The Application of Artificial Intelligence in Healthcare Practice: An Umbrella Review

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Statement on open data and ethics

The data supporting the findings of this study are available from the corresponding author upon reasonable request. As this study is an umbrella review, it does not report or involve the use of any animal or human data and therefore did not require ethics approval or informed consent.

CRediT authorship contribution statement

Adam Andersen: Conceptualization, Data curation, Formal analysis, Methodology, Coding for data traction and quality assessment, Project administration, Software, Validation, Visualization, Writing –original draft, Writing –review & editing, Managing references.

Ruiping Huang: Conceptualization, Writing –review & editing, Coding for data extraction and quality assessment, Software, Validation, Project administration.

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Declaration of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of generative AI in scientific writing

During the preparation of this work, the authors used ChatGPT to proofread grammar. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Article highlights

- This umbrella review summarizes 181 systematic reviews on AI applications across healthcare practice fields.
- 70% of the reviews reported AI models trained on diagnostic imaging, EHR, and biomarker data.
- There has been recent growth in AI using wearable, sensor, and other health data.
- Diagnosis, prognosis, and treatment comprised over 80% of the applications in all the reviews.
- Ethical concerns, including privacy, accuracy, bias, and explainability, were raised in over half of the reviews.

Abstract

Artificial intelligence (AI) is rapidly transforming healthcare practice, with growing evidence supporting its use in diagnosis, prognosis, treatment planning, and operational decision-making. The proliferation of systematic reviews in recent years underscores the need for an updated synthesis of the literature to inform research, policy, and practice. We searched PubMed, Web of Science, Scopus, IEEE Xplore, and CINAHL for systematic reviews and meta-analyses published between 2019 and November 2024. Eligible reviews focused on AI applications in healthcare practice, were peer-reviewed, and written in English. A total of 181 reviews met the inclusion criteria. Publication volume increased steadily, peaking in 2024. AI research was concentrated in high-density domains, such as radiology, oncology, and critical care. Across reviews, diagnostic imaging, electronic health record (EHR) data, and biomarkers/laboratory results accounted for 70% of training data sources, though newer data types, such as wearable device and sensor data, emerged from 2022 onward. Diagnosis, prognosis, and treatment comprised over 80% of AI applications, with novel uses emerging in recent years. Ethical concerns were reported in 64.6% of reviews, with privacy, model accuracy, data and algorithmic bias, and explainability as recurrent themes. The proportion of reviews reporting ethical concerns increased from 2021 to 2024. AI applications in healthcare are expanding in scope, diversifying in data sources, and evolving toward novel clinical and operational uses. The human-centered AI or Human-AI-Human paradigm, integrating computational precision with clinical expertise, holds significant promise but will require parallel advances in governance, regulatory frameworks, and ethical oversight to ensure safe adoption.

Keywords: artificial intelligence, machine learning, healthcare, systematic review, clinical applications

1. Introduction

Artificial intelligence (AI) is rapidly developing and playing an increasingly important role in healthcare practice (Goktas & Grzybowski, 2025). AI technologies applied in healthcare offer opportunities to facilitate diagnosis, treatment, and prognosis, among other applications. The number of studies and reviews focusing on AI in healthcare practice has dramatically increased in the past decade (Ali et al., 2023). For example, according to PubMed, 2879 reviews focusing on AI in healthcare have been published from 2020 to September 2025. The growing number of AI reviews demonstrates its potential to improve healthcare outcomes on a large scale. This study synthesizes recent systematic reviews on AI applications in healthcare to map the current landscape, track the recent trends, and help guide future research.

AI research increasingly demonstrates that combining human expertise with AI capabilities can produce superior outcomes compared to either working in isolation (Zöller et al., 2025; Anderson et al., 2023). This combination is now referred to as human-AI collaboration, human-centered AI, or Human-AI-Human (H-AI-H) (OSPI, 2024). In clinical settings, H-AI-H decision-making has the potential to improve diagnostic and prognostic accuracy, generate effective treatment options, and enhance care planning by integrating computational precision with clinical judgment and contextual awareness (Oberije et al., 2024; Liu et al., 2025; Lång et al., 2023). For example, AI models may rapidly analyze imaging or laboratory data, while clinicians validate results, consider patient-specific factors, and make the final decision. This collaborative paradigm not only leverages the strengths of both humans and machines but also addresses some of the concerns related to overreliance on autonomous systems.

With the rapid advancement of AI, a large number of review studies have summarized the AI development and its growing integration into clinical workflows. Loh et al. (2022) conducted a systematic review of AI applications in healthcare from 2011 to 2022. The authors identified several categories of AI applications, including imaging and test results interpretation, diagnosis, treatment, patient data management, healthcare administration, and predictive medicine. The AI applications span many medical specialties and diseases. For example, Rashid et al. (2022) conducted a systematic review of AI applications in acute respiratory distress syndrome (ARDS). The findings included several applications with high levels of accuracy, including diagnosis, prognosis, and treatment. Xu & Xu (2024) conducted a systematic review of machine learning (ML) applications in preventative healthcare. Specifically, the use of ML to prevent or manage chronic disease, which represented several of the top ten leading causes of death worldwide in 2021 (WHO, 2021).

To synthesize those reviews, an umbrella review is needed. An umbrella review, also known as a review of reviews, is particularly suited to synthesizing a large and diverse body of evidence (Grant & Booth, 2009). Kolasa et al. (2024) conducted a literature review of systematic

reviews of machine learning (ML) in healthcare and greatly synthesized the knowledge and improved our understanding of this important topic. The authors identified 220 systematic reviews published between 2010 and March 2023. They analyzed the reviews and showed the distribution of publication year, diagnoses, data types used to train models, and types of machine learning models used. They found that the most common diagnoses studied were neoplasms and diseases of the nervous system. Imaging and clinical notes were the two leading types of data sources used to train AI models. Overall, their findings highlighted both the rapid growth of ML-related healthcare research and gaps in explainability, validation, and integration into clinical workflows, contributing to our understanding of AI in healthcare.

Building on the previous reviews, we can further advance the understanding of AI in healthcare by synthesizing the reviews in the following ways:

(a) An update is needed to capture the recent advancement of AI applications in healthcare. Kolasa et al. (2024) reviewed the reviews up to March 2023, and 88% of the included reviews were published between 2020 and 2021. AI technology and research have advanced dramatically since then. Notably, the release of ChatGPT in late 2022 and the rapid diffusion of large language models (LLMs) in subsequent years have marked a major turning point in AI research and applications (Liu et al., 2023). With the advancement of AI applications in healthcare, reviews on AI in healthcare have skyrocketed in recent years. According to PubMed, 648 reviews focused on AI applications in healthcare practice were published between April 2023 and November 2024.

(b) A longitudinal analysis is needed to capture how themes have changed over time, such as data types and applications. A longitudinal analysis would help us understand the progress of AI in healthcare and predict its future development. For example, Cicek and Bagci (2025) identified new data types and applications. New data types, such as remote monitoring data, can allow for earlier detection and diagnosis. New applications, such as automating clinical documentation via AI-driven ambient listening tools, have been implemented into clinical practice.

(c) Ethical concerns need to be captured. Issues such as privacy, accuracy, bias, and explainability are significant challenges in healthcare (Bouderhem, 2024). To our knowledge, the analysis of ethical concerns about AI in healthcare and their evolution over time has not been extensively researched.

To fill in the gaps, we conduct an umbrella review, addressing the following research questions:

1. What are the characteristics of the review studies on AI applications in healthcare practice?

2. Healthcare data types
    a. What types of healthcare data have been used to train AI models?
    b. How have the healthcare data types changed over time?

3. AI healthcare applications
    a. What AI tools have been applied in healthcare practice?
    b. How have AI tools in healthcare practice changed over time?

4. Ethical concerns
    a. What are the ethical concerns about AI applications in healthcare practice?
    b. How have ethical concerns changed over time?

By answering these questions, we aim to provide a comprehensive overview of AI in healthcare practice, identify key trends, and highlight the gaps and limitations. This approach offers a holistic perspective on the current state of AI in healthcare practice, informs scholars entering the AI field, and guides future endeavors in this rapidly evolving area.

2. Methods

To answer the research questions, we conducted an umbrella review and managed the review process using Covidence, a systematic review data management software (https://www.covidence.org/). During the review process, we referenced the widely adopted Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page et al., 2021) (Figure 1). This section presents the search strategy, inclusion and exclusion criteria, screening process, data extraction and quality assessment, and data analysis methods.

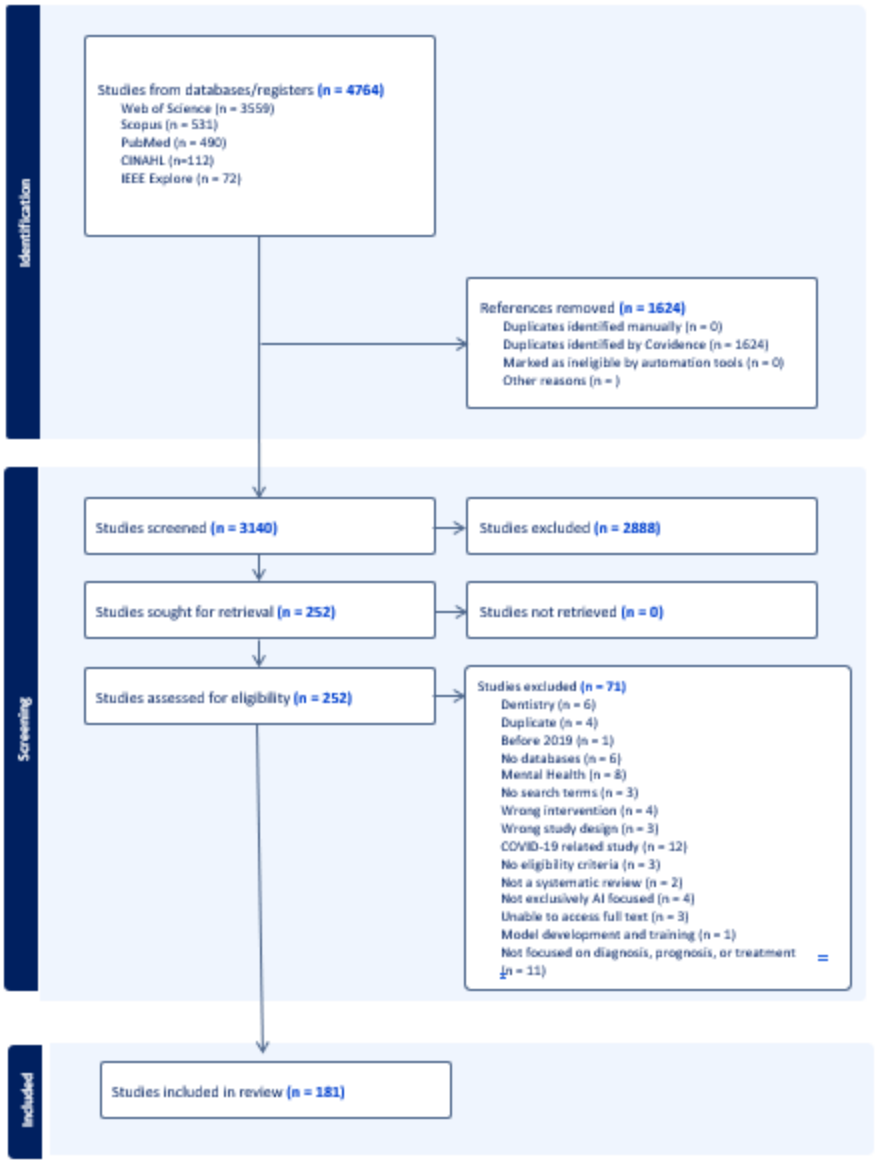

Figure 1: Search and screening processes exported from Covidence

2.1. Search Strategy and Study Selection

Keyword Search. In November 2024, the first author searched five databases: PubMed, Web of Science, Scopus, IEEE Xplore, and CINAHL. These databases were selected for their relevance to healthcare and AI, ensuring comprehensive coverage in our umbrella review. We used keywords related to AI and healthcare practice, ("artificial intelligence" OR "AI" OR "chatgpt" OR "large language models" OR "machine learning" OR "deep learning" OR "neural networks" OR "predictive analytics") AND ("Delivery of Health Care" OR "healthcare" OR "health care") AND ("Medicine" OR "Dentistry" OR "Nursing" OR "Pharmacy" OR "Allied Health" OR "Public Health" OR "Health Services administration" OR "Social work" OR "therapy" OR

"diagnosis" OR "prognosis" OR "surgery" OR "prevention" OR "risk") AND ('Systematic review"). The initial search yielded 3140 articles after duplicates were removed.

2.2. Inclusion and Exclusion Criteria

We generated inclusion and exclusion criteria from the iteration of team brainstorming, discussion, and pilot testing (Table 1). Two researchers screened each paper independently in Covidence and included reviews that meet the following criteria: (a) articles published between 2019 and November 2024, (b) systematic reviews, meta-analyses, or scoping reviews; (c) focusing on AI applications in healthcare practice; (d) AI technology as the central focus; (e) peer-reviewed journal articles and conference papers; and (f) English articles.

The inclusion and exclusion criteria were designed to balance comprehensiveness with relevance and rigor. (a) Publication Year: Restricting the timeframe to 2019–2024 ensured that the umbrella review captured the rapid acceleration of AI research following key technological advances, including the advent of LLMs, while excluding earlier literature less reflective of the current state of the field. According to PubMed, the number of systematic reviews started to substantially increase in 2019 and every year after. (b) Study Design: Limiting to systematic reviews, meta-analyses, and scoping reviews provided a consistent level of methodological quality and transparency in search, selection, and synthesis processes, while excluding narrative reviews or technical papers that lacked systematic rigor. (c) Review Focus: Focusing specifically on AI applications in healthcare practice, rather than adjacent domains such as education or basic algorithm development, allowed for clearer insights into clinical and operational implications. In addition, reviews were excluded if they focused on COVID-19, dentistry, or psychiatry and mental health. These areas were excluded to maintain a focused scope on broader AI applications across general medical specialties. COVID-19, dentistry, and psychiatry often feature unique AI challenges and extensive dedicated review literature. (d) Source of Publication: Restricting the reviews to peer-reviewed journal articles and conference papers ensured scholarly vetting, while excluding grey literature minimized concerns about varying quality. Finally, (e) Language: We only reviewed English-language publications due to the constraints of the research team, while acknowledging that this may have excluded relevant studies in other languages. Collectively, these criteria were intended to create a dataset that was both representative of the state of knowledge and methodologically robust to support meaningful synthesis.

Table 1
Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Publication Year	2019 to November 2024	Articles published before 2019

Study Design	Systematic review / Meta-analysis / Scoping review (reviews that show at least the three elements: searching database, search terms, and inclusion and exclusion criteria)	Non-systematic reviews (reviews that don't show the three elements: searching database, search terms, and inclusion and exclusion criteria)
Review Focus	Reviews focus on AI applications in healthcare practice (AI tools that can be used by a healthcare professional to provide care for a patient in a healthcare setting (hospital or clinic).	1. AI tools not applied to an aspect of healthcare practice, such as education and research. 2. Reviews focused on COVID-19, Dentistry, or Psychiatry and Mental Health 3. Not focused on AI or only partially focused on AI: (1) Reviews that do not report on any aspect of AI (applications, impact, interpretation, or technologies). (2) Reviews that focus on topics like augmented reality (AR), virtual reality (VR), blockchain, metaverse, or other technologies that may incorporate AI partially or not at all, rather than having AI as the central focus.
Source of Publication	Peer-reviewed journals and conference papers	White papers, book chapters, technical reports, dissertations, and empirical studies
Language	English	Not English

2.3. Screening Process

After we selected papers and removed the duplicates (n = 3140), we screened the remaining papers in two steps. First, the first and second authors independently screened the titles and abstracts of 229 articles. Title and abstract screening inter-rater agreement had a Cohen's kappa of 0.82, which was interpreted as excellent inter-rater agreement (Landis & Koch, 1977). We resolved the discrepancies through group discussions among the three authors. With inter-rater agreement established, the first author screened the remaining articles, resulting in 252 articles for full-text screening.

The first and third authors screened seven papers independently based on the full texts. Full text screening inter-rater agreement had a Cohen's kappa of 1.0, which was interpreted as excellent inter-rater agreement. With inter-rater agreement established, the first author screened the remaining articles, resulting in 181 articles for data extraction.

2.4. Data Extraction

The first author drafted the initial data extraction rubric (Table 2) based on the research questions. The research team then collaboratively refined these rubrics, pilot-tested them with 10 papers through discussion and iterative revisions, and finalized them when no more revisions were needed.

Using the finalized rubric (Table 2), we coded the review articles to answer the research questions: (a) RQ1, Characteristics of AI applications: Publication year, journal, funding support, study count, study type, first author country of origin, medical specialty, delivery type; (b) RQ2, Data types; (c) RQ3, AI tools used in healthcare practice; and (d) RQ4, Ethical concerns: Ethical concerns reported by the author(s).

Using the finalized rubrics, the first and third authors independently coded 10 randomly selected studies to establish inter-rater agreement and resolved conflicts through group discussion. Cohen's kappa was 0.82, indicating excellent inter-rater agreement. The first and third authors then independently coded the remaining papers, resolving ambiguities through group discussion to ensure accuracy and consistency.

Table 2
Extraction rubric.

Checklist Item	Choices
1. Publication Year [Single Choice]	• 2019 • 2020 • 2021 • 2022 • 2023 • 2024
2. Journal	Text
3. Funding Support [Single Choice]	• Public funding (NIH, NSF, etc) • Private funding (Industry, foundations, etc) • Not funded • Not reported
4. Study Count (the number of studies finally included in the review)	Text

5. Type of studies included in the review [Single Choice]	• Empirical • Mixed • Not reported
6. Country/Region (the country/region of the first author)	Text
7. Medical Specialty: Age category [Single Choice]	• Adult (Age 18 and up) • Pediatric (Age 0-17) • Adult and pediatrics • Unspecified
8. Medical Specialty: Specialty Type	Text
9. Healthcare Delivery Type [Single Choice]	• In person • Telehealth • In person and telehealth • Not specified • Other
10. Data types mentioned in the review [Multiple Choice]	• Vital signs (Heart Rate, Blood Pressure, Respiratory Rate, SpO2) • Diagnostic imaging (X-ray, MRI, CT, PET, Ultrasound, Nuclear Medicine scan, mammography) • Biomarkers (lab tests of bodily fluids or tissue sample such as blood, urine, stool, saliva, etc.) • Special testing: Electrocardiogram (ECG), Pulmonary function tests, etc.) • Wearable device data • Electronic health record documentation (text-based medical notes) • Genetic markers • Not reported • Other
11. Focus of AI healthcare application [Multiple Choice]	• Diagnosis • Treatment • Prognosis (predicted outcome or course of disease) • Monitoring and prevention • Not reported • Other

12. Ethical concerns reported by the author(s) [Single Choice]	• Yes • No

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2.5. Data Analysis

We systematically examined the selected reviews quantitatively and qualitatively. Quantitatively, we calculated frequencies and proportions for categorical variables, such as publication year, funding support, medical specialties, application, and data types, and presented the major results through tables and figures. Qualitatively, we synthesized themes and patterns that add more depth to answering the research questions. We identified the trends and gaps and recommended how to advance future research on AI applications in healthcare practice.

3. Results

3.1. RQ1: Characteristics of AI applications in healthcare practice

We described the characteristics of the reviews from multiple dimensions. Figures 2 through 5 show the general information about the reviews, including publication year, country, journals, and medical specialty. (a) The number of reviews consistently increased from 2019 to 2024, peaking at 73 in 2024 (Figure 2). The number of reviews in 2019 and 2020 is much smaller than the later years. (b) The first author's country of origin, the top four common countries/regions for the first author were the United States (n = 21, 11.6%), the United Kingdom (n = 13, 7.2%), Australia and India (n = 10, 5.5% respectively), and China, Italy, and Saudi Arabia (n = 9, 5% respectively) (Figure 3). (c) The reviews appeared in 133 journals, with the top five journals ranging from two to 10 total reviews (Figure 4). (d) The reviews can be categorized into three main themes: health profession, disease/condition, and other. The three themes can be further classified into sub-categories, in particular, health professions into five and disease/condition into 19 sub-categories. (e) Figure 5 linked the medical specialties to disease/condition and the other themes. Many connections exist between specialties, diseases/conditions, and applications with AI tools, creating a network effect. Medical specialties such as radiology, critical care, and emergency medicine, and diseases such as cancer, heart disease, and infection have more linkages than other specialties and diseases. These highly linked themes have more AI-related research. The themes with fewer linkages indicate opportunities for more research, such as gerontology, geriatric disease, and gynecologic disease. (f) The patient age group was mostly unspecified (n = 135, 75%), with the remaining reviews focusing on adults (n = 24, 13%), pediatrics (n = 7, 4%), or adults and pediatrics (n = 15, 8%). (g) The healthcare delivery type was

mostly not specified (n=176, 97%), with the remaining reviews reporting in person care or telehealth and in person care.

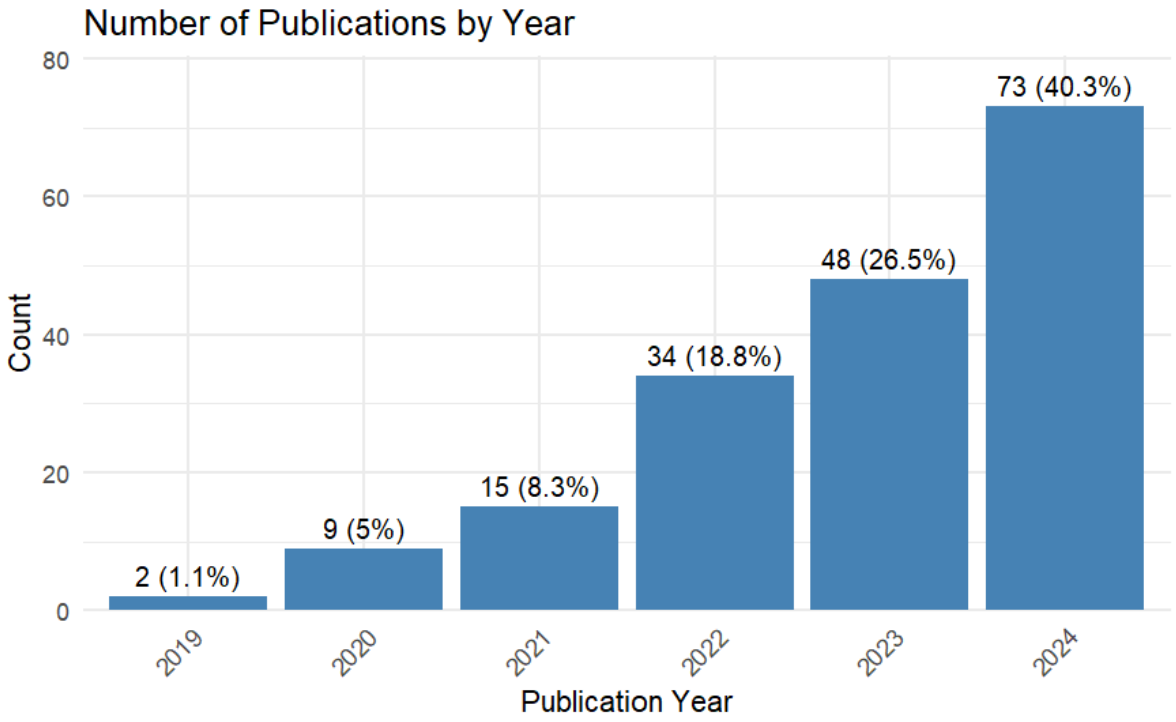

Fig. 2. Number of publications by year (n=181)

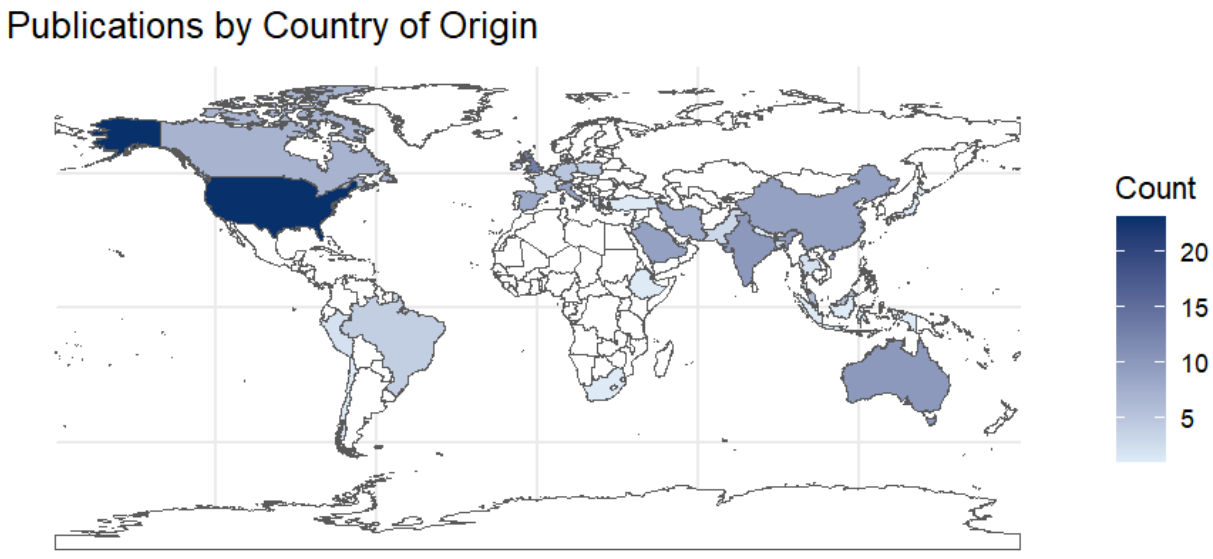

Fig. 3. First author(s) country/region of origin

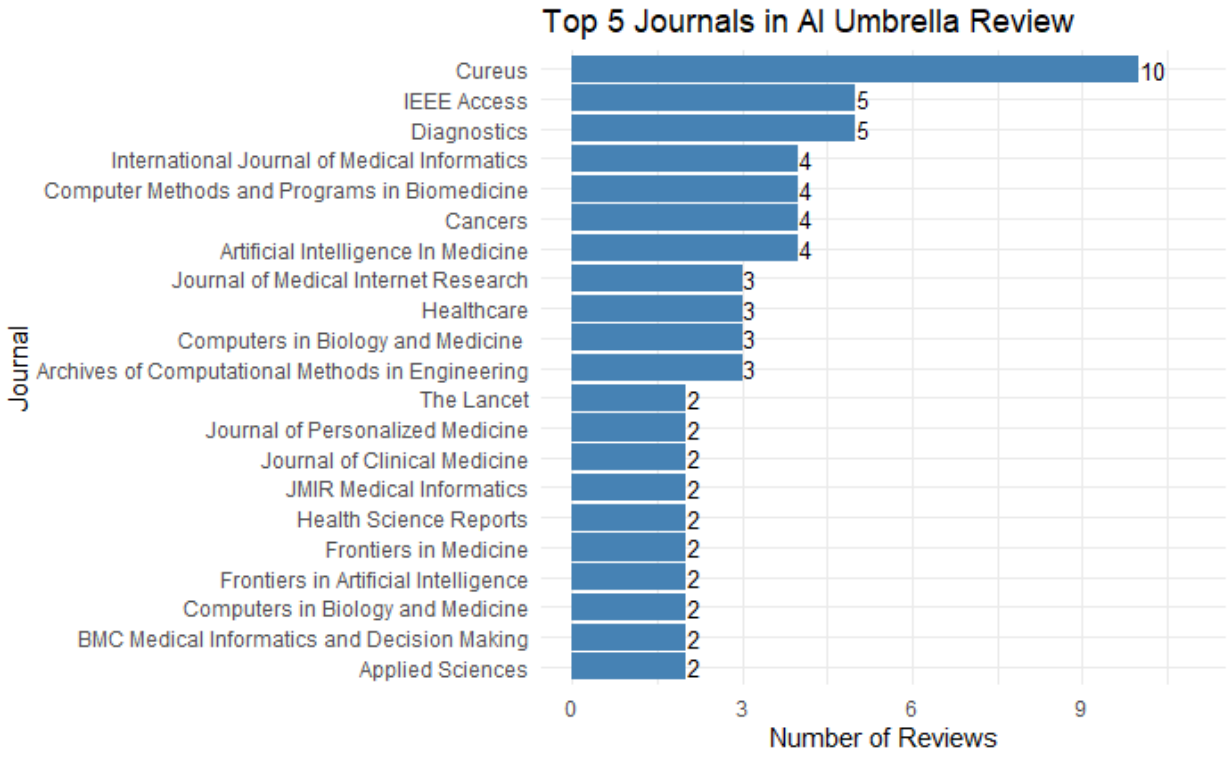

Fig. 4. Counts of the top five journals included in the umbrella review

Table 3

Thematic Categories of the Reviews

Theme category	Theme sub-category	Count
Health Profession	Medicine	43
	Nursing	6
	Pharmacy	1
	Physical Therapy	1
	Nutrition	1
	Total	**52**
Disease/Condition	Cancer	27
	Heart disease	10
	Infections	9
	Bone, Joint, and Spine disease	9
	Lung and airway disease	7
	Diabetes and Related disease	6
	Vascular disease	5
	Neurovascular disease	4
	Ear disease	4
	Neurological disease	4
	Skin disease	3
	Liver disease	2
	Pregnancy	2
	Eye disease	2
	Cardiometabolic disease	1
	Digestive disease	1
	Geriatric disease	1
	Thyroid disease	1
	Gynecologic disease	1
	Total	**99**
Other themes		
	Not specified	11
	Clinical decision and prediction	7
	Patient safety	5
	Chronic disease and aging	4
	Other	3
	Total	**30**

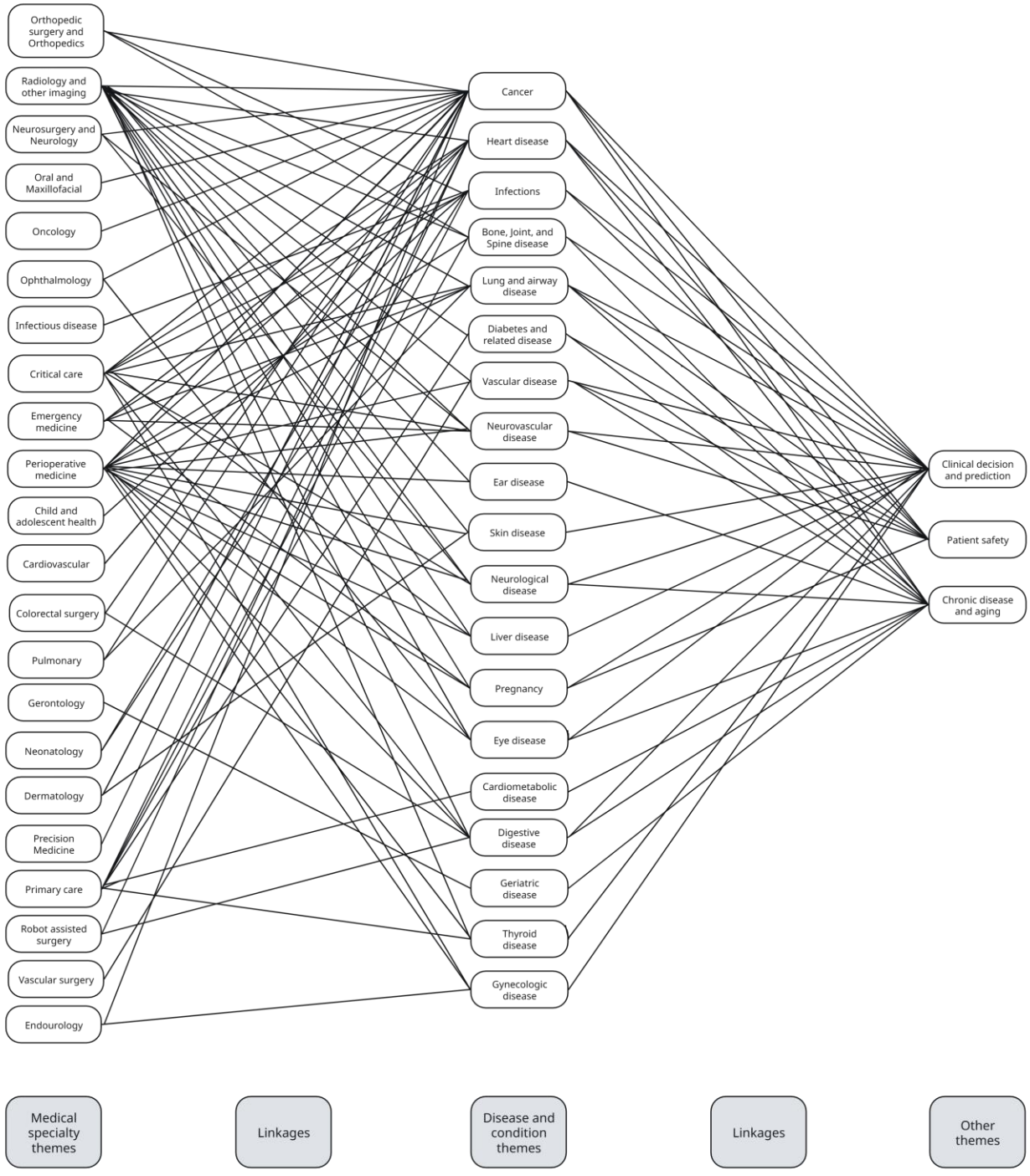

Fig. 5. Linkages between medical specialties, disease/conditions, and other themes

3.2. RQ2a and b: Healthcare data types used to train AI models and change over time

The types of healthcare data used to train AI models were extracted during the full-text review phase of the umbrella review. As shown in Figure 6, three data types comprised 70% of the data types in all the reviews: diagnostic imaging, electronic health record (EHR), and biomarkers and laboratory tests. As one review may report more than one data type, the total count is above 181. Figure 7 shows how the data type changes over time. Similarly, the aforementioned three data types comprise a majority of the data types each year. Wearable device data and other data types appear in greater numbers in 2023 and 2024. This trend suggests that new data types are emerging to train AI models. This topic is explored further in the narrative review.

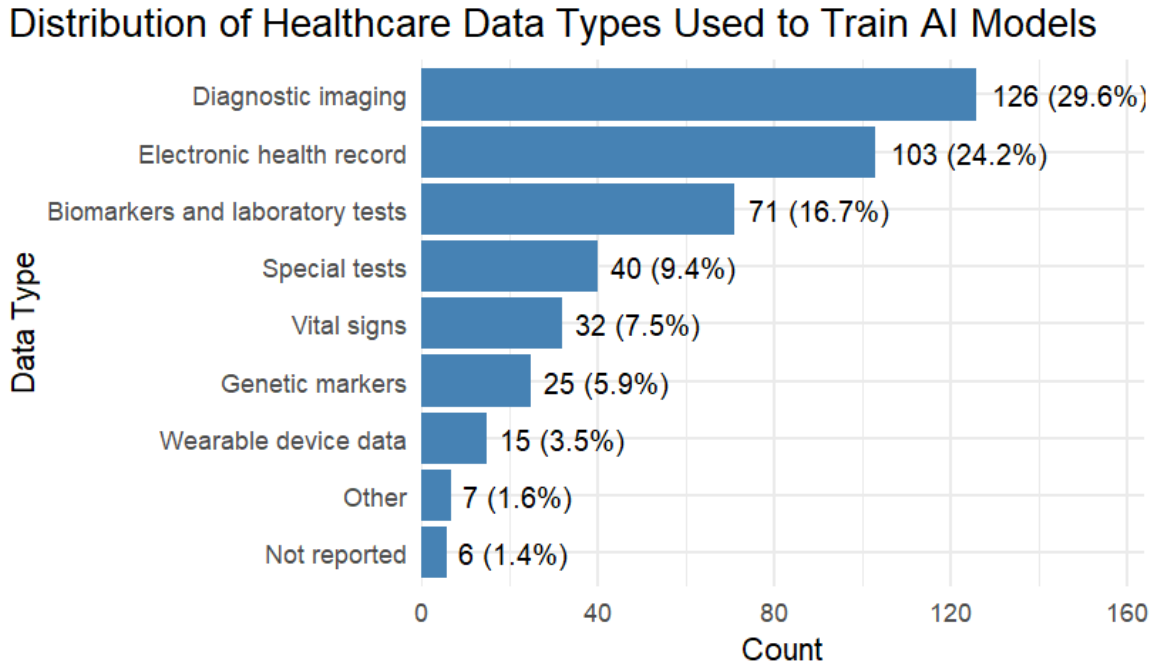

Fig. 6. Distribution of healthcare data types used to train AI models

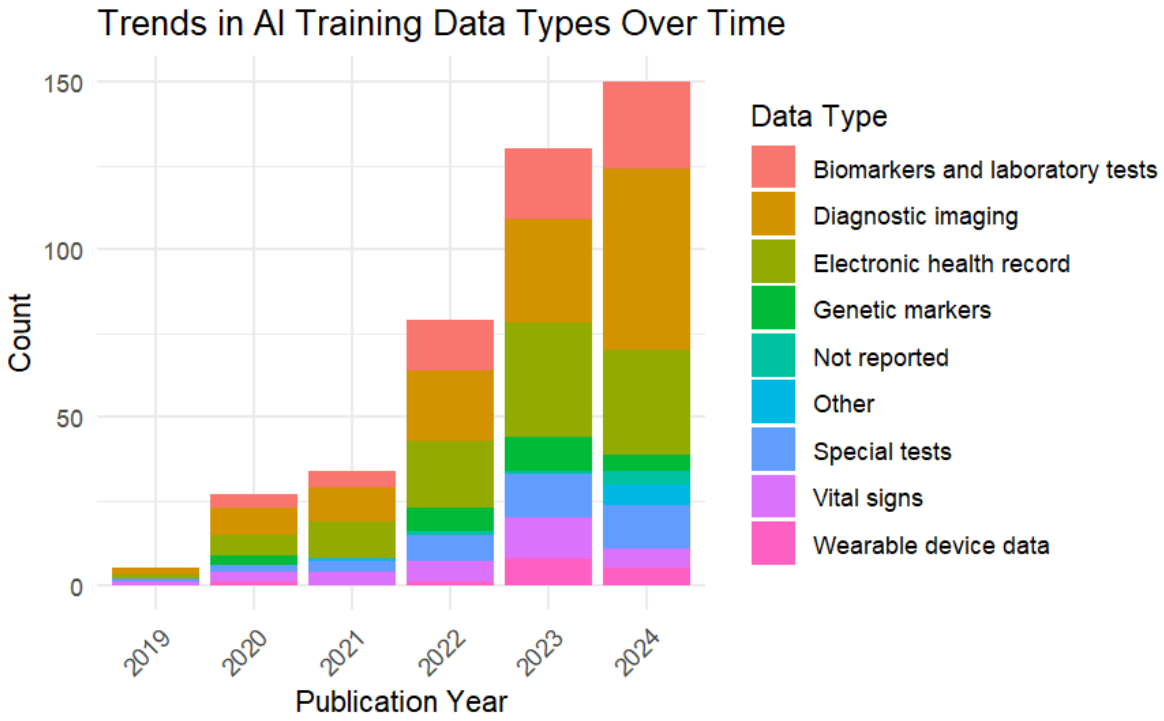

Fig. 7. Distribution of healthcare data types over time

3.2.1. Narrative review of healthcare data types used to train AI models

Across systematic reviews of AI applications in healthcare, diagnostic imaging, EHR, and biomarkers/laboratory test results consistently dominate model development. Diagnostic imaging was the leading source of data used to train AI models in this review. Imaging data includes radiographs, CT scans, MRIs, photographs, and other images. Islam et al. (2020) investigated the accuracy of deep learning (DL) algorithms to detect diabetic retinopathy in retinal fundus photograph. The results showed that DL algorithms had high sensitivity and specificity for detecting retinopathy. Sensitivity and specificity, the proportion of true positives and true negatives, respectively, are critical measures for diagnostic tests (Pacurari, 2023). A later review by Grzybowski et al. (2024) reported that several AI models used to detect diabetic retinopathy have received approval from the US Food and Drug Administration (FDA) and have been implemented in clinical practice. This study, among many others, demonstrates how significant advances in imaging data-trained models are now augmenting or automating the interpretation of imaging data.

Another leading source of data is from EHRs. EHRs are data-rich, containing sources of medical, demographic, and billing data. Jones et al. (2021) investigated AI models using EHR primary care data to facilitate early cancer diagnosis. The results were inconclusive, but the authors

endorsed continued work and research with models based on EHR data because of the strong potential to improve patient outcomes. Ruksakulpiwat et al. (2024) systematically reviewed the use of AI in nursing care. They found that EHR data, when paired with ML approaches, can effectively identify patients at high risk for hospital readmission. The review concluded that most models remain at the proof-of-concept or feasibility stage, with limited evidence of widespread, routine use in nursing practice. The authors emphasized the need for prospective validation and real-world implementation studies before these tools can be reliably adopted in daily care. Early identification of sepsis is another growth area using EHR data. Rao et al. (2024) reviewed 16 studies focused on early diagnosis of neonatal sepsis. They found that ML models using EHR and laboratory data consistently outperformed traditional diagnostic methods, with some approaches predicting sepsis hours before clinical recognition and achieving accuracies above 99%. However, most studies relied on retrospective datasets and few offered prospective validation, underscoring the need for further real-world testing. Other empirical research, outside the scope of this umbrella review, indicates that AI tools for the early detection of sepsis in adults have received FDA approval and are already being implemented in clinical practice (Bhargava et al., 2024).

Other data sources have emerged in recent years, such as wearable device data, sensor data, and other health data. Gudigar et al. (2024) investigated the use of AI to detect and assess hypertension. The traditional methods of measuring blood pressure are now being complemented with wearable device data. Wearable devices include smart watches, patch-based monitors, and other devices. These devices allow for continuous remote monitoring that can facilitate earlier detection of hypertension and more proactive management of existing hypertension. In addition, Buijs et al. (2024) investigated the use of scheduling data. They found that historical scheduling data can be used to train models that identify patients at higher risk of missing their appointment. The model can then identify certain time slots that can be overbooked based on this information and prevent outpatient appointment no-shows. Increasingly diverse data types present more opportunities to build AI models that can improve patient care and clinical operations.

3.3. RQ3a and b: Application of AI tools in healthcare practice and change over time

The application of AI tools in healthcare practice was extracted during the full-text review phase of the umbrella review. As shown in Figure 8, the distribution of AI healthcare applications, diagnosis, prognosis, and treatment comprised over 80% of the applications in all the reviews. This pattern takes into account that one review may have multiple applications reported. Figure 9 shows the application of AI in healthcare over time. Similarly, the aforementioned three applications comprise a majority of the data types each year. An additional trend is the appearance of other applications in 2023 through 2024, showing that new applications are emerging.

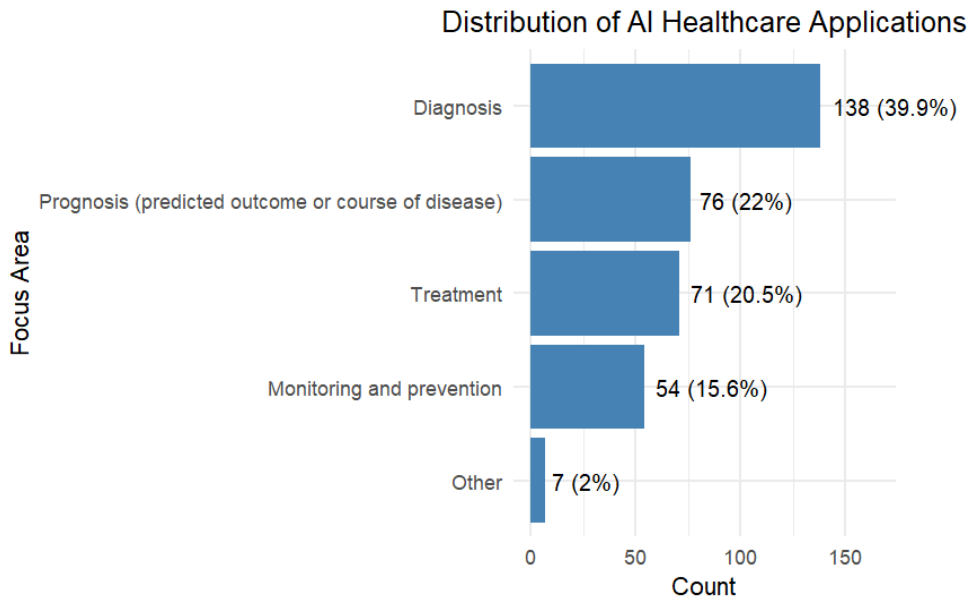

Fig. 8. Distribution of AI healthcare applications

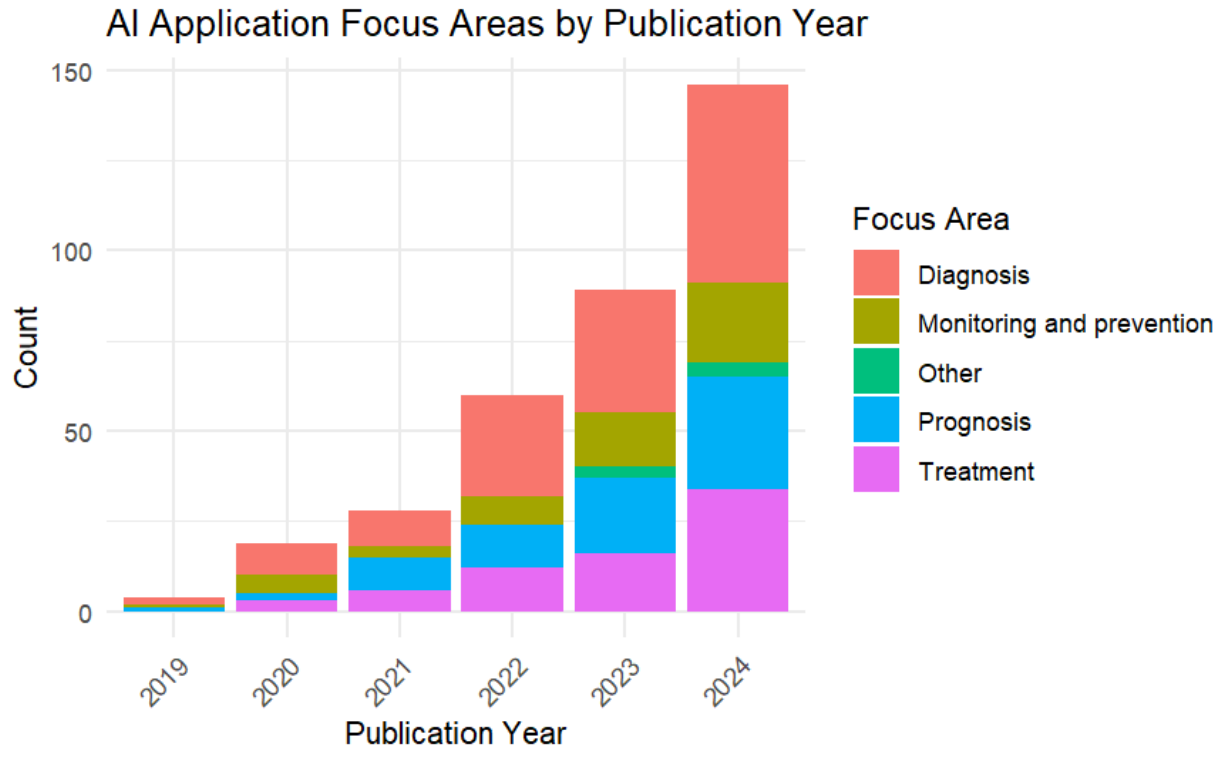

Fig. 9. Distribution of AI healthcare applications over time

3.3.1. Narrative review of the application of AI tools in healthcare practice

AI applications in healthcare have rapidly expanded, with diagnosis, prognosis, and treatment dominating the landscape. This trend is reflected consistently across umbrella review data, where these three categories comprise over 80% of applications. Diagnosis, defined as identifying a disease, condition, or injury based on signs and symptoms, was the leading AI application every year (NCI, 2011). For example, AI tools in radiology have demonstrated strong diagnostic capabilities in fracture detection. A meta-analysis by Wong et al. (2024) reported that AI models for diagnosing hand and wrist fracture and dislocation yielded high accuracy, with an Area under the curve (AUC) of 0.946. They recommended prospective external validation to further test the accuracy of these models. Other articles (e.g., Voelker, 2018; Zech et al., 2022), outside the scope of this umbrella review, indicate that fracture detection models have received FDA approval and the models are used to aid clinical decision-making, not replace it.

The second most common AI application was prognosis, which is defined as the predicted outcome or course of a disease, including the chance of recovery or recurrence (NCI, 2011). For example, ML applications for prognosis in lung cancer have demonstrated higher discriminative ability than traditional logistic regression models, with analyses showing improved survival prediction accuracy (Didier, 2024). Ullah et al. (2024) showed that ML had similar discriminative ability in prognosing abdominal aortic aneurysms. The authors of both reviews reported that ML holds promise for more accurate prognosis and enhancing personalized treatment strategies. In addition, both reviews emphasized that further validation using prospective data is required before widespread clinical adoption.

Treatment-based AI models research has increased dramatically in recent years. Obimba et al. (2024) reviewed AI technologies in cancer treatment for older adults, synthesizing evidence across seven studies on lung, breast, and gastrointestinal cancers. The authors found that while AI-assisted approaches such as treatment planning tools (e.g., Watson for Oncology, ChatGPT) show promise, their effectiveness for older adults was generally comparable to or less effective than standard care. Pressman et al. (2024) reported that LLMs have significant potential to assist during the preoperative, intraoperative, and postoperative phases of surgical care, including risk assessment, patient education, and real-time surgical guidance. Other empirical research, outside the scope of this umbrella review, indicates that an AI-powered surgical robot and platform has recently received FDA approval and has been implemented in clinical practice (Cadière et al., 2024).

AI model research focused on monitoring and prevention has also increased in recent years. For example, Moffat and Xu (2022) compared the performance of ML models with the Modified Early Warning Score (MEWS) to monitor for risk of in-hospital cardiac arrest (IHCA). The MEWS score is a risk assessment tool used to identify patients who may need an increased level of care. Utilizing MEWS can allow for earlier detection or prevention of adverse medical events

such as IHCA. The results showed ML models had similar or superior performance compared to MEWS; however, variability in study design and data sources limits generalizability. Leghissa et al. (2023) investigated ML models' ability to detect or predict frailty in elderly people. Earlier detection or prediction of frailty can lead to more effective treatment and more optimal allocation of resources. The results were inconclusive due to varying definitions of frailty and data sources to build models.

Beyond traditional clinical applications, new domains are emerging. For example, Salman et al. (2023) investigated the use of AI models to predict total knee arthroplasty implant component sizes. The authors reported moderate to high accuracy in the review. Sacoransky et al. (2024) investigated the use of LLMs to generate structured radiology reports. The authors concluded that LLMs demonstrate the capability to generate reports and save radiologists' time and resources. Overall, the use of LLMs to assist in clinical documentation has advanced significantly in the past two years. New applications of AI tools are emerging in healthcare practice, and further growth of this trend is possible moving forward.

3.4. RQ4a and b: Ethical concerns and change over time

We extracted the ethical concerns reported in the results, discussion, or conclusion of the reviews. Ethical concerns include data privacy, model accuracy, data and algorithm bias, and explainability. Figure 10 shows that the majority of reviews report ethical concerns (64.6% Yes and 35.4% No). The count of ethical concerns reported increased each year from 2021 through 2024(Figure 11). The increasing proportion of reviews reporting ethical concerns suggests growing awareness and perceived challenges.

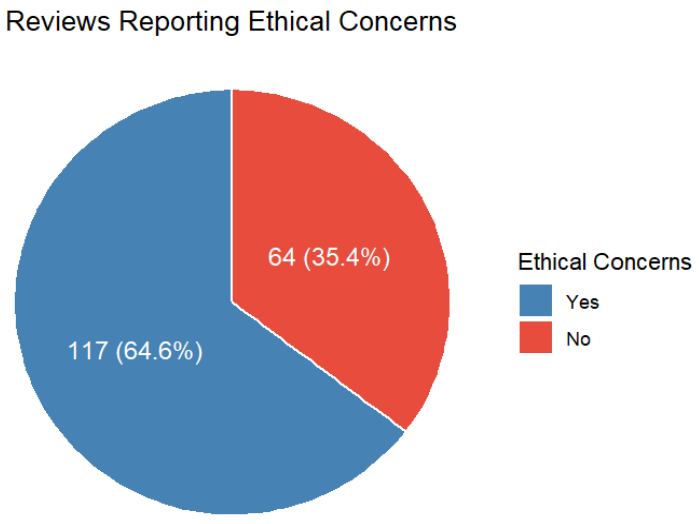

Fig. 10. Ethical concerns reported by the review authors

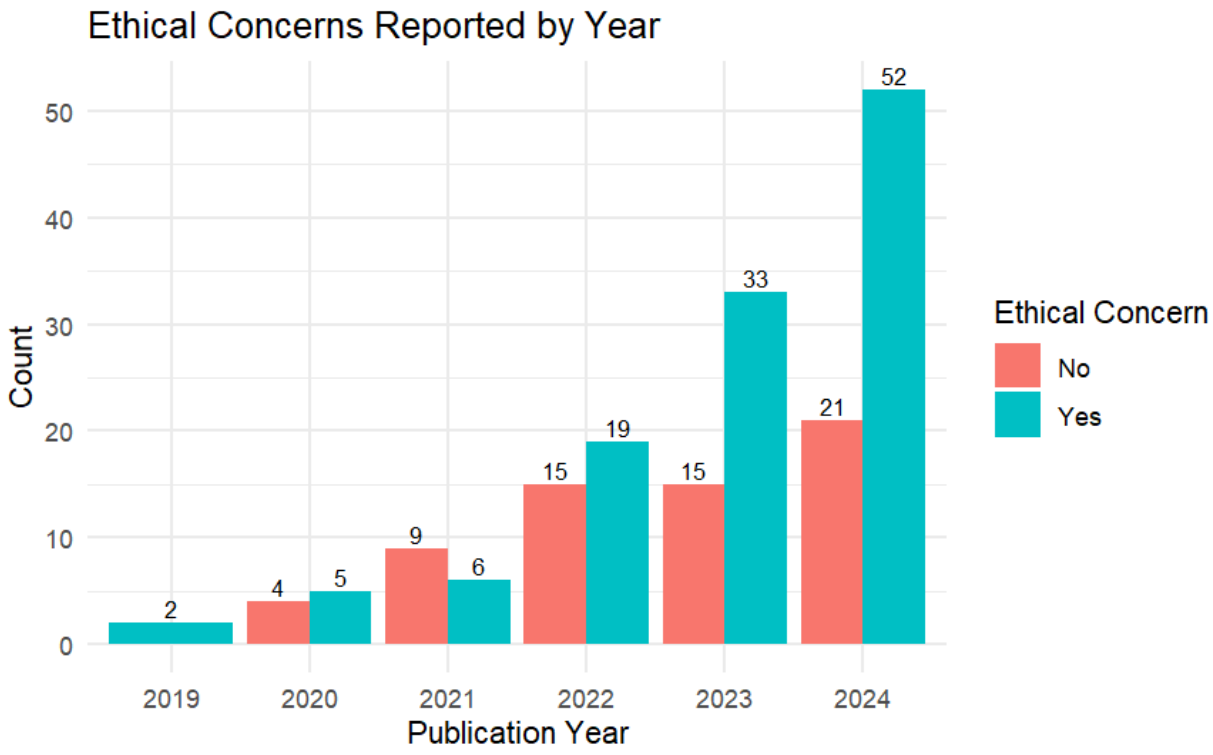

Fig. 11. Ethical concerns reported by the review authors over time

3.4.1. Narrative review of ethical concerns

Ethical concerns in the reviews ranged from data privacy issues, model accuracy, data and algorithmic bias, and explainability concerns. Each of these ethical concerns has the potential to compromise patient safety.

Data Privacy. AI models require extensive use of healthcare data. In the United States, some of this data may be protected by legislation such as the Health Insurance Portability and Accountability Act (HIPAA) (HHS, 2021). In the review of Kitsios et al. (2023), the authors emphasized that healthcare organizations should ensure that protocols and protections are in place to gain consent for and secure the collection and use of data to train models. Ali et al. (2023) discussed concerns about protecting patient data that is fed into the model once it is implemented. The risk of a data breach is a serious threat that has unfortunately become commonplace. The authors emphasized the importance of regulation and safeguards to ensure that health data is secure.

Model Accuracy. In their review of early cancer diagnosis using primary care data, Jones et al. (2021) recommended that prospective data is needed to further validate AI models for implementation in practice, in addition to the retrospective data. Plana et al. (2022) also

recommended more rigorous validation in their review. Specifically, they suggested that more randomized clinical trials (RCTs) are needed to further test the accuracy of AI models, given that the FDA has approved 343 AI applications, but they found that only 41 RCTs have been reported. Xavier et al. (2024) suggested that algorithm performance should be available for healthcare professionals and leaders to make informed decisions regarding which models are the most accurate. This is especially relevant for LLMs given their tendency to hallucinate or generate false content. Veneziani et al. (2024) reported additional concerns about model accuracy. Specifically, the algorithms to interpret subtle emotional and behavioral cues are limited during patient evaluations. The authors recommended that clinicians must find a balance between integrating AI technology without sacrificing the human connection and reasoning that are essential to clinical decision making.

Data and Algorithmic Bias. In their review of AI applications used in the detection, management, and prognosis of bone metastases, Papalia et al. (2024) reported that ensuring diverse data sets representing different patient populations is essential for safe adoption, because the diverse data allows for generalizability and widespread implementation. Radaelli et al. (2024) also reported that the effectiveness of AI models is limited by the quality of data used to train the models. For example, if a dataset does not contain certain variables, e.g.,blood culture data to predict infections, this missing data may lead to bias and limit the generalizability of the model. In their review of AI applications for clinical decision support in acute ischemic stroke, Akay et al. (2023) emphasized the need for high-quality training and validation data. Biased or incomplete data could lead to flawed predictions and potential patient harm. They recommended policy requirements for data used to build and validate AI models.

Explainability. Javidan et al. (2022) reported concerns about the “black box” dilemma that algorithms present. That is, many AI applications lack explainability. Explainability is especially challenging with deep learning models, which often make it difficult to interpret how predictors contribute to a specific output. As AI models become more advanced and complex, explainability decreases about how an output is generated. The decrease in explainability can make decision-making more challenging than ever.

4. Discussion

4.1. RQ1: Characteristics of AI applications in healthcare practice

The steady increase in the number of systematic reviews from 2019 to 2024 highlights the accelerating interest in and adoption of AI applications in healthcare. While earlier years (2019–2020) may have smaller sample sizes due to the emerging nature of this research field, the peak in 2024 suggests that AI has transitioned from a niche focus to a mainstream research priority. This trend mirrors broader trends in AI adoption across industries, particularly as healthcare organizations seek solutions for diagnostic efficiency, predictive modeling, and operational improvement.

Geographically, the dominance of first authors from the United States, United Kingdom, Australia, India, China, Italy, and Saudi Arabia reflects both the concentration of AI research infrastructure and the policy environments that support innovation in these countries. The breadth of 133 journals publishing on this topic underscores the interdisciplinary nature of AI in healthcare and indicates that the research community is distributed across clinical, technical, and policy-oriented outlets.

The network effect observed between medical specialties, diseases/conditions, and other themes suggests that certain domains (e.g., radiology, critical care, cancer) act as "AI research hubs" where tool development and validation are more advanced. Underrepresented areas, such as geriatric and gynecologic disease, may represent untapped opportunities. Targeting these gaps could broaden the impact of AI in healthcare beyond its current strongholds.

4.2. RQ2a and b: Healthcare data types used to train AI models and change over time

Diagnostic imaging, EHR data, and biomarkers/laboratory results consistently dominate as training data sources, accounting for about 70% of all data types across reviews. This dominance reflects their availability, structure, and established role in clinical decision-making. Kolasa et al. (2024) reported a similar finding in their umbrella review, with the three data types accounting for 75% of all data types. Imaging data, in particular, benefits from decades of digitization, making it ideal for deep learning applications. EHR data offers breadth, capturing demographic, clinical, and billing information, but challenges remain in standardization, interoperability, and data quality.

The emergence of wearable device data, sensor data, and other nontraditional sources from 2022 onward represents a shift toward continuous, real-world data capture. Emerging data types, such as AI-assisted hypertension detection and predictive models for appointment no-shows, illustrate the expanding scope of what constitutes "healthcare data." The expansion in healthcare data could enable more proactive, precise, convenient, and personalized healthcare, because it integrates continuous, real-world physiological data rather than only relying on traditional health data. However, the new data types also raise issues of integration, privacy, regulatory oversight, access to devices, and bias mitigation.

4.3. RQ3a and b: Application of AI tools in healthcare practice and change over time

Diagnosis, prognosis, and treatment remain the dominant AI applications, which align with the clinical imperative to improve patient outcomes through better detection, risk stratification, and intervention planning. The high accuracy reported for diagnostic tasks, such as fracture detection and diabetic retinopathy screening, demonstrates AI's potential to aid or partially automate specialized tasks. Prognostic models, particularly in critical care settings, show promise for enabling earlier, targeted interventions. Using AI for treatment has increased every year but remains at an early stage, with research focusing on more retrospective data. However, promising advances are happening with surgical care and AI-powered robotics.

The appearance of newer applications in 2023-2024, such as LLMs for documentation and AI-assisted surgical planning, suggests that AI's role is expanding beyond traditional clinical endpoints. These applications could have downstream benefits in workflow efficiency, patient communication, and cost containment. Consequently, these applications can significantly reduce administrative burden for clinicians, allow more time for direct patient interaction, and improve the quality of patient records for subsequent care. However, the translation of novel applications into routine practice will depend on robust validation, regulatory approval, and integration into existing clinical workflows.

4.4. RQ4a and b: Ethical concerns and change over time

The upward trend in both the number and proportion of reviews citing ethical concerns reflects growing awareness of the risks and unintended consequences of AI in healthcare. The most frequently cited issues include data privacy, model inaccuracy, data and algorithmic bias, and explainability, which align with themes in broader AI ethics discourse. The "black box" challenge or the lack of explainability, in particular, underscores tension between accuracy and interpretability, especially for deep learning models.

The persistence of these concerns suggests that technical advances alone will be insufficient. The H-AI-H model of human + AI integration is essential to ensure ethical oversight. Progress in governance, regulation, and stakeholder engagement is essential. Strategies such as bias audits, explainable AI methods, and benchmarking standards for validation could help address these concerns. Moreover, ethical considerations are likely to become more complex as data sources diversify and applications expand, making interdisciplinary collaboration critical between clinicians, data scientists, ethicists, and policymakers. Overall, further research is warranted to ensure safety and earn the trust of regulators, clinicians, and patients.

5. Conclusions and Limitations

5.1. Major Findings

This umbrella review makes several key contributions to the understanding of AI applications in healthcare practice. First, we synthesized evidence from 181 systematic reviews to characterize AI in healthcare across multiple dimensions, including publication trends, geographic distribution, thematic focus, and medical specialties. We identified high-density research areas, such as radiology, oncology, and critical care, alongside underrepresented specialties and conditions, highlighting opportunities for future investigation.

Second, we analyzed the types of healthcare data used to train AI models. Diagnostic imaging, EHR data, and biomarkers/laboratory results accounted for approximately 70% of data sources, reflecting their accessibility and clinical relevance. However, emerging sources such as wearable device and sensor data indicate a shift toward continuous, real-world data capture, with implications for personalized care and operational efficiency.

Third, we examined AI applications in healthcare practice and found that diagnosis, prognosis, and treatment dominate the current landscape. Reviews in later years showed the emergence of novel applications, including the use of LLMs for clinical documentation and AI tools for operational decision-making.

Fourth, we documented an upward trend in reported ethical concerns, with bias, privacy, safety, transparency, and explainability emerging as recurring themes. The growing prevalence of such concerns suggests an increasing awareness of the governance, regulatory, and trust-building requirements for successful AI adoption in healthcare.

Collectively, these findings provide a panoramic view of the AI healthcare literature and can help researchers, clinicians, and policymakers identify both the existing AI applications in healthcare practices and critical gaps that warrant further exploration.

5.2 Limitations and Implications

Despite efforts to ensure a comprehensive synthesis, several limitations should be acknowledged. First, while our search spanned multiple major academic databases and was updated through November 2024, relevant systematic reviews may have been missed if they were indexed outside these sources, published after our cutoff date, written in languages other than English, or reported in the grey literature. As AI in healthcare is evolving rapidly, future umbrella reviews should incorporate incoming publications to capture new developments.

Second, we focused exclusively on systematic reviews that reported applications of AI in healthcare practice. Reviews that examined AI algorithms without discussing their clinical or operational applications were excluded. Although this exclusion aligns with our practice-oriented scope, reviews on AI technical development merit separate synthesis to provide complementary insights into algorithmic innovation.

Third, the heterogeneity of included reviews, spanning diverse clinical specialties, data types, and evaluation methods, limited our ability to perform pooled quantitative analyses. Our synthesis relied on reported findings, which may be influenced by varying review quality, incomplete reporting, and differing definitions of AI. While we described thematic and temporal trends, the absence of standardized metrics across reviews constrains direct comparisons among these reviews.

Finally, our scope excluded AI applications in adjacent domains such as public health, healthcare research, healthcare administration, and health professions education. These areas may represent significant opportunities for AI-driven applications and should be explored in future reviews. In sum, this umbrella review underscores the rapid expansion, concentration, and diversification of AI applications in healthcare. Meanwhile, it also draws attention to the ethical, methodological, and policy challenges that must be addressed to successfully integrate AI into healthcare practice and improve health outcomes and efficiency.

References

Akay, E. M. Z., Hilbert, A., Carlisle, B. G., Madai, V. I., Mutke, M. A., & Frey, D. (2023). Artificial intelligence for clinical decision support in acute ischemic stroke: A systematic review. *Stroke,* 54(6), 1505–1516. 10.1161/STROKEAHA.122.041442

Ali, O., Abdelbaki, W., Shrestha, A., Elbasi, E., Alryalat, M. A. A., & Dwivedi, Y. K. (2023). A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities. *Journal of Innovation & Knowledge,* 8(1), 100333. 10.1016/j.jik.2023.100333

Anderson, P. G., Baum, G. L., Keathley, N., Sicular, S., Venkatesh, S., Sharma, A., Daluiski, A., Potter, H., Hotchkiss, R., Lindsey, R. V., & Jones, R. M. (2023). Deep learning assistance closes the accuracy gap in fracture detection across clinician types. *Clinical Orthopaedics and Related Research,* 481(3), 580–588. 10.1097/CORR.0000000000002385

Bhargava, A., Carlos López-Espina, Schmalz, L., Khan, S., Watson, G. L., Urdiales, D., Updike, L., Kurtzman, N., Dagan, A., Doodlesack, A., Stenson, B. A., Sarma, D., Reseland, E., Lee, J. H.,Kravitz, M. S., Antkowiak, P. S., Shvilkina, T., Espinosa, A., Halalau, A., Shapiro, N. I. (2024). FDA-Authorized AI/ML tool for sepsis prediction: Development and validation. *NEJM AI*,1(12), 10.1056/AIoa2400867

Bouderhem, R. (2024). Shaping the future of AI in healthcare through ethics and governance. *Humanities and Social Sciences Communications,* 11(1), 416. 10.1057/s41599-024-02894-w

Buijs, E., Maggioni, E., Mazziotta, F., Lega, F., & Carrafiello, G. (2024). Clinical impact of AI in radiology department management: a systematic review. *La Radiologia Medica,* 129(11), 1656–1666. 10.1007/s11547-024-01880-1

Cadière, G., Himpens, J., Poras, M., Boyer, N., & Cadière, B. (2024). Feasibility and safety study of the use of a new robot (Maestro™) for laparoscopic surgery. *Obesity Surgery,* 34(9), 3561–3568. 10.1007/s11695-024-07409-9

Cicek, V., & Bagci, U. (2025). Position of artificial intelligence in healthcare and future perspective. *Artificial Intelligence in Medicine,* 167, 103193. 10.1016/j.artmed.2025.103193

Definition of diagnosis - NCI Dictionary of Cancer Terms - NCI (2011, -02-02). Retrieved Sep 9, 2025, from https://www.cancer.gov/publications/dictionaries/cancer-terms/def/diagnosis

Definition of prognosis - NCI Dictionary of Cancer Terms - NCI (2011, -02-02). Retrieved Sep 26, 2025, from https://www.cancer.gov/publications/dictionaries/cancer-terms/def/prognosis

Didier, A. J., Nigro, A., Noori, Z., Omballi, M. A., Pappada, S. M., & Hamouda, D. M. (2024). Application of machine learning for lung cancer survival prognostication—A systematic

review and meta-analysis. *Frontiers in Artificial Intelligence,* 7, 10.3389/frai.2024.1365777

Goktas, P., & Grzybowski, A. (2025). Shaping the future of healthcare: Ethical clinical challenges and pathways to trustworthy AI. *Journal of Clinical Medicine,* 14(5), 1605. 10.3390/jcm14051605

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Information and Libraries Journal,* 26(2), 91–108. 10.1111/j.1471-1842.2009.00848.

Grzybowski, A., Jin, K., Zhou, J., Pan, X., Wang, M., Ye, J., & Wong, T. Y. (2024). Retina fundus photograph-based artificial intelligence algorithms in medicine: A Systematic review. *Ophthalmology and Therapy, 13*(8), 2125–2149. 10.1007/s40123-024-00981-4

Gudigar, A., Kadri, N. A., Raghavendra, U., Samanth, J., Maithri, M., Inamdar, M. A., Prabhu, M. A., Hegde, A., Salvi, M., Yeong, C. H., Barua, P. D., Molinari, F., & Acharya, U. R. (2024). Automatic identification of hypertension and assessment of its secondary effects using artificial intelligence: A systematic review (2013-2023). *Computers in Biology and Medicine,* 172, 108207. 10.1016/j.compbiomed.2024.108207

Human-Centered Artificial Intelligence in Schools. Retrieved Sep 9, 2025, from https://ospi.k12.wa.us/student-success/resources-subject-area/human-centered-artificial-intelligence-school

Islam, M. M., Yang, H., Poly, T. N., Jian, W., & Jack Li, Y. (2020). Deep learning algorithms for detection of diabetic retinopathy in retinal fundus photographs: A systematic review and meta-analysis. *Computer Methods and Programs in Biomedicine,* 191, 105320. 10.1016/j.cmpb.2020.105320

Javidan, A. P., Li, A., Lee, M. H., Forbes, T. L., & Naji, F. (2022). A systematic review and bibliometric analysis of applications of artificial intelligence and machine learning in vascular surgery. *Annals of Vascular Surgery,* 85, 395–405. 10.1016/j.avsg.2022.03.019

Jones, O. T., Calanzani, N., Saji, S., Duffy, S. W., Emery, J., Hamilton, W., Singh, H., de Wit, N.J., & Walter, F. M. (2021). Artificial intelligence techniques that may be applied to primary care data to facilitate earlier diagnosis of cancer: Systematic review. *Journal of Medical Internet Research,* 23(3), e23483. 10.2196/23483

Kitsios, F., Kamariotou, M., Syngelakis, A. I., & Talias, M. A. (2023). Recent advances of artificial intelligence in healthcare: A systematic literature review. *Applied Sciences,* 13(13), 7479. 10.3390/app13137479

Kolasa, K., Admassu, B., Hołownia-Voloskova, M., Kędzior, K. J., Poirrier, J., & Perni, S. (2024). Systematic reviews of machine learning in healthcare: a literature review. *Expert Review of Pharmacoeconomics & Outcomes Research,* 24(1), 63–115. 10.1080/14737167.2023.2279107

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159–174. https://pubmed.ncbi.nlm.nih.gov/843571/

Leading causes of death worldwide 2021 . Retrieved Sep 10, 2025, from https://www.statista.com/statistics/1488587/leading-causes-of-death-worldwide-2021/

Leghissa, M., Carrera, Á, & Iglesias, C. A. (2023). Machine learning approaches for frailty detection, prediction and classification in elderly people: A systematic review. *International Journal of Medical Informatics, 178*, 105172. 10.1016/j.ijmedinf.2023.105172

Liu, Y., Han, T., Ma, S., Zhang, J., Yang, Y., Tian, J., He, H., Li, A., He, M., Liu, Z., Wu, Z., Zhao, L., Zhu, D., Li, X., Qiang, N., Shen, D., Liu, T., & Ge, B. (2023). Summary of ChatGPT-related research and perspective towards the future of large language models. *Meta-Radiology,* 1(2), 100017. 10.1016/j.metrad.2023.100017

Liu, Z., Li, Y., Shu, P., Zhong, A., Jiang, H., Pan, Y., Yang, L., Ju, C., Wu, Z., Ma, C., Chen, C., Kim, S., Dai, H., Zhao, L., Sun, L., Zhu, D., Liu, J., Liu, W., Shen, D., . . . Li, X. (2025). Radiology-GPT: A large language model for radiology. *Meta-Radiology,* 3(2), 100153. 10.1016/j.metrad.2025.100153

Loh, H. W., Ooi, C. P., Seoni, S., Barua, P. D., Molinari, F., & Acharya, U. R. (2022). Application of explainable artificial intelligence for healthcare: A systematic review of the last decade (2011–2022). *Computer Methods and Programs in Biomedicine,* 226, 107161.10.1016/j.cmpb.2022.107161

Lång, K., Josefsson, V., Larsson, A., Larsson, S., Högberg, C., Sartor, H., Hofvind, S., Andersson, I., & Rosso, A. (2023). Artificial intelligence-supported screen reading versus standard double reading in the mammography screening with artificial intelligence trial (MASAI): A clinical safety analysis of a randomised, controlled, non-inferiority, single-blinded, screening accuracy study. *The Lancet Oncology, 24*(8), 936–944. 10.1016/S1470-2045(23)00298-X

Moffat, L. M., & Xu, D. (2022). Accuracy of machine learning models to predict in-hospital cardiac arrest: A systematic review. *Clinical Nurse Specialist CNS, 36*(1), 29–44. 10.1097/NUR.0000000000000644

Narasimha Rao, K. V. K. L., Dadabada, P. K., & Jaipuria, S. (2024). A systematic literature review of predictive analytics methods for early diagnosis of neonatal sepsis. *Discover Public Health,* 21(1), 96. 10.1186/s12982-024-00219-5

Obimba, D. C., Esteva, C., Nzouatcham Tsicheu, E. N., & Wong, R. (2024). Effectiveness of artificial intelligence technologies in cancer treatment for older adults: A Systematic review. *Journal of Clinical Medicine,* 13(17), 4979. 10.3390/jcm13174979

Oberije, C. J. G., Currie, R., Leaver, A., Redman, A., Teh, W., Sharma, N., Fox, G., Glocker, B., Khara, G., Nash, J., Ng, A. Y., & Kecskemethy, P. D. (2025). Assessing artificial intelligence in breast screening with stratified results on 306,839 mammograms across geographic regions, age, breast density and ethnicity: A retrospective investigation evaluating screening (ARIES) study. *BMJ Health & Care Informatics,* 32(1), e101318. 10.1136/bmjhci-2024-101318

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ,* 372, n71. 10.1136/bmj.n71

Pacurari, A. C., Bhattarai, S., Muhammad, A., Avram, C., Mederle, A. O., Rosca, O., Bratosin, F., Bogdan, I., Fericean, R. M., Biris, M., Olaru, F., Dumitru, C., Tapalaga, G., & Mavrea, A. (2023). Diagnostic accuracy of machine learning AI architectures in detection and classification of lung cancer: A systematic review. *Diagnostics,* 13(13), 2145. 10.3390/diagnostics13132145

Papalia, G. F., Brigato, P., Sisca, L., Maltese, G., Faiella, E., Santucci, D., Pantano, F., Vincenzi, B., Tonini, G., Papalia, R., & Denaro, V. (2024). Artificial intelligence in detection, management, and prognosis of bone metastasis: A systematic review. *Cancers,* 16(15), 2700. 10.3390/cancers16152700

Plana, D., Shung, D. L., Grimshaw, A. A., Saraf, A., Sung, J. J. Y., & Kann, B. H. (2022). Randomized clinical trials of machine learning interventions in health care: A systematic review. *JAMA Network Open,* 5(9), e2233946. 0.1001/jamanetworkopen.2022.33946

Pressman, S. M., Borna, S., Gomez-Cabello, C. A., Haider, S. A., Haider, C. R., & Forte, A. J. (2024). Clinical and surgical applications of large language models: A systematic review. *Journal of Clinical Medicine*, 13(11), 3041. 10.3390/jcm13113041

Radaelli, D., Di Maria, S., Jakovski, Z., Alempijevic, D., Al-Habash, I., Concato, M., Bolcato, M., & D'Errico, S. (2024). Advancing patient safety: The future of artificial intelligence in mitigating healthcare-associated infections: A systematic review. *Healthcare (Basel, Switzerland),* 12(19), 1996. 10.3390/healthcare12191996

Rashid, M., Ramakrishnan, M., Chandran, V. P., Nandish, S., Nair, S., Shanbhag, V., & Thunga, G. (2022). Artificial intelligence in acute respiratory distress syndrome: A systematic review. *Artificial Intelligence in Medicine,* 131, 102361. 10.1016/j.artmed.2022.102361

Rights (OCR), O. f. C. (2021, -06-09). *Health Information Privacy.* Retrieved Sep 17, 2025, from https://www.hhs.gov/hipaa/index.html

Ruksakulpiwat, S., Thorngthip, S., Niyomyart, A., Benjasirisan, C., Phianhasin, L., Aldossary, H., Ahmed, B. H., & Samai, T. (2024). A systematic review of the application of artificial intelligence in nursing care: Where are we, and what's next? *Journal of Multidisciplinary Healthcare,* 17, 1603–1616. 10.2147/JMDH.S459946

Sacoransky, E., Kwan, B. Y. M., & Soboleski, D. (2024). ChatGPT and assistive AI in structured radiology reporting: A systematic review. *Current Problems in Diagnostic Radiology,* 53(6), 728–737. 10.1067/j.cpradiol.2024.07.007

Salman, L. A., Khatkar, H., Al-Ani, A., Alzobi, O. Z., Abudalou, A., Hatnouly, A. T., Ahmed, G., Hameed, S., & Al Ateeq Aldosari, M. (2024). Reliability of artificial intelligence in predicting total knee arthroplasty component sizes: a systematic review. *European*

Journal of Orthopaedic Surgery & Traumatology: Orthopedie Traumatologie, 34(2), 747–756. 10.1007/s00590-023-03784-8

Ullah, N., Kiu Chou, W., Vardanyan, R., Arjomandi Rad, A., Shah, V., Torabi, S., Avavde, D., Airapetyan, A. A., Zubarevich, A., Weymann, A., Ruhparwar, A., Miller, G., & Malawana, J. (2024). Machine learning algorithms for the prognostication of abdominal aortic aneurysm progression: a systematic review. *Minerva Surgery,* 79(2), 219–227. 10.23736/S2724-5691.23.10130-4

Veneziani, I., Marra, A., Formica, C., Grimaldi, A., Marino, S., Quartarone, A., & Maresca, G. (2024). Applications of artificial intelligence in the neuropsychological assessment of dementia: A systematic review. *Journal of Personalized Medicine,* 14(1), 113. 10.3390/jpm14010113

Voelker, R. (2018). Diagnosing fractures with AI. *JAMA,* 320(1), 23. 10.1001/jama.2018.8565

Wong, C. R., Zhu, A., & Baltzer, H. L. (2024). The accuracy of artificial intelligence models in hand/wrist fracture and dislocation diagnosis: A systematic review and meta-analysis. *JBJS Reviews,* 12(9)10.2106/JBJS.RVW.24.00106

Xavier, D., Miyawaki, I., Campello Jorge, C. A., Freitas Silva, G. B., Lloyd, M., Moraes, F., Patel, B., & Batalini, F. (2024). Artificial intelligence for triaging of breast cancer screening mammograms and workload reduction: A meta-analysis of a deep learning software. *Journal of Medical Screening,* 31(3), 157–165. 10.1177/09691413231219952

Xu, D., & Xu, Z. (2024). Machine learning applications in preventive healthcare: A systematic literature review on predictive analytics of disease comorbidity from multiple perspectives. *Artificial Intelligence in Medicine,* 156, 102950. 10.1016/j.artmed.2024.102950

Zech, J. R., Santomartino, S. M., & Yi, P. H. (2022). Artificial intelligence (AI) for fracture diagnosis: An overview of current products and considerations for clinical adoption, From the AJR special series on AI applications. *AJR. American Journal of Roentgenology,* 219(6), 869–878. 10.2214/AJR.22.27873

Zöller, N., Berger, J., Lin, I., Fu, N., Komarneni, J., Barabucci, G., Laskowski, K., Shia, V., Harack, B., Chu, E. A., Trianni, V., Kurvers, R. H. J. M., & Herzog, S. M. (2025). Human-AI collectives most accurately diagnose clinical vignettes. *Proceedings of the National Academy of Sciences of the United States of America,* 122(24), e2426153122. 10.1073/pnas.2426153122

Appendix A. The systematic reviews included in this umbrella review

Author/Year	Title	Journal Name	Country/Region of the First author	Theme/Focus
Abdul 2024	Applications of artificial intelligence in the field of oral and maxillofacial pathology: a systematic review and meta-analysis.	BMC Oral Health	Saudi Arabia	Oral and Maxillofacial Pathology
Abdulazeem 2023	A systematic review of clinical health conditions predicted by machine learning diagnostic and prognostic models trained or validated using real-world primary health care data.	PLOS ONE	Germany	Primary Health Care
Aghakhani 2024	Machine Learning Models for Predicting Sudden Sensorineural Hearing Loss Outcome: A Systematic Review.	Annals of Otology, Rhinology, & Laryngology	Iran	Sensorineural Hearing Loss

Aharonu 2023	Systematic Review of Deep Learning Techniques for Lung Cancer Detection	International Journal of Advanced Computer Science and Applications	India	Lung Cancer
Ahmad 2024	Artificial intelligence and machine learning in neurosurgery: A review of diagnostic significance and treatment planning efficiency	West African Journal of Radiology	Saudi Arabia	Neurosurgery
Akay 2023	Artificial Intelligence for Clinical Decision Support in Acute Ischemic Stroke: A Systematic Review.	Stroke	Germany	Acute Ischemic Stroke
Aleksandra 2024	Artificial Intelligence in Optimizing the Functioning of Emergency Departments; a Systematic Review of Current Solutions.	Archives of Academic Emergency Medicine	Poland	Emergency Departments
Alhalafi 2024	Utilizing Artificial Intelligence Among	Cureus	Saudi Arabia	Diabetes

	Patients With Diabetes: A Systematic Review and Meta-Analysis.			
Alhasan 2021	Clinical Applications of Artificial Intelligence, Machine Learning, and Deep Learning in the Imaging of Gliomas: A Systematic Review.	Cureus	Saudi Arabia	Gliomas
Ali 2023	A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities	Journal of Innovation & Knowledge	Kuwait	Healthcare
Allaume 2023	Artificial Intelligence-Based Opportunities in Liver Pathology-A Systematic Review.	Diagnostics	France	Liver Pathology
Allen 2024	The Promise of Explainable AI in Digital Health for Precision Medicine: A Systematic Review.	Journal of Personalized Medicine	USA	Precision Medicine

Alnahedh 2024	Role of Machine Learning and Artificial Intelligence in the Diagnosis and Treatment of Refractive Errors for Enhanced Eye Care: A Systematic Review.	Cureus	Saudi Arabia	Refractive Errors for Enhanced Eye Care
Alsaleh 2023	Prediction of disease comorbidity using explainable artificial intelligence and machine learning techniques: A systematic review.	International Journal of Medical Informatics	United Kingdom, Saudi Arabia	Disease comorbidity
Amin 2023	Artificial Intelligence to Improve Antibiotic Prescribing: A Systematic Review.	Antibiotics	Ireland	Antibiotic Prescribing
Aversano 2023	A systematic review on artificial intelligence techniques for detecting thyroid diseases	PeerJ Computer Science	Italy	Thyroid Disease
Awang 2024	Deep learning techniques for	Health Science Reports	Malaysia	Alzheimer's disease

	Alzheimer's disease detection in 3D imaging: A systematic review			
Baddal 2024	Harnessing of Artificial Intelligence for the Diagnosis and Prevention of Hospital-Acquired Infections: A Systematic Review.	Diagnostics	Turkey	Hospital-Acquired Infections
Badr 2022	Performance of artificial intelligence using oral and maxillofacial CBCT images: A systematic review and meta-analysis.	Nigerian Journal of Clinical Practice	Saudi Arabia	Oral and Maxillofacial
Baker 2023	Machine learning for understanding and predicting neurodevelopmental outcomes in premature infants: a systematic review.	Pediatric research	Australia	Neonatology
Balakrishnan 2023	Machine learning approaches in	Progress in Biophysics and Molecular Biology	Malaysia	Tuberculosis

	diagnosing tuberculosis through biomarkers - A systematic review.			
Bali 2024	Analysis of Deep Learning Techniques for Prediction of Eye Diseases: A Systematic Review	Archives of Computational Methods in Engineering	India	Eye diseases
Balla 2023	Pediatrics in Artificial Intelligence Era: A Systematic Review on Challenges, Opportunities, and Explainability	Indian Pediatrics	United Kingdom	Pediatrics
Barrera 2023	Application of machine learning and artificial intelligence in the diagnosis and classification of polycystic ovarian syndrome: a systematic review	Frontiers in Endocrinology	United States	Polycystic ovarian syndrome
Beculic 2024	Sensitivity and specificity of machine learning and deep	Brain and Spine	Bosnia and Herzegovina	Vertebral fractures

	learning algorithms in the diagnosis of thoracolumbar injuries resulting in vertebral fractures: A systematic review and meta-analysis.			
Bedi 2024	Testing and Evaluation of Health Care Applications of Large Language Models: A Systematic Review.	Journal of the American Medical Association	United States	Not specified
Bektas 2022	Machine Learning Algorithms for Predicting Surgical Outcomes after Colorectal Surgery: A Systematic Review.	World Journal of Surgery	The Netherlands	Colorectal surgery
Bellini 2022	Machine learning in perioperative medicine: a systematic review.	Journal of Anesthesia, Analgesia and Critical Care	Italy	Perioperative medicine
Ben-Israel 2020	The impact of machine learning on patient care: A systematic review.	Artificial Intelligence In Medicine	Canada	Not specified

Bertini 2021	Using Machine Learning to Predict Complications in Pregnancy: A Systematic Review.	Frontiers in Bioengineering and Biotechnology	Chile	Pregnancy
Bhardwaj 2022	An Investigational Approach for the Prediction of Gastric Cancer Using Artificial Intelligence Techniques: A Systematic Review	Archives of Computational Methods in Engineering	India	Gastric Cancer
Buijs 2024	Clinical impact of AI in radiology department management: a systematic review.	La radiologia medica	Italy	Radiology
Cao 2023	Machine Learning in Diagnosing Middle Ear Disorders Using Tympanic Membrane Images: A Meta-Analysis	The Laryngoscope	United Kingdom	Middle ear disorders
Chan 2023	Diagnostic Test Accuracy of artificial intelligence-assisted detection of acute	Computers in Biology and Medicine	Singapore	Acute coronary syndrome

	coronary syndrome: A systematic review and meta-analysis.			
Changhez 2024	Evaluating the Efficacy and Accuracy of AI-Assisted Diagnostic Techniques in Endometrial Carcinoma: A Systematic Review.	Cureus	Pakistan	Endometrial carcinoma
Choudhury 2020	Role of Artificial Intelligence in Patient Safety Outcomes: Systematic Literature Review	JMIR Medical Informatics	United States	Patient safety
Choy 2023	Systematic review of deep learning image analyses for the diagnosis and monitoring of skin disease.	NPJ Digital medicine	United Kingdom	Skin disease
Dagher 2024	Artificial intelligence/machine learning for neuroimaging to predict hemorrhagic	Journal of Neuroimaging	United States	Hemorrhagic transformation

	transformation: Systematic review/meta-analysis			
Darsha Jayamini 2024	Investigating Machine Learning Techniques for Predicting Risk of Asthma Exacerbations: A Systematic Review.	BMC Pulmonary Medicine	China	Asthma
Das 2023	Application of machine learning in measurement of ageing and geriatric diseases: a systematic review.	BMC Geriatrics	India	Geriatric diseases
Deimazar 2023	Machine learning models to detect and predict patient safety events using electronic health records: A systematic review	International Journal of Medical Informatics	Iran	Patient safety
Delpino 2022	Machine learning for predicting chronic diseases: a systematic review.	Public Health	Brazil	Chronic disease
Didier 2024	Application of machine learning for lung cancer	Frontiers in Artificial Intelligence	United States	Lung cancer

	survival prognostication-A systematic review and meta-analysis.			
Eguia 2024	Clinical Decision Support and Natural Language Processing in Medicine: Systematic Literature Review.	Journal of Medical Internet Research	Spain	Clinical Decision Support
Entezari 2023	Improving Resource Utilization for Arthroplasty Care by Leveraging Machine Learning and Optimization: A Systematic Review.	Arthroplasty Today	Canada	Arthroplasty
Escala-Besa 2024	The Use of Artificial Intelligence for Skin Disease Diagnosis in Primary Care Settings: A Systematic Review.	Healthcare	Spain	Skin disease
Ferrara 2024	Risk Management and Patient Safety in the Artificial Intelligence	Healthcare	Italy	Patient safety

	Era: A Systematic Review.			
Fowler 2023	Artificial intelligence as a diagnostic aid in cross-sectional radiological imaging of surgical pathology in the abdominopelvic cavity: a systematic review.	BMJ Open	United Kingdom	Abdominopelvic cavity
Fowler 2023	Artificial intelligence as a diagnostic aid in cross-sectional radiological imaging of surgical pathology in the abdominopelvic cavity: a systematic review.	BMJ Open	United Kingdom	Abdominopelvic cavity
Furriel 2023	Artificial intelligence for skin cancer detection and classification for clinical environment: a systematic review.	Frontiers in Medicine	Brazil	Skin cancer
Ghaddaripouri 2024	The effect of machine learning algorithms in the prediction, and	Health Science Reports	Iran	Meningitis

	diagnosis of meningitis: A systematic review.			
Giddings 2024	Factors influencing clinician and patient interaction with machine learning-based risk prediction models: a systematic review.	The Lancet	United Kingdom	Risk prediction models
Gomes 2023	Use of Deep Neural Networks in the Detection and Automated Classification of Lesions Using Clinical Images in Ophthalmology, Dermatology, and Oral Medicine-A Systematic Review.	Journal of Digital Imaging	Brazil	Ophthalmology, Dermatology, and Oral Medicine
Gosak 2022	Artificial intelligence based prediction models for individuals at risk of multiple diabetic complications: A systematic review of the literature.	Journal of Nursing Management	Slovenia	Diabetes

Grzybowski 2024	Retina Fundus Photograph-Based Artificial Intelligence Algorithms in Medicine: A Systematic Review.	Ophthalmology and Therapy	Poland	Ophthalmology (Retina Fundus)
Gu 2022	Performance of deep learning in the detection of intracranial aneurysm: systematic review and meta analysis	European Journal of Radiology	China	Intracranial aneurysm
Gudigar 2024	Automated System for the Detection of Heart Anomalies Using Phonocardiograms: A Systematic Review	IEEE Access	India and Malaysia	Heart Anomalies
Gudigar 2024	Automatic identification of hypertension and assessment of its secondary effects using artificial intelligence: A systematic review (2013-2023).	Computers in Biology and Medicine	India	Hypertension
Gupta 2020	A Systematic Review of Machine Learning	Sensors	United States	Hematopoietic Stem Cell Transplantation

	Techniques in Hematopoietic Stem Cell Transplantation (HSCT).			
Gurmessa 2023	A comprehensive evaluation of explainable Artificial Intelligence techniques in stroke diagnosis: A systematic review	Cogent Engineering	Ethiopia	Stroke
Gutierrez-Tobal 2022	Reliability of machine learning to diagnose pediatric obstructive sleep apnea: Systematic review and meta-analysis.	Pediatric Pulmonology	Spain	Obstructive sleep apnea
Habib 2022	Artificial intelligence to classify ear disease from otoscopy: A systematic review and meta-analysis.	Clinical Otolaryngology	Australia	Ear disease
Hameed 2021	The Ascent of Artificial Intelligence in Endourology: a	Current Urology Reports	India	Endourology

	Systematic Review Over the Last 2 Decades			
Hani 2023	Machine-learning Algorithms for Ischemic Heart Disease Prediction: A Systematic Review	Current Cardiology Reviews	Jordan	Ischemic heart disease
Hansen 2024	Deep learning performance compared to healthcare experts in detecting wrist fractures from radiographs: A systematic review and meta-analysis.	European Journal of Radiology	Denmark	Wrist fractures
Hoodbhoy 2021	Machine Learning for Child and Adolescent Health: A Systematic Review.	Pediatrics	The Netherlands	Child and adolescent health
Hossain 2022	The role of machine learning in developing non-magnetic resonance imaging based biomarkers for multiple sclerosis: A systematic review.	BMC Medical Informatics and Decision Making	Australia	Multiple sclerosis

Hossain 2023	Natural Language Processing in Electronic Health Records in relation to healthcare decision-making: A systematic review.	Computers in Biology and Medicine	Bangladesh	Electronic health records
Hussain 2024	A Systematic Review of Artificial Intelligence Applications in the Management of Lung Disorders.	Cureus	United States	Lung disorders
Hussein 2023	Using Artificial Intelligence to Predict the Development of Kyphosis Disease: A Systematic Review.	Cureus	Qatar	Kyphosis disease
Islam 2020	Deep learning algorithms for detection of diabetic retinopathy in retinal fundus photographs: A systematic review and meta-analysis.	Computer Methods and Programs in Biomedicine	Taiwan	Diabetic retinopathy
Javidan 2022	A Systematic Review and Bibliometric	Annals of Vascular Surgery	Canada	Vascular surgery

	Analysis of Applications of Artificial Intelligence and Machine Learning in Vascular Surgery.			
Jeong 2023	Artificial intelligence and prediction of cardiometabolic disease: Systematic review of model performance and potential benefits in indigenous populations.	Artificial Intelligence In Medicine	Australia	Cardiometabolic Disease
Jones 2021	Artificial Intelligence Techniques That May Be Applied to Primary Care Data to Facilitate Earlier Diagnosis of Cancer: Systematic Review.	Journal of Internet Medical Research	United Kingdom	Cancer
Jones 2022	Artificial intelligence and machine learning algorithms for early detection of skin cancer in community and primary care settings: a systematic review	The Lancet	United Kingdom	Skin cancer

Jung 2024	Artificial intelligence in fracture detection with different image modalities and data types: A systematic review and meta-analysis.	PLOS Digital Health	United States	Fracture
Kanan 2024	AI-Driven Models for Diagnosing and Predicting Outcomes in Lung Cancer: A Systematic Review and Meta-Analysis.	Cancers	Saudi Arabia	Lung cancer
Katzman 2024	Deep Learning for Pneumothorax Detection on Chest Radiograph: A Diagnostic Test Accuracy Systematic Review and Meta Analysis.	Artificial Intelligence	Canada	Pneumothorax
Khalifa 2024	Artificial Intelligence for Clinical Prediction: Exploring Key Domains and Essential Functions	Computer Methods and Programs in Biomedicine Update	Australia	Clinical prediction

Kitsios 2023	Recent Advances of Artificial Intelligence in Healthcare: A Systematic Literature Review	Applied Sciences	Greece	Not specified
Klug 2024	From admission to discharge: a systematic review of clinical natural language processing along the patient journey.	BMC Medical Informatics and Decision Making	Germany	Not specified
Kolasa 2024	Systematic reviews of machine learning in healthcare: a literature review.	Expert Review of Pharmacoeconomics & Outcomes Research	Poland	Not specified
Koo 2024	Systematic Review of the Application of Artificial Intelligence in Healthcare and Nursing Care.	Malaysian Journal of Medical Science	Malaysia	Nursing care
Koul 2023	Artificial Intelligence Techniques to Predict the Airway Disorders Illness: A Systematic Review	Archives of Computational Methods in Engineering	India	Airway disorders

Kumar 2022	A Systematic Review of Artificial Intelligence Techniques in Cancer Prediction and Diagnosis.	Archives of Computational Methods in Engineering	India	Cancer
Lajczak 2024	Artificial intelligence - an aid for physicians in chordoma management? A systematic review of current applications	Oncology in Clinical Practice	Poland	Chordoma
Lans 2023	Social determinants of health in prognostic machine learning models for orthopaedic outcomes: A systematic review.	Journal of Evaluation in Clinical Practice	United States	Orthopaedics
Leghissa 2023	Machine learning approaches for frailty detection, prediction and classification in elderly people: A systematic review.	International Journal of Medical Informatics	Spain	Frailty detection
Liastuti 2022	Detecting Left Heart Failure in Echocardiography	Reviews in Cardiovascular Medicine	Indonesia	Heart Failure

	through Machine Learning: A Systematic Review.			
Liawrungrueang 2024	Artificial Intelligence-Assisted MRI Diagnosis in Lumbar Degenerative Disc Disease: A Systematic Review.	Global Spine Journal	Thailand	Lumbar Degenerative Disc Disease
Liu 2023	Machine-learning versus traditional approaches for atherosclerotic cardiovascular risk prognostication in primary prevention cohorts: a systematic review and meta-analysis.	European Heart Journal	Australia	Atherosclerosis
Liu 2023	Artificial Intelligence for the Classification of Pigmented Skin Lesions in Populations with Skin of Color: A Systematic Review.	Dermatology	Australia	Skin lesions
Liu 2024	Application of Artificial Intelligence Methods on	Bioengineering	Singapore	Osteoporosis

	Osteoporosis Classification with Radiographs-A Systematic Review			
Loh 2022	Application of explainable artificial intelligence for healthcare: A systematic review of the last decade (2011-2022).	Computer Methods and Programs in Biomedicine	Singapore	Not specified
Luo 2024	The Influence of the Novel Computer-Aided Triage System Based on Artificial Intelligence on Endovascular Therapy in Patients with Large Vascular Occlusions: A Meta-Analysis.	World Neurosurgery	China	Vascular Occlusions
Rony 2024	Artificial Intelligence-Driven Advancements in Otitis Media Diagnosis: A Systematic Review	IEEE Access	Bangladesh	Otitis Media
Malak 2019	Neonatal intensive care decision support	Springer Nature	Iran	Neonatal Intensive Care

	systems using artificial intelligence techniques: a systematic review			
Manetas-Stavrakakis 2023	Accuracy of Artificial Intelligence-Based Technologies for the Diagnosis of Atrial Fibrillation: A Systematic Review and Meta-Analysis.	MDPI Journal of Clinical Medicine	Greece	Atrial Fibrillation
Mangold 2021	Machine Learning Models for Predicting Neonatal Mortality: A Systematic Review.	Neonatology	USA	Neonatal Mortality
Martinez-Ortigosa 2023	Applications of Artificial Intelligence in Nursing Care: A Systematic Review	Hindawi Journal of Nursing Management	Spain	Nursing Care
Mendo 2021	Machine Learning in Medical Emergencies: a Systematic Review and Analysis.	Journal of Medical Systems	Spain	Medical Emergencies
Moazemi 2023	Artificial intelligence for clinical decision support for monitoring	Frontiers in Medicine	Germany	Cardiovascular ICU Decisions

	patients in cardiovascular ICUs: A systematic review.			
Moffat 2022	Accuracy of Machine Learning Models to Predict In-hospital Cardiac Arrest: A Systematic Review.	Clinical Nurse Specialist	United States	Cardiac arrest
Moghadam 2024	Impact of Artificial Intelligence in Nursing for Geriatric Clinical Care for Chronic Diseases: A Systematic Literature Review	IEEE Access	Iran	Geriatric chronic disease (nursing)
Moura 2021	Artificial intelligence in the management and treatment of burns: A systematic review	Burns & Trauma	United Kingdom	Burns
Moya-Salazar 2024	After a few months, what are the uses of OpenAIâ€™s ChatGPT in medicine? A Scopus-based systematic review	Electronic Journal of General Medicine	Peru	Not specified
Mpanya 2021	Predicting mortality and hospitalization in heart	IJC Heart & Vasculature	South Africa	Heart failure

	failure using machine learning: A systematic literature review.			
Mushtaq 2024	Artificial intelligence and machine learning in peritoneal dialysis: a systematic review of clinical outcomes and predictive modeling.	International Urology and Nephrology	Pakistan	Peritoneal dialysis
Nawi 2022	Machine Learning Models in Prediabetes Screening: A Systematic Review	Journal of Clinical and Diagnostic Research	Malaysia	Prediabetes
Nogales 2024	A systematic review of the application of deep learning techniques in the physiotherapeutic therapy of musculoskeletal pathologies.	Computers in Biology and Medicine	Spain	Physical therapy
Obimba 2024	Effectiveness of Artificial Intelligence Technologies in Cancer Treatment for Older	Journal of Clinical Medicine	United States	Cancer

	Adults: A Systematic Review.			
O'Connor 2023	Artificial intelligence in nursing and midwifery: A systematic review.	Journal of Clinical Nursing	United Kingdom	Nursing and Midwifery
Ogink 2021	Wide range of applications for machine-learning prediction models in orthopedic surgical outcome: a systematic review	Acta Orthopaedica	The Netherlands	Orthopedic surgery
Olender 2023	Application of machine learning approaches in predicting clinical outcomes in older adults - a systematic review and meta-analysis.	BMC Geriatrics	United Kingdom	Gerontology
Omar 2024	Utilizing natural language processing and large language models in the diagnosis and prediction of infectious diseases: A systematic review.	American Journal of Infection Control	Isreal	Infectious disease

Ong 2024	Oncologic Applications of Artificial Intelligence and Deep Learning Methods in CT Spine Imaging-A Systematic Review	Cancers	Singapore	Oncology
Orji 2023	Application of Artificial Intelligence and Machine Learning in Diagnosing Scaphoid Fractures: A Systematic Review.	Cureus	United States	Scaphoid fractures
Ozsahin 2023	The Systematic Review of Artificial Intelligence Applications in Breast Cancer Diagnosis	Diagnostics	United Arab Emirates	Breast cancer
Papalia 2024	Artificial Intelligence in Detection, Management, and Prognosis of Bone Metastasis: A Systematic Review	Cancers	Italy	Bone metastasis
Patel 2023	Artificial Intelligence in the Detection of Barrett's Esophagus: A Systematic Review.	Cureus	United States	Barrett's esophagus

Payrovnaziri 2020	Explainable artificial intelligence models using real-world electronic health record data: a systematic scoping review.	Journal of the American Medical Informatics Association	United States	Not specified
Peng 2022	Detection of Systemic Diseases From Ocular Images Using Artificial Intelligence: A Systematic Review.	Asia-Pacific Journal of Ophthalmology	Singapore	Ophthalmology
Petmezas 2024	Recent advancements and applications of deep learning in heart failure: A systematic review.	Computers in Biology and Medicine	Greece	Heart failure
Piliuk 2023	Artificial intelligence in emergency medicine. A systematic literature review.	International Journal of Medical Informatics	Germany	Emergency medicine
Plana 2022	Randomized Clinical Trials of Machine Learning Interventions in Health Care: A Systematic Review.	JAMA Network Open	United States	Not specified

Pressman 2024	Clinical and Surgical Applications of Large Language Models: A Systematic Review.	Journal of Clinical Medicine	United States	Medicine and Surgery
Radaelli 2024	Advancing Patient Safety: The Future of Artificial Intelligence in Mitigating Healthcare-Associated Infections: A Systematic Review.	Healthcare	Italy	Infectious disease
Rahman 2024	Artificial Intelligence-Based Algorithms and Healthcare Applications of Respiratory Inductance Plethysmography: A Systematic Review	Algorithms	Bangladesh	Respiratory Inductance Plethysmography
Ranchon 2023	Development of artificial intelligence powered apps and tools for clinical pharmacy services: A systematic review.	International Journal of Medical Informatics	France	Pharmacy
Rao 2024	A systematic literature review of predictive	Discover Public Health	India	Neonatal sepsis

	analytics methods for early diagnosis of neonatal sepsis			
Rashid 2022	Artificial intelligence in acute respiratory distress syndrome: A systematic review.	Artificial Intelligence In Medicine	India	Acute respiratory distress syndrome
Raymond 2022	Nurse practitioners' involvement and experience with AI-based health technologies: A systematic review.	Applied Nursing Research	Canada	Nurse practitioner
Reinhardt 2024	AI-accelerated prostate MRI: a systematic review.	British Journal of Radiology	Ireland	Prostate cancer
Rezayi 2022	Effectiveness of Artificial Intelligence for Personalized Medicine in Neoplasms: A Systematic Review.	BioMed Research International	Iran	Neoplasms
Roman 2023	The Expanding Role of ChatGPT (Chat-Generative Pre-Trained Transformer) in	Cureus	United Arab Emirates	Neurosurgery

	Neurosurgery: A Systematic Review of Literature and Conceptual Framework.			
Rosenbacke 2024	How Explainable Artificial Intelligence Can Increase or Decrease Clinicians' Trust in AI Applications in Health Care: Systematic Review.	Journal of Medical Internet Research	Denmark	Not specified
Ruksakulpiwat 2024	A Systematic Review of the Application of Artificial Intelligence in Nursing Care: Where are We, and What's Next?	Journal of Multidisciplinary Healthcare	Thailand	Nursing
Hussain 2022	Deep Learning Based Image Processing for Robot Assisted Surgery: A Systematic Literature Survey	IEEE Access	Italy	Robot assisted surgery
Sacoransky 2024	ChatGPT and assistive AI in structured	Current Problems in Diagnostic Radiology	Canada	Radiology

	radiology reporting: A systematic review.			
Salama 2024	Artificial Intelligence and Machine Learning in Cancer Pain: A Systematic Review.	Journal of Pain and Symptom Management	United States	Cancer pain
Salman 2023	Artificial intelligence and machine learning in aneurysmal subarachnoid hemorrhage: Future promises, perils, and practicalities	Journal of the Neurological Sciences	United States	Aneurysmal subarachnoid hemorrhage
Salman 2024	Reliability of artificial intelligence in predicting total knee arthroplasty component sizes: a systematic review	European Journal of Orthopaedic Surgery & Traumatology	Qatar	Total knee arthroplasty
Scardoni 2020	Artificial intelligence-based tools to control healthcare associated infections: A systematic review of the literature.	Journal of Infection and Public Health	Italy	Healthcare associated infections

Shen 2019	Artificial Intelligence Versus Clinicians in Disease Diagnosis: Systematic Review.	JMIR Medical Informatics	China	Not specified
Singareddy 2023	Artificial Intelligence and Its Role in the Management of Chronic Medical Conditions: A Systematic Review.	Cureus	United States	Chronic medical conditions
Sinha 2024	Artificial Intelligence and Machine Learning in Predicting the Response to Immunotherapy in Non-small Cell Lung Carcinoma: A Systematic Review.	Cureus	Nepal	Non-small cell lung carcinoma
Souza 2024	Applications of artificial intelligence in facial plastic and reconstructive surgery: a systematic review.	Current Opinion in Otolaryngology and Head and Neck Surgery	United States	Facial plastic and reconstructive surgery
Sreedharan 2024	Applications of artificial intelligence in emergency and critical	Frontiers in Artificial Intelligence	Qatar	Emergency and critical care

	care diagnostics: a systematic review and meta-analysis.			
Sukumarran 2024	Machine and deep learning methods in identifying malaria through microscopic blood smear: A systematic review	Engineering Applications of Artificial Intelligence	Malaysia	Malaria
Sun 2021	Prediction models for prognosis of influenza: A systematic review and critical appraisal	Signa Vitae	China	Influenza
Sun 2024	Advanced AI-driven image fusion techniques in lung cancer diagnostics: systematic review and meta-analysis for precision medicine	Robotic Intelligence and Automation	China	Lung cancer
Syed 2021	Application of Machine Learning in Intensive Care Unit (ICU) Settings Using MIMIC	Informatics	United States	Critical care

	Dataset: Systematic Review.			
Tan 2023	Identifying epilepsy surgery candidates with natural language processing: A systematic review.	Journal of Clinical Neuroscience	Australia	Epilepsy surgery
Temperley 2024	Current applications and future potential of ChatGPT in radiology: A systematic review.	Journal of Medical Imaging and Radiation Oncology	Ireland	Radiology
Teoh 2024	Deciphering Knee Osteoarthritis Diagnostic Features With Explainable Artificial Intelligence: A Systematic Review	Elsevier Preprint	Malaysia	Osteoarthritis
Thakur 2022	Recent Application of Artificial Intelligence in Non-Gynecological Cancer Cytopathology: A Systematic Review.	Cancers	Korea	Non-Gynecological Cancer
Thenault 2020	The Application of Artificial Intelligence in Prostate Cancer	Applied Sciences	France	Prostate Cancer

	Management-What Improvements Can Be Expected? A Systematic Review			
TheodoreArmand 2024	Applications of Artificial Intelligence, Machine Learning, and Deep Learning in Nutrition: A Systematic Review.	Nutrients	South Korea	Nutrition
Thomsen 2024	Time for Using Machine Learning for Dose Guidance in Titration of People With Type 2 Diabetes? A Systematic Review of Basal Insulin Dose Guidance	Journal of Diabetes Science and Technology	Denmark	Type 2 Diabetes
THONG 2023	Diagnostic test accuracy of artificial intelligence-based imaging for lung cancer screening: A systematic review and meta-analysis	Lung Cancer	Singapore	Lung Cancer
Trinh 2023	The use of natural language processing in	International Journal for Quality in Health Care	Australia	Falls

	detecting and predicting falls within the healthcare setting: a systematic review.			
Tulloch 2020	Machine Learning in the Prevention, Diagnosis and Management of Diabetic Foot Ulcers: A Systematic Review	IEEE Access	United Kingdom	Diabetic foot ulcers
Ullah 2023	CLINICAL DECISION SUPPORT SYSTEM (CDSS) FOR HEART DISEASE DIAGNOSIS AND PREDICTION BY MACHINE LEARNING ALGORITHMS: A SYSTEMATIC LITERATURE REVIEW	Journal of Mechanics in Medicine and Biology	Pakistan	Heart disease
Ullah 2024	Machine learning algorithms for the prognostication of abdominal aortic aneurysm progression: a systematic review.	Minerva Surgery	United Kingdom	Abdominal aortic aneurysm

UzunOzsahin 2022	The Systematic Review of Artificial Intelligence Applications in Breast Cancer Diagnosis.	Diagnostics	United Arab Emirates	Breast cancer
Veneziani 2024	Applications of Artificial Intelligence in the Neuropsychological Assessment of Dementia: A Systematic Review.	Journal of Personalized Medicine	Italy	Dementia
Villavicencio 2024	The Role of Artificial Intelligence in the Diagnosis of Neoplastic Diseases: A Systematic and Bibliometric Review	International Journal of Online and Biomedical Engineering	Peru	Neoplastic diseases
Wong 2024	The Accuracy of Artificial Intelligence Models in Hand/Wrist Fracture and Dislocation Diagnosis: A Systematic Review and Meta-Analysis.	Journal of Bone and Joint Surgery	Canada	Hand and wrist fracture
Wu 2024	Machine Learning Models for Predicting	Diagnostics	Taiwan	Sepsis-associated acute kidney injury

	Mortality in Critically Ill Patients with Sepsis-Associated Acute Kidney Injury: A Systematic Review.			
Xavier 2024	Artificial intelligence for triaging of breast cancer screening mammograms and workload reduction: A meta-analysis of a deep learning software.	Sage	Brazil	Breast Cancer
Xu 2023	Automated detection of airflow obstructive diseases: A systematic review of the last decade (2013-2022).	Computer Methods and Programs in Biomedicine	Australia	Airflow obstructive diseases
Xu 2024	Machine learning applications in preventive healthcare: A systematic literature review on predictive analytics of disease comorbidity from multiple perspectives.	Artificial Intelligence In Medicine	China	Disease Comorbidity

Yamada 2021	Detection of flat colorectal neoplasia by artificial intelligence: A systematic review	Best Practice and Research Clinical Gastroenterology	Japan	Colorectal Neoplasia
Yew 2023	Transforming epilepsy research: A systematic review on natural language processing applications	Epilepsia	Netherlands	Epilepsy
Yin 2021	Role of Artificial Intelligence Applications in Real-Life Clinical Practice: Systematic Review.	Journal of Medical Internet Research	Singapore	Clinical Practice
Yu 2024	Machine learning-based 30-day readmission prediction models for patients with heart failure: a systematic review.	European Journal of Cardiovascular Nursing	South Korea	Heart failure
Zadnorouzi 2024	Artificial intelligence (AI) applications in improvement of IMRT and VMAT radiotherapy treatment planning	Radiography	Iran	IMRT and VMAT radiotherapy

	processes: A systematic review.			
Zahia 2020	Pressure injury image analysis with machine learning techniques: A systematic review on previous and possible future methods.	Artificial Intelligence in Medicine	Spain	Pressure Injury
Zamanian 2024	Application of artificial intelligence techniques for non-alcoholic fatty liver disease diagnosis: A systematic review (2005-2023).	Computer Methods and Programs in Biomedicine	Iran	Liver Disease
Zheng 2021	Artificial intelligence performance in detecting tumor metastasis from medical radiology imaging: A systematic review and meta-analysis.	Clinical Medicine	China	Tumor Metastasis
Zhong 2022	Application of machine learning in predicting the risk of postpartum	Journal of Affective Disorders	China	Postpartum Depression

	depression: A systematic review			
Zubair 2024	Clinical applications of artificial intelligence in identification and management of bacterial infection: Systematic review and meta-analysis.	Saudi Journal of Biological Sciences	Saudi Arabia	Bacterial Infection