: Unveiling Ethical Challenges Through Meta-Synthesis of Evidence**

**Abstract**

BACKGROUND: With the rapid advancement of artificial intelligence (AI) technologies in healthcare systems, alongside its numerous benefits, various ethical concerns have emerged regarding its application in different areas. This study aimed to identify the ethical challenges associated with the implementation of AI in healthcare.

MATERIALS AND METHODS: This research employed a qualitative meta-synthesis method using a thematic analysis approach. In accordance with the PRISMA guidelines, qualitative and review studies published between 2010 and 2025 that addressed ethical issues related to AI applications in healthcare were analyzed. The quality of the included studies was assessed using the CASP checklist, and the confidence in the findings was evaluated based on the GRADE-CERQual approach.

RESULTS: Out of 38 selected studies, 7 main themes and 33 subthemes were identified. The key challenges included violations of privacy and data security, limited transparency and explain ability, algorithmic bias, undermining the autonomy of patients and healthcare professionals, interference with professional responsibilities, reduced quality of clinical judgment, and regulatory and legal gaps. Furthermore, the commercial use of health data and the absence of integrated ethical frameworks have exacerbated concerns related to justice, public trust, and human-centered care.

CONCLUSION: The findings of this study indicate that the ethical and evidence-based integration of AI into healthcare requires the development of transparent regulatory frameworks, the enhancement of ethical digital literacy within the medical profession, and the formulation of comprehensive policies to protect patient rights and promote health equity. These results can serve as a strategic foundation for decision-making by policymakers, technology developers, and clinical professionals.

**Keywords: Artificial Intelligence, Ethical Challenges, Healthcare, Meta-synthesis, Medical Ethics**

**Introduction**

Artificial Intelligence (AI) has created numerous opportunities in education and research across various disciplines, particularly in the field of medicine (1–4). However, in recent years, the rapid advancements in AI technologies have given rise to growing concerns, drawing significant attention to the ethical dimensions and associated challenges of its application (5). Among these concerns are ethical dilemmas, potential infringements of intellectual property rights, lack of transparency in content generation processes, legal ambiguities, and the increasing difficulty in distinguishing AI-generated content from that produced by humans (6,7). Furthermore, an overreliance on AI in healthcare settings poses a serious threat to the development and retention of professional competencies among healthcare providers. If AI-based tools are predominantly used as substitutes for clinical decision-making, there is a risk that medical professionals may gradually lose critical skills, and increasing dependence on technology could undermine clinical judgment and reduce autonomy in medical practice (8,9). These adverse consequences not only affect the quality of care but also influence public and professional perceptions of AI in medicine (10).

Despite the vast opportunities that Artificial Intelligence (AI) offers for transforming educational processes, research activities, and clinical services within the healthcare sector, insufficient attention to the ethical challenges and potential consequences of its implementation may lead to serious—and in some cases, irreversible—risks for medical care systems. Neglecting these dimensions can not only undermine public trust in intelligent technologies but also disrupt fundamental principles of medical ethics, violate patient rights, and exacerbate inequalities in healthcare access and delivery. Given these concerns, the identification, analysis, and categorization of ethical challenges arising from AI integration in health systems is an urgent necessity for responsible policymaking and the sustainable development of AI within health-oriented frameworks. In response to this pressing need, the present study adopts a meta-synthesis approach to systematically and critically integrate findings from existing qualitative and review-based literature in this domain. The primary objective is to develop a comprehensive, nuanced, and multidimensional understanding of the key ethical challenges and implications associated with AI in healthcare. This synthesized perspective is intended to inform the development of ethically grounded strategies, strengthen theoretical foundations, and enhance evidence-based decision-making in this critically important field.

**Materials and Methods**

We conducted a thematic synthesis of qualitative and review studies in accordance with the PRISMA guidelines. We included qualitative and review studies that focused on the ethical challenges associated with the application of artificial intelligence in healthcare. Study appraisal involved the use of a validated quality assessment tool (11). Thematic synthesis techniques (12) were employed for analysis and synthesis, and the GRADE-CERQual approach (13) was applied to assess the confidence in the review findings.

*Criteria for inclusion*

This review included peer-reviewed qualitative studies and systematic published between 2010 and 2025 that focused on ethical challenges related to AI in healthcare and were available in English. Studies were excluded if they lacked ethical focus, were non-empirical (e.g., editorials, commentaries), not peer-reviewed, unavailable in full text, or addressed AI ethics outside healthcare contexts.

*Search strategy*

A comprehensive search strategy was developed to identify relevant studies across major academic databases, including PubMed, Scopus, Web of Science, and Embase. The search combined controlled vocabulary terms and free-text keywords related to artificial intelligence, ethics, and healthcare. Specifically, the following search terms were used: ("artificial intelligence" OR "machine learning" OR "deep learning" OR "AI") AND ("ethics" OR "ethical issues" OR "ethical challenges" OR "ethical considerations" OR "bioethics") AND ("healthcare" OR "health care" OR "medicine" OR "clinical practice" OR "medical ethics") AND ("qualitative study" OR "qualitative research" OR "systematic review" OR "narrative review" OR "thematic synthesis").

*Study selection*

All retrieved records were organized using Microsoft Excel, where duplicates were eliminated, and titles were initially screened to remove clearly irrelevant entries. The remaining articles underwent abstract screening. To ensure consistency in the selection process, two reviewers (KF, NC) independently reviewed a subset of abstracts based on the predetermined inclusion and exclusion criteria. Subsequently, the remaining abstracts were divided between them for individual screening, and non-relevant studies were excluded. Full-text assessments were conducted by the same two reviewers, with additional input and consensus from a third or fourth reviewer (SD or MB) when necessary. Articles not published in English were translated into English using free online translation tools, such as Google Translate.



Figure 1: The process of screening articles based on the PRISMA

*Quality assessment*

To assess the methodological rigor of the included studies, we utilized the Critical Appraisal Skills Programme (CASP) qualitative checklist (14) a widely accepted tool frequently applied in qualitative evidence syntheses (15). Two reviewers (AA, AH) independently appraised each study, and any discrepancies in their assessments were resolved through discussion or, when necessary, consultation with a third reviewer (GJ).

Table 1: Quality assessment of selected articles based on the CASP

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| References | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Total |
| 16 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 17 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 18 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 19 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 100 |
| 20 | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | 90 |
| 21 | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | 90 |
| 22 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 80 |
| 23 | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | 90 |
| 24 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 25 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 26 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 27 | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | 90 |
| 28 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 29 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 30 | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 60 |
| 31 | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | 90 |
| 32 | No | Yes | No | No | Yes | No | Yes | Yes | No | Yes | 50 |
| 33 | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 100 |
| 34 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 35 | Yes | Yes | Yes | Yes | Yes | No | Yes | No | Yes | Yes | 80 |
| 36 | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | 50 |
| 37 | Yes | Yes | No | No | No | No | Yes | No | No | No | 30 |
| 38 | Yes | Yes | No | No | No | No | Yes | No | Yes | Yes | 50 |
| 39 | Yes | Yes | Yes | No | No | No | Yes | No | Yes | Yes | 60 |
| 40 | Yes | Yes | No | No | No | No | Yes | No | Yes | Yes | 50 |
| 41 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 42 | Yes | Yes | No | No | No | No | Yes | No | Yes | Yes | 50 |
| 43 | Yes | Yes | Yes | No | Yes | No | Yes | No | Yes | Yes | 70 |
| 44 | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | 60 |
| 45 | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | 60 |
| 46 | Yes | Yes | No | No | No | No | Yes | No | Yes | Yes | 50 |
| 47 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 48 | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | 60 |
| 49 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 50 | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | 70 |
| 51 | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | 60 |
| 52 | Yes | Yes | Yes | No | Yes | No | Yes | Yes | Yes | Yes | 80 |
| 53 | Yes | Yes | No | No | No | No | Yes | No | Yes | Yes | 50 |

*Data extraction and analysis*

The analysis was guided by the core principles of thematic synthesis (12). We began by conducting an in-depth reading of all included studies and selected an index study that closely aligned with the review’s focus. The key findings and themes reported in this index paper were systematically coded and organized within a spreadsheet, forming the basis of an initial thematic framework. As subsequent studies were reviewed, their findings were coded and integrated into this evolving framework, which was refined iteratively as new data were incorporated. The analysis involved identifying patterns across studies, while also actively seeking out contradictory or disconfirming data—evidence that challenged either the emerging themes or the reviewers’ prior assumptions. This step was essential in ensuring the robustness of the synthesis. Data extraction and thematic development occurred in parallel. Descriptive themes were constructed from both participant quotations and the authors’ interpretations in the original studies. Once all authors reached agreement on the descriptive thematic framework, we evaluated the confidence in each review finding using the GRADE-CERQual approach (13). This tool considers several dimensions: methodological rigor and relevance of contributing studies, the coherence of the synthesized finding, and the richness and quantity of supporting data. Based on these criteria, each finding was assigned a confidence rating of high, moderate, low, or very low. The processes of data extraction, synthesis, and CERQual assessment were conducted concurrently. Following this assessment, the descriptive findings were grouped into broader, interpretive themes, and the final thematic framework was established through author consensus.

*Data validation*

To ensure the reliability of the extracted concepts, the primary researcher compared their interpretations with those of an expert in the field. Inter-rater agreement was then assessed using Cohen’s Kappa coefficient, yielding a value of k = 0.664, with a significance level of p = 0.001. According to the interpretation guidelines provided by Jensen (54), this level of agreement is considered acceptable, indicating substantial consistency between raters.

**Results**

Table 2 presents the results of the content analysis of the reviewed articles. The process involved initially extracting key codes or concepts. These codes were then categorized into sub-themes based on their similarities and differences. Subsequently, the sub-themes were grouped into main themes through a similar comparative analysis.

Table 2: Results of the Content Analysis of the Articles

|  |  |  |
| --- | --- | --- |
| Main theme | Sub-themes | **Key concepts (codes)** |
| Challenges related to data privacy and security | Violation of privacy and individual control over data | The risk of violating patient privacy and the unintended disclosure of personal information (18, 22, 30, 31, 37, 44, 48, 51, 47, 49, 43, 40, 41, 46); the loss of patient control over their health data, transforming them from "data owners" to "data subjects" (16, 21, 25, 26, 32); the sharing of data with third parties without sufficient consent or transparency (40, 41, 43); the lack of effective technical and organizational measures to safeguard data (40, 48); and the vulnerability of AI-based systems to cyberattacks and cloud security threats (43, 46). |
| Ambiguity in data ownership and rights | The indeterminacy of the boundaries of personal data ownership and the manner in which secondary use of such data is conducted (25, 27, 30, 31, 33); the lack of transparency concerning the role of major technology companies and the potential commercial exploitation of publicly financed data (26, 33); the neglect of data owners' rights, especially in low-income countries facing "data poverty" (31); and concerns regarding the insufficient evaluation of the quality of synthetic data produced by AI (35). |
| Deficiencies in transparency, informed consent, and data governance in AI-based platforms | The use of health data without patients’ informed consent or clear communication regarding its intended use (23, 24, 39, 40); the tension between the free flow of data and the need to protect patient privacy (27); and the weakness of enforcement mechanisms alongside an imbalance between process transparency and data protection (25, 38). |
| Unethical and biased use of data | The large-scale collection and storage of personal data for algorithm training without a clear focus on serving the public interest (16, 24); the potential manipulation of data and development of algorithms with biases or unethical objectives (24, 46); limitations in effectively anonymizing data in personalized training contexts (45); and the violation of individuals’ rights to control their information as profit-driven motives increasingly influence data usage practices (45, 46, 49). |
| Challenges related to transparency and explainability | Lack of transparency in the functioning and structure of artificial intelligence models | The "black box" problem in algorithms and the lack of transparency in their decision-making processes (21, 26, 28, 29, 32, 33, 34, 38, 41, 43, 44, 49, 50, 51); the inability of end-users, including physicians and patients, to interpret AI performance (26, 31, 34); ambiguity in the training and learning processes of models (26) and insufficient information for assessing their quality (16, 26); and the risk of interpretability being used as a façade to obscure underlying technical shortcomings (25). |
| Weakness in validation and standardized reporting | The absence of precise criteria for validating AI-generated responses and the lack of standardized frameworks for reporting the development and evaluation of medical algorithms (26, 30); coupled with the difficulty of verifying the accuracy and reliability of AI outputs, particularly in domains involving sensitive information (30, 37). |
| AI hallucination and misinformation | The generation of incorrect yet seemingly convincing responses (hallucinations), which may mislead users (16, 26, 43, 44); the presentation of outdated or historically based information that may no longer be valid (16); the lack of mechanisms for informed evaluation of the accuracy of AI-generated texts (30); and the unreliability of citations produced by AI systems (30). |
| Legal challenges in explainability | The violation of intellectual property rights in AI-generated content and the redistribution of such material without proper attribution (43); alongside concerns about the influence of algorithmic biases on medical decision-making, particularly when used by non-expert users (34). |
| Challenges related to fairness and algorithmic discrimination | Inherent biases in training data and model design | The use of incomplete, noisy, biased, or improperly labeled data for training models (16, 23, 26, 30, 31, 34, 38, 42, 49, 50); the reproduction of historical, social, cultural, and racial inequalities embedded in training datasets (18, 28, 30, 33, 34, 42, 43, 44, 45); the systematic or unintentional exclusion of marginalized groups from data or analyses (18, 34, 50); the neglect of linguistic, cultural, and geographical diversity in model design and training (22, 38); and the failure to account for contextual differences between the characteristics of data and the environments in which algorithms are applied (38). |
| Algorithmic discrimination in performance and outcomes | The generation of discriminatory responses or recommendations, particularly based on race, language, or gender (16, 22, 24); the risk of stigmatization or the production of unfair outcomes for specific groups (49, 50, 52); conflicts of interest, value-laden judgments, and designer biases influencing algorithmic development (16, 33, 52); the reinforcement of harmful stereotypes and groupthink (16, 33); and inconsistent algorithmic performance across different medical domains without clear justification (23). |
| Lack of clear standards for evaluating fairness and mitigating bias | The lack of regular assessments of algorithmic impacts on different population groups (23, 38); the absence of consensus on how to achieve algorithmic transparency (51) and the lack of established standards for accuracy and fairness (46); and the trade-off of fairness in favor of improving algorithmic accuracy or performance (38, 45). |
| Consequences of unequal access to and utilization of health AI | The exacerbation of digital inequality and the reduction of inclusivity in low-income countries (18, 20, 21, 31, 49, 50, 51); the lack of patient-centeredness in system design, resulting in tools that fail to meet real-world needs (21); the neglect of concerns and specific needs of vulnerable groups such as women, the elderly, rural populations, and ethnic minorities (18, 38); and the infrastructural gap between high-income and low-income countries in access to health AI technologies (21, 31, 50, 51). |
| Challenges related to autonomy and informed consent | Limitations in achieving genuine informed consent | The difficulty patients face in understanding AI systems due to their technical complexity, black-box nature, or lack of operational transparency (25, 38, 47); the absence of a clear and comprehensible process for obtaining informed consent from patients (22, 25, 47, 50); the risk of uninformed or incorrect decision-making resulting from hidden algorithmic biases (24, 47); and the use of personal data for model training without informed consent (24, 50). |
| Undermining the autonomy of patients and physicians | The reduction of patients’ autonomy in decision-making when confronted with AI-based decision-support systems (18, 21, 22, 32, 47, 52); the threat to physicians’ professional independence resulting from overreliance on AI outputs (25, 52); conflicts between human judgment and algorithmic recommendations, particularly in complex clinical situations (22, 33); and the use of AI as a tool for coercion or treatment imposition rather than aligning with patient preferences (19, 20, 23, 32). |
| The commercialization of health and the harm to decision-making autonomy | The negative impact of embedding advertisements or commercial interests in recommender systems on patient decision-making autonomy (16, 20); the imposition of behavioral theories (such as prospect theory) to influence health behaviors in ways that may be unjust (19); and the shifting of health responsibility from the system to the individual without providing adequate structural support (18). |
| Neglect of the patient’s individual role and intrinsic value | The objectification, mechanization, and disempowerment of patients within the treatment process (22, 32); the neglect of patient preferences, cultural values, and social circumstances in algorithm design (34, 47); the diminished effectiveness of personalized medicine due to poor generalizability and systematic data biases (23, 47); and the reduction of the patient from an active participant to a passive algorithmic consumer (16, 22). |
| Challenges within professional practice and the obligations of ethical responsibility | Ambiguity in moral responsibility | Ambiguity in determining accountability in cases of algorithmic error or adverse treatment outcomes (19, 23, 24, 26, 30, 39, 47); the lack of responsibility assumed by developers for the results and performance of AI systems (22, 30); the inability to clearly allocate shared responsibility among stakeholders (22); and the risk of automating decisions without human oversight, thereby weakening ethical supervision (22, 39). |
| Erosion of bioethical principles and the decline of ethical engagement | The erosion of healthcare professionals’ moral agency and the reduction of ethical decision-making to technical calculation (18, 20, 23); the risk of succumbing to technological determinism and the uncritical assumption of the inherent “rightness” of technology (18, 20, 25); the reduction of ethical principles to rhetorical symbols or decorative standards without enforceable mechanisms (22, 25); the prevalence of superficial and uncritical ethics that overlook cultural and clinical contexts (18, 24); and the inadequacy of principle-based frameworks in addressing complex moral situations (19, 35). |
| The conflict between technology and human values in decision-making | The dominance of AI models in clinical decision-making and the corresponding devaluation of human judgment in treatment (20, 22, 23, 48); the threat to core bioethical principles posed by the uncritical acceptance of AI technologies (48); the reduction of human life to statistical data with insufficient regard for individual dignity (17, 24); and the overreliance on the numerical precision of models without adequate consideration of clinical context (23). |
| The inadequacy of professional ethics education in the technological era | The lack of adequate training for physicians in addressing the ethical challenges posed by AI (22, 48); the weakening of moral decision-making skills due to the dominance of technical models (48); and the absence of professional education aimed at understanding and evaluating ethically charged technological decisions (48). |
| The commercialization of technology and the threat to professional trust | The commercial orientation of AI development goals and their conflict with the humanistic and ethical duties of the healthcare system (16, 17, 20); the erosion of patient trust in physicians due to the prominent role of algorithms in treatment (16); and the misalignment between the profit-driven objectives of technology companies and the core values of healthcare (17, 22). |
| Challenges related to treatment and clinical reliability | Diminished quality of clinical decision-making and the weakening of human judgment | The rise of false confidence among physicians due to reliance on AI, which may undermine clinical judgment—particularly among less experienced doctors (16, 22); the erosion of tacit knowledge and clinical expertise as a result of exclusive dependence on data and algorithms (22, 23, 33); and the reduction of the physician’s role to merely validating AI outputs, thereby diminishing professional autonomy in treatment (23, 32). |
| Lack of contextual awareness and human understanding in AI systems | The inability of AI systems to comprehend the subjective, cultural, social, and value-laden experiences of patients (22, 32, 34, 43, 47, 50); their incapacity to process qualitative and meaningful human data, and the absence of mechanisms for integrating lived human experience (22, 34); and the erosion of human-centered care due to the quantitatively driven nature of AI models (23, 30, 52). |
| Risks associated with errors, biases, and incomplete data in treatment | Errors in medical records or inaccurate predictions resulting from low-quality data (16, 47); the use of non-representative or poorly matched data for the target population (44, 50); the emergence of large-scale collective errors due to algorithmic faults (32); and uninformed decision-making lacking valid clinical context (16, 17, 45). |
| Ambiguity in accountability and quality control of treatment | The unclear ethical and professional boundaries of AI’s role in clinical decision-making (19, 30, 40); the absence of mechanisms for resolving conflicts between AI recommendations and human judgment (38); and the complexity of ensuring quality of care when human involvement is reduced (52). |
| The gap between technological development and successful clinical implementation | Insufficient validation and poor generalizability of models to diverse populations (17, 44); the gap between medical evidence and actual patient behaviors in real-world applications (32, 36); and AI's inability to provide up-to-date and reliable insights based on the latest medical research (30). |
| Erosion of the human relationship and therapeutic trust | The weakening of the physician–patient relationship and the erosion of mutual trust due to intensive technological intervention (16, 48, 52); and the threat of eliminating the human element from healthcare, leading to a decline in the quality of therapeutic communication (32, 52). |
| Legal, policy, and regulatory challenges | Lack of binding and harmonized laws and frameworks | The absence of dedicated regulations for autonomous intelligent technologies and automated algorithms (16, 27, 29, 30, 50); the lag in regulatory development compared to the rapid pace of AI advancements (27, 38); the lack of a global, harmonized, and binding framework for ethics and law in health-related AI (21, 27, 42, 43, 47, 50, 51); and the incompatibility of existing legal frameworks with the challenges posed by emerging technologies (29, 35, 43, 45). |
| Ambiguity in legal and professional accountability | The difficulty in assigning blame for AI-related errors (27, 28, 30, 38, 41, 43); the ambiguity of responsibility among developers, physicians, institutions, and technology companies (26, 32, 38, 41, 47); the absence of transparent bodies for licensing, oversight, or accountability in response to algorithmic mistakes (30, 41, 42); and the lack of corporate accountability for patient harm caused by AI systems (39). |
| Policy gaps and weak regulatory oversight | The absence of standardized approaches for the ethical and scientific evaluation of models (21, 25, 35, 50); the lack of clear criteria for assessing the real-world clinical utility of algorithms (25); the difficulty in evaluating the trustworthiness of complex and multifaceted models (35, 50); and the lack of dynamic and human-centered ethical oversight mechanisms (41, 49). |
| Commercialization, hidden interests, and structural pressure | The infiltration of tech industry discourse into health policy-making, leading to unethical standardization practices (25, 32, 39); the instrumental use of biometric data by insurance companies to deny services to high-risk individuals (38, 41); the strategic use of technical expertise by technology firms to exert undue influence on policymaking (25); and the elitist framing of health technology due to the concentration of its benefits among specific, privileged groups (47). |
| Weak infrastructure and inequality in access and benefit | The lack of infrastructure in under-resourced countries or regions to ensure equitable access to AI technologies (26, 44); the digital literacy gap and patients' inability to manage their data or engage effectively (21); and the significant financial burden that the implementation of AI technologies places on healthcare organizations (20, 23). |
| Lack of stakeholder participation and inclusive governance | The lack of genuine involvement of patients, health information managers, and ethics professionals in the design and oversight of AI systems (21, 22, 36, 39); insufficient collaboration among designers, clinicians, and policymakers (22); and the absence of a shared ethical authority to guide high-level decision-making (35). |

The content analysis reveals that the most frequently addressed theme, cited in over 35 studies, concerns challenges related to data privacy and security, underscoring a widespread concern regarding the control, ownership, and protection of health data in AI-based platforms. Closely following this are transparency and explainability challenges, highlighted in over 32 studies, particularly focusing on the "black box" nature of algorithms and the lack of standardized validation protocols. Issues of fairness and algorithmic discrimination appear in approximately 28 studies, with emphasis on biased datasets and the exclusion of marginalized populations. Autonomy and informed consent challenges were identified in 25 studies, raising alarms about the diminishing decision-making power of patients and physicians. Ethical concerns tied to professional responsibility emerged in 22 studies, while legal and regulatory gaps and clinical reliability issues were addressed in around 20 and 18 studies, respectively. These frequencies reflect the multidimensional ethical and practical implications that must be addressed to ensure trustworthy, equitable, and human-centered AI integration in healthcare.

**Discussion**

The aim of this study is to identify the ethical challenges of artificial intelligence in healthcare. To achieve this objective, a content analysis was conducted on selected qualitative and review studies. In total, seven main themes and thirty-three sub-themes were identified. The following sections provide a detailed explanation of each main theme.

*Challenges related to data privacy and security*

Given the extensive data requirements associated with the application of artificial intelligence technologies in the healthcare sector, the preservation of patient privacy has emerged as one of the fundamental challenges in this domain. Although data encryption has been proposed as a means to mitigate security risks, the complexity of such methods may reduce the transparency of algorithmic operations, thereby potentially undermining patient trust in the healthcare system. Safeguarding patient information presents a major concern in the application of AI technologies within medical settings. The necessity of utilizing extensive datasets to train these systems raises the risk of compromising individuals’ private health records. While strategies such as data encryption have been introduced to mitigate these risks, they often reduce the system’s interpretability, as complex security protocols can obscure algorithmic processes. This lack of clarity in data handling may erode trust between patients and healthcare providers, potentially discouraging open communication due to fears over confidentiality breaches (55). Pervasive monitoring technologies in users’ personal environments result in significant privacy intrusions and turn the home into a medicalized space, which may cause psychological distress. At the same time, data-driven systems require vast amounts of information, often collected without clear user awareness or control. Users may struggle to understand who accesses their data and for what purpose, especially given the potential for indefinite storage. Compared to traditional in-person care, the risk of data leakage or loss is substantially higher (56). The findings of this section are consistent with those reported in case studies (16, 18, 21, 22, 23, 24, 25, 26, 27, 30, 31, 32, 33, 35, 37, 38, 39, 40, 41, 43, 44, 45, 46, 47, 48, 49, 51).

*Challenges related to transparency and explainability*

The lack of transparency in artificial intelligence systems represents not merely a technical shortcoming, but also an epistemic and ethical crisis within modern medicine. This is due to the delegation of decision-making processes to mechanisms that lie beyond human comprehension, thereby rendering accountability ambiguous. The inability to fully understand or interpret the outcomes generated by such systems poses significant challenges to defining and scaling professional ethical standards. This opacity is manifested in three semantic dimensions: lack of disclosure (where individuals are unaware that automated decisions are being made about them), epistemic opacity (when there is no access to or understanding of how decisions are made), and explanatory opacity (the inability to explain why a specific output is generated). Such opacity can hinder individuals from exercising data-related rights and weaken the trust between patients and physicians. Moreover, AI systems may rely on features that are unfamiliar or irrelevant to clinicians, with no clear scientific explanation for their association with clinical outcomes (57). AI models, particularly deep learning systems, are often described as “black boxes” and epistemically opaque, meaning their internal decision-making processes are not transparent—even to experts. This poses a serious ethical challenge; as critical medical decisions are being made by systems whose reasoning cannot be fully understood or explained. Such opacity directly conflicts with core principles of medical ethics, especially the patient’s right to informed consent, which requires clear information about the logic, significance, and potential consequences of diagnostic or therapeutic interventions (58). The findings of this section align with those reported in study (16, 21, 25, 26, 28, 29, 30, 31, 32, 33, 34, 37, 38, 41, 43, 44, 49, 50, 51).

*Challenges related to fairness and algorithmic discrimination*

The issue of fairness in artificial intelligence is not merely a technical flaw, but rather a reflection of unjust human structures that are reproduced—and even amplified—through algorithmic systems. Despite their seemingly neutral design, medical algorithms are often built upon datasets that may be rooted in historical, social, and racial biases. Consequently, the emergence of injustice within these systems is not only possible but also probable. The issue of fairness in the use of artificial intelligence systems arises primarily from unintended algorithmic biases and inherent statistical distortions embedded in the design and functioning of these technologies. These biases, often subtle yet deeply rooted, can lead to significant consequences across various domains, including healthcare, law, and social systems (59). AI algorithms are only as reliable as the data they are built on and are not entirely autonomous, as they reflect human-designed logic. Human errors and biases can be amplified through these systems, especially when applied to large datasets. Moreover, the homogeneity of input data often leads to the under- or over-representation of certain population groups, potentially reinforcing existing health disparities (60). The findings of this section are consistent with those presented in study (16, 18, 20, 21, 22, 23, 24, 26, 28, 30, 31, 33, 34, 38, 42, 43, 44, 45, 46, 49, 50, 51, 52).

*Challenges related to autonomy and informed consent*

The reliance of artificial intelligence on personal health data and information derived from social networks for decision-making in situations where individuals lack decision-making capacity is based on the assumption that one's digital identity accurately reflects their real-world preferences. However, this assumption is highly contentious. Given the dynamic nature of human values and preferences, decisions made on the basis of past behaviors and online presence may lead to a misrepresentation of an individual’s current wishes. Data from personal health records and social media can be used by AI to support medical decision-making when an individual is incapacitated and no human surrogate is available. However, human preferences are dynamic, and it is uncertain whether a competent individual would consent to AI-generated decisions based on inferred online behavior. Social media identities often do not reflect genuine personal values, and AI systems may prioritize cost-efficiency over individual well-being. This raises ethical concerns, especially when surrogate decision-makers are present but potentially overruled by AI due to automation bias. Ultimately, this creates a tension between human-centered care and algorithm-driven efficiency (61). Khawaja and Bélisle-Pipon (62) warn that commercial providers of therapeutic AI may, under the guise of promoting patient autonomy, lead to therapeutic misconception—where users fail to accurately understand the system’s capabilities and limitations. The findings of this section are in alignment with those reported in study (16, 18, 19, 20, 21, 22, 23, 24, 25, 32, 33, 34, 38, 47, 50, 52).

*Challenges within professional practice and the obligations of ethical responsibility*

The generative and creative nature of these models renders them prone to "hallucination"—the production of inaccurate or fabricated information—a characteristic that, in contexts such as healthcare, constitutes not merely an error but a potential threat to human life. Physicians’ concerns about disruptions to clinical workflows caused by the integration of artificial intelligence reflect an inherent tension between technological determinism and the preservation of coherence within experience- and evidence-based healthcare systems. It is important to note that large language models (LLMs) have not yet been approved for diagnostic or therapeutic use. These models, originally designed for creative tasks, are inherently prone to generating inaccurate information (hallucinations) and exhibiting bias. This means there is no official assurance that they meet the safety and efficacy standards required for clinical applications (63). The integration of AI into clinical workflows has also introduced tension. Investigators conducting randomized controlled trials aimed to assess the effectiveness of AI without compromising patient safety or disrupting established care pathways with proven outcomes. Clinicians expressed concerns that modifying existing workflows to accommodate AI systems might unintentionally impact the quality of patient care or increase the workload for healthcare staff (64). AI’s ability to analyze large volumes of patient data enables the detection of hidden patterns, but it also carries the risk of overdiagnosis. This involves identifying conditions that would not have impacted the patient's health if left undetected. The consequences may include unnecessary treatments, potential harm to patients, and the misuse of healthcare resources (65). The findings of this section are consistent with those presented in study (16, 17, 18, 19, 20, 22, 23, 24, 25, 35, 48).

*Challenges related to treatment and clinical reliability*

The growing role of artificial intelligence tools in medical diagnostics, while seemingly promising on the surface, carries the deeper risk of gradually eroding human clinical judgment. Clinical judgment arises from a synthesis of experience, human insight, and direct patient interaction—elements that no algorithm has yet been able to fully replicate. Excessive reliance on machine-generated outputs may lead to a form of "cognitive surrender," wherein the physician assumes the role of a passive validator of algorithmic suggestions rather than engaging in critical analysis. Although AI models demonstrate high accuracy, excessive reliance on machine-generated outputs may diminish the role of human expertise in medical decision-making. This is particularly troubling in complex cases that require a comprehensive evaluation of the patient’s clinical condition, comorbidities, and personal preferences (66). The findings of this section converge with those reported in study (16, 17, 19, 22, 23, 30, 32, 34, 36, 38, 40, 43, 44, 45, 47, 48, 50, 52).

*Legal, policy, and regulatory challenges*

Policies, regulatory frameworks, and governance mechanisms related to artificial intelligence also play a decisive role in shaping its ethical implications. A notable gap currently exists between existing legal structures and the rapid pace of technological advancements in this domain. Conflicting interests often emerge between those who develop and manage AI models and the goals of public health, particularly when viewed through the lens of government accountability and the inclusion of key stakeholders such as physicians and patients. One of the frequently raised concerns in AI-driven healthcare is the ambiguity surrounding accountability in the event of diagnostic or treatment errors. The technical complexity of AI systems, coupled with their proprietary nature, limits transparency, public scrutiny, and legal recourse. While some sources argue that healthcare professionals should be held responsible for AI-assisted decisions, others emphasize the responsibility of developers to ensure the safety, effectiveness, and suitability of AI systems for diverse patient populations (67). The discourse on responsible surveillance and the preference for proactive over reactive regulatory approaches highlights the need for ethical frameworks to reduce public distrust and enable the ethical use of AI surveillance technologies in public health. The intersection of public and private sector surveillance further complicates data privacy and ethical use; as private companies often adhere to lower ethical standards than governmental bodies. Moreover, health-related data generated outside clinical settings typically fall outside the scope of privacy regulations. This regulatory gap allows commercial data collectors to legally aggregate individuals' behavioral and social data from various sources for health and non-health purposes (68). With the rapid expansion of artificial intelligence in the healthcare sector, a significant regulatory gap has become increasingly evident. There is currently no clearly defined regulatory body, no standardized trial procedures, and no transparent accountability mechanisms in place to address potential harms caused by AI. This situation, often referred to as a "regulatory vacuum," is particularly concerning in the context of legal responsibility for AI-driven decisions. While data protection regulations—such as the GDPR in the European Union and HIPAA in the United States—are in effect, a comprehensive framework governing the clinical application of AI remains absent (69). The findings of this section align with those reported in study (16, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 32, 35, 36, 38, 39, 41, 42, 43, 44, 45, 47, 49, 50, 51).

**Conclusion**

The findings of this study reveal that the growing integration of artificial intelligence (AI) into healthcare systems, despite its substantial benefits, is accompanied by profound ethical challenges. These challenges affect multiple dimensions of medical practice, including decision-making, justice, privacy, professional accountability, and public trust. The qualitative content analysis identified seven major themes and thirty-three subthemes, among which the most critical were lack of algorithmic transparency, inherent data biases, erosion of patient and physician autonomy, threats to data security, and gaps in legal and regulatory frameworks. Addressing these challenges requires not only structural reforms in health policy but also the development of multidimensional ethical frameworks, enhancement of ethically grounded digital literacy among healthcare professionals, and improvement of accountability mechanisms within AI technologies. Moreover, the insights gained from this study can serve as a strategic foundation for informed decision-making by policymakers, technology developers, and clinical practitioners. The responsible, transparent, and human-centered integration of AI into healthcare is only achievable through the systematic incorporation of bioethical principles, distributive justice, and core human values in the design, implementation, and oversight of these technologies.

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**Conflicts of interest**

There are no conflicts of interest

**References**

1. Jafari F, Keykha A. Identifying the opportunities and challenges of artificial intelligence in higher education: a qualitative study. Journal of Applied Research in Higher Education. 2024 Jul 9;16(4):1228-45.
2. Keykha A, Mohammadi H, Darabi F, Hosseini SS. Identifying the Applications of Artificial Intelligence in the Assessment of Medical Students. Strides in Development of Medical Education. 2025 Apr 20.
3. Keykha, A., Imanipour, M., Shahrokhi, J., & Amiri, M. (2025). The Advantages and Challenges of Electronic Exams: A Qualitative Research based on Shannon Entropy Technique. Journal of Advances in Medical Education & Professionalism, 13(1), 1.
4. Keykha A, Behravesh S, Ghaemi F. ChatGPT and Medical Research: A Meta-Synthesis of Opportunities and Challenges. Journal of Advances in Medical Education & Professionalism. 2024 Jul 1;12(3):135.
5. Taiwo E, Akinsola A, Tella E, Makinde K, Akinwande M. A Review of the Ethics of Artificial Intelligence and its Applications in the United States. arXiv preprint arXiv:2310.05751. 2023 Oct 9.
6. Sallam M. ChatGPT utility in healthcare education, research, and practice: systematic review on the promising perspectives and valid concerns. InHealthcare 2023 Mar 19 (Vol. 11, No. 6, p. 887). MDPI.
7. Jeyaraman M, Ramasubramanian S, Balaji S, Jeyaraman N, Nallakumarasamy A, Sharma S. ChatGPT in action: Harnessing artificial intelligence potential and addressing ethical challenges in medicine, education, and scientific research. World journal of methodology. 2023 Sep 20;13(4):170.
8. Korkmaz S. Artificial intelligence in healthcare: a revolutionary ally or an ethical dilemma?. Balkan Medical Journal. 2024 Mar 1;41(2):87.
9. Ahmad SF, Han H, Alam MM, Rehmat M, Irshad M, Arraño-Muñoz M, Ariza-Montes A. Impact of artificial intelligence on human loss in decision making, laziness and safety in education. Humanities and Social Sciences Communications. 2023 Jun 9;10(1):1-4.
10. Floridi L. Translating principles into practices of digital ethics: Five risks of being unethical. Philosophy & Technology. 2019 Jun;32(2):185-93.
11. Walsh D, Downe S. Appraising the quality of qualitative research. Midwifery. 2006 Jun 1;22(2):108-19.
12. Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. BMC medical research methodology. 2008 Dec;8:1-0.
13. Lewin S, Booth A, Glenton C, Munthe-Kaas H, Rashidian A, Wainwright M, Bohren MA, Tunçalp Ö, Colvin CJ, Garside R, Carlsen B. Applying GRADE-CERQual to qualitative evidence synthesis findings: introduction to the series. Implementation Science. 2018 Jan;13:1-0.
14. Critical Appraisal Skills Program. 10 questions to help you make sense of qualitative research: CASP qualitative check list. 2006
15. Carroll C, Booth A. Quality assessment of qualitative evidence for systematic review and synthesis: is it meaningful, and if so, how should it be performed?. Research synthesis methods. 2015 Jun;6(2):149-54.
16. Sheth S, Baker HP, Prescher H, Strelzow JA. Ethical considerations of artificial intelligence in health care: examining the role of generative pretrained transformer-4. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2022 May 13:10-5435.
17. Collins BX, Bélisle-Pipon JC, Evans BJ, Ferryman K, Jiang X, Nebeker C, Novak L, Roberts K, Were M, Yin Z, Ravitsky V. Addressing ethical issues in healthcare artificial intelligence using a lifecycle-informed process. JAMIA open. 2024 Dec;7(4):ooae108.
18. Vandemeulebroucke T. The ethics of artificial intelligence systems in healthcare and medicine: from a local to a global perspective, and back. Pflügers Archiv-European Journal of Physiology. 2024 Jul 6:1-1.
19. Soares A, Piçarra N, Giger JC, Oliveira R, Arriaga P. Ethics 4.0: Ethical dilemmas in healthcare mediated by social robots. International Journal of Social Robotics. 2023 May;15(5):807-23.
20. Zarif A. The ethical challenges facing the widespread adoption of digital healthcare technology. Health and technology. 2022 Jan;12(1):175-9.
21. Karimian G, Petelos E, Evers SM. The ethical issues of the application of artificial intelligence in healthcare: a systematic scoping review. AI and Ethics. 2022 Nov;2(4):539-51.
22. Iniesta R. The human role to guarantee an ethical AI in healthcare: a five-facts approach. AI and Ethics. 2025 Feb;5(1):385-97.
23. Ganesan S, Somasiri N. Navigating the Integration of Machine Learning in Healthcare: Challenges, Strategies, and Ethical Considerations. Journal of Computational and Cognitive Engineering. 2024 Aug 29;4(1):8-23.
24. Emdad FB, Ho SM, Ravuri B, Hussain S. Towards a unified utilitarian ethics framework for healthcare artificial intelligence. arXiv preprint arXiv:2309.14617. 2023 Sep 26.
25. Arbelaez Ossa L, Milford SR, Rost M, Leist AK, Shaw DM, Elger BS. AI through ethical lenses: a discourse analysis of guidelines for AI in Healthcare. Science and Engineering Ethics. 2024 Jun 4;30(3):24.
26. Jeyaraman M, Balaji S, Jeyaraman N, Yadav S. Unraveling the ethical enigma: artificial intelligence in healthcare. Cureus. 2023 Aug 10;15(8).
27. Chikhaoui E, Alajmi A, Larabi-Marie-Sainte S. Artificial intelligence applications in healthcare sector: ethical and legal challenges. Emerging Science Journal. 2022 May 29;6(4):717-38.
28. Elendu C, Amaechi DC, Elendu TC, Jingwa KA, Okoye OK, Okah MJ, Ladele JA, Farah AH, Alimi HA. Ethical implications of AI and robotics in healthcare: A review. Medicine. 2023 Dec 15;102(50):e36671.
29. Naik N, Hameed BM, Shetty DK, Swain D, Shah M, Paul R, Aggarwal K, Ibrahim S, Patil V, Smriti K, Shetty S. Legal and ethical consideration in artificial intelligence in healthcare: who takes responsibility?. Frontiers in surgery. 2022 Mar 14;9:862322.
30. Wang C, Liu S, Yang H, Guo J, Wu Y, Liu J. Ethical considerations of using ChatGPT in health care. Journal of Medical Internet Research. 2023 Aug 11;25:e48009.
31. Mohammad Amini, M., Jesus, M., Fanaei Sheikholeslami, D., Alves, P., Hassanzadeh Benam, A. and Hariri, F., 2023. Artificial intelligence ethics and challenges in healthcare applications: a comprehensive review in the context of the European GDPR mandate. Machine Learning and Knowledge Extraction, 5(3), pp.1023-1035.
32. Morley J, Machado CC, Burr C, Cowls J, Joshi I, Taddeo M, Floridi L. The ethics of AI in health care: a mapping review. Social science & medicine. 2020 Sep 1;260:113172.
33. Char DS, Abràmoff MD, Feudtner C. Identifying ethical considerations for machine learning healthcare applications. The American Journal of Bioethics. 2020 Nov 1;20(11):7-17.
34. Dankwa-Mullan I. Health equity and ethical considerations in using artificial intelligence in public health and medicine. Preventing chronic disease. 2024 Aug 22;21:E64.
35. Ning Y, Teixayavong S, Shang Y, Savulescu J, Nagaraj V, Miao D, Mertens M, Ting DS, Ong JC, Liu M, Cao J. Generative artificial intelligence and ethical considerations in health care: a scoping review and ethics checklist. The Lancet Digital Health. 2024 Nov 1;6(11):e848-56.
36. McLennan S, Fiske A, Tigard D, Müller R, Haddadin S, Buyx A. Embedded ethics: a proposal for integrating ethics into the development of medical AI. BMC Medical Ethics. 2022 Jan 26;23(1):6.
37. Frost EK, Bosward R, Aquino YS, Braunack-Mayer A, Carter SM. Public views on ethical issues in healthcare artificial intelligence: protocol for a scoping review. Systematic Reviews. 2022 Jul 15;11(1):142.
38. Solanki P, Grundy J, Hussain W. Operationalising ethics in artificial intelligence for healthcare: a framework for AI developers. AI and Ethics. 2023 Feb;3(1):223-40.
39. Machado H, Silva S, Neiva L. Publics’ views on ethical challenges of artificial intelligence: a scoping review. AI and Ethics. 2025 Feb;5(1):139-67.
40. Adeniyi AO, Arowoogun JO, Okolo CA, Chidi R, Babawarun O. Ethical considerations in healthcare IT: A review of data privacy and patient consent issues. World Journal of Advanced Research and Reviews. 2024 Feb 28;21(2):1660-8.
41. Wu Y, Liu XM. Navigating the ethical landscape of AI in healthcare: Insights from a content analysis. IEEE Technology and Society Magazine. 2023 Sep 22;42(3):76-87.
42. Boudi AL, Boudi M, Chan C, Boudi FB, Boudi A. Ethical Challenges of Artificial Intelligence in Medicine. Cureus. 2024 Nov 26;16(11).
43. Sallstrom L, Morris O, Mehta H. Artificial intelligence in Africa’s healthcare: ethical considerations. ORF Issue Brief. 2019 Sep 9;312:1-1.
44. Zhui L, Fenghe L, Xuehu W, Qining F, Wei R. Ethical considerations and fundamental principles of large language models in medical education. Journal of Medical Internet Research. 2024 Aug 1;26:e60083.
45. Busch F, Adams LC, Bressem KK. Biomedical ethical aspects towards the implementation of artificial intelligence in medical education. Medical science educator. 2023 Aug;33(4):1007-12.
46. Franco D’Souza R, Mathew M, Mishra V, Surapaneni KM. Twelve tips for addressing ethical concerns in the implementation of artificial intelligence in medical education. Medical Education Online. 2024 Dec 31;29(1):2330250.
47. Perkins M, Pregowska A. The role of artificial intelligence in higher medical education and the ethical challenges of its implementation. Artificial Intelligence in Health. 2024 Oct 21;2(1):1-3.
48. Weidener L, Fischer M. Proposing a principle-based approach for teaching AI ethics in medical education. JMIR Medical Education. 2024 Feb 9;10(1):e55368.
49. Lu H, Alhaskawi A, Dong Y, Zou X, Zhou H, Ezzi SH, Kota VG, Hasan Abdulla Hasan Abdulla M, Abdalbary SA. Patient autonomy in medical education: navigating ethical challenges in the age of artificial intelligence. INQUIRY: The Journal of Health Care Organization, Provision, and Financing. 2024 Sep;61:00469580241266364.
50. Khosravi M, Zare Z, Mojtabaeian SM, Izadi R. Ethical challenges of using artificial intelligence in healthcare delivery: a thematic analysis of a systematic review of reviews. Journal of Public Health. 2024 Feb 26:1-1.
51. Shoghli A, Darvish M, Sadeghian Y. Balancing Innovation and Privacy: Ethical Challenges in AI-Driven Healthcare. Journal of Reviews in Medical Sciences. 2024 Dec 16;4(1):1-1.
52. Al-Hwsali A, Al-Saadi B, Abdi N, Khatab S, Solaiman B, Alzubaidi M, Abd-alrazaq A, Househ M. Legal and ethical principles of artificial intelligence in public health: scoping review. Journal of Public Health Ethics. 2022 Nov 24;8(2):112-25.
53. Mahomed S. Healthcare, artificial intelligence and the Fourth Industrial Revolution: Ethical, social and legal considerations. South African Journal of Bioethics and Law. 2018 Nov 1;11(2):93-5.
54. Jensen LA, Allen MN. Meta-synthesis of qualitative findings. Qualitative health research. 1996 Nov;6(4):553-60.
55. Chen M, Zhou AE, Jain N, Gronbeck C, Feng H, Grant-Kels JM. Ethics of artificial intelligence in dermatology. Clinics in Dermatology. 2024 May 1;42(3):313-6.
56. Rubeis G. iHealth: The ethics of artificial intelligence and big data in mental healthcare. Internet interventions. 2022 Apr 1;28:100518.
57. Astromskė K, Peičius E, Astromskis P. Ethical and legal challenges of informed consent applying artificial intelligence in medical diagnostic consultations. AI & SOCIETY. 2021 Jun;36:509-20.
58. Kawamleh S. Against explainability requirements for ethical artificial intelligence in health care. AI and Ethics. 2023 Aug;3(3):901-16.
59. Rudzicz F, Saqur R. Ethics of artificial intelligence in surgery. arXiv preprint arXiv:2007.14302. 2020 Jul 28.
60. Anom BY. Ethics of Big Data and artificial intelligence in medicine. Ethics, Medicine and Public Health. 2020 Oct 1;15:100568.
61. Arnold MH. Teasing out artificial intelligence in medicine: an ethical critique of artificial intelligence and machine learning in medicine. Journal of bioethical inquiry. 2021 Mar;18(1):121-39.
62. Khawaja Z, Bélisle-Pipon JC. Your robot therapist is not your therapist: understanding the role of AI-powered mental health chatbots. Frontiers in Digital Health. 2023 Nov 8;5:1278186.
63. Hasan SS, Fury MS, Woo JJ, Kunze KN, Ramkumar PN. Ethical application of generative artificial intelligence in medicine. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2025 Apr 1;41(4):874-85.
64. Youssef A, Nichol AA, Martinez-Martin N, Larson DB, Abramoff M, Wolf RM, Char D. Ethical considerations in the design and conduct of clinical trials of artificial intelligence. JAMA network open. 2024 Sep 3;7(9):e2432482
65. Quinn TP, Coghlan S. Readying medical students for medical AI: The need to embed AI ethics education. arXiv preprint arXiv:2109.02866. 2021 Sep 7.
66. Ramoni D, Scuricini A, Carbone F, Liberale L, Montecucco F. Artificial intelligence in gastroenterology: Ethical and diagnostic challenges in clinical practice. World Journal of Gastroenterology. 2025 Mar 14;31(10):102725.
67. Murphy K, Di Ruggiero E, Upshur R, Willison DJ, Malhotra N, Cai JC, Malhotra N, Lui V, Gibson J. Artificial intelligence for good health: a scoping review of the ethics literature. BMC medical ethics. 2021 Dec;22:1-7.
68. Federico CA, Trotsyuk AA. Biomedical data science, artificial intelligence, and ethics: navigating challenges in the face of explosive growth. Annual Review of Biomedical Data Science. 2024 Apr 10;7.
69. Carter SM, Rogers W, Win KT, Frazer H, Richards B, Houssami N. The ethical, legal and social implications of using artificial intelligence systems in breast cancer care. The Breast. 2020 Feb 1;49:25-32.