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THE ROLE OF ARTIFICIAL INTELLIGENCE IN IMPROVING THE QUALITY OF PRIMARY HEALTHCARE

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Artificial intelligence (AI) is increasingly used to support various aspects of healthcare. However, the implementation of AI in primary healthcare (PHC) requires a better understanding of its impact on fundamental aspects of quality. This systematic review aims to investigate the role of AI in improving the most important dimensions of quality in primary healthcare, in particular, access, continuity, efficiency, communication, and coordination. Three databases were used for the search, namely PubMED, Scopus, and WoS. The analysis includes articles published between 1 January 2020 and 31 March 2025 in peer-reviewed journals. The search strategy includes a combination of keywords related to AI and specific dimensions of primary healthcare quality. After considering all eligibility criteria based on the PICo framework, 34 studies were included in the analysis. Firstly, the study shows that the use of AI in primary healthcare primarily affects the efficiency of care by supporting the diagnosis of various health problems. Secondly, AI can enhance healthcare accessibility by improving access to specialist services and adapting this care to the needs of patients. In the administrative area, it can optimize access by managing service queues. There is also a growing body of evidence of supporting AI's role in family doctor-patient communication. However, no evidence currently exists of a beneficial effect of AI on improving coordination and continuity in primary care.

Keywords: efficiency, coordination, communication, accessibility, primary healthcare, continuity, artificial intelligence

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1. INTRODUCTION

The foundation of all healthcare systems is primary healthcare (PHC), which focuses on providing basic and comprehensive healthcare services to patients and communities. Its role is crucial in disease prevention, promoting healthy lifestyles, and diagnosing and solving common health problems (Rajpal, 2024). Primary care encompasses routine care, care for urgent but minor or common health problems from infancy to the end of life. It encompasses the different dimensions of health– mental, physical, and social – focusing on caring for the whole person. Functioning as the frontline of care, primary care examines, diagnoses, and treats many patients, thereby reducing the need for specialist referrals (Ranjbari, Abbasgholizadeh Rahimi, 2024).

PHC is an essential aspect of providing high-quality healthcare to patients. In the scientific literature, the quality of primary care includes the first contact and continuity of care provided mainly by general practitioners (GP) and nursing staff, excluding services provided exclusively by specialist care providers (Kueper et al., 2022). The unique features of primary care that distinguish it from other areas of health care therefore include access to primary care, the long-term and continuous nature of patient care, and the allocation of patients to specific general practitioners, who coordinate the care throughout the health care system (Terry et al., 2022). Furthermore, quality assessments of primary care should also take into account the effectiveness of the care provided; specifically, studies conducted among primary care patients in Europe indicate that interpersonal aspects (communication) can also be an important element of this quality (Bower et al., 2003).

In recent years, the role of artificial intelligence (AI) in medicine has expanded rapidly, significantly influencing various domains of healthcare, including primary care. AI typically refers to computational systems designed to replicate or simulate human cognitive functions, such as reasoning, learning, adaptation, interaction, and sensory processing (Tran et al., 2019). These systems are capable of handling large and complex datasets, enabling them to make decisions either independently or with minimal human oversight. Common applications include diagnostic tools powered by AI, natural language processing (NLP) technologies, and predictive analytics driven by machine learning (ML). Clinical decision-support systems may also incorporate AI elements, such as assessment frameworks, automated alerts, and risk prediction tools that employ established algorithms and rules. The growing interest in AI and AI-related advancements in healthcare have been largely fuelled by improvements in computing capabilities and the availability of vast digital data resources (Tran et al., 2019).

To date, examples of AI tools for primary care have been described that focus on risk prediction, workforce assessment (Wingrove et al., 2020), and extracting information from EMR data. In contrast to many widely used digital tools, the core function of artificial intelligence extends beyond merely transmitting or organizing

information: it involves analysing data, generating insights, and participating in the development and assessment of new knowledge. This capability positions AI as a valuable aid for general practitioners, supporting them in their clinical responsibilities and enhancing the overall quality of primary care services (Siira et al., 2024).

The effectiveness and scale of AI adoption in primary healthcare are strongly influenced by a country's level of socio-economic and technological development, as well as by the underlying model of its healthcare system. In high-income countries, where digital maturity, infrastructure readiness and investment capacity are higher, AI solutions tend to be implemented more widely and generate more visible improvements in PHC quality (Hee Lee, Yoon, 2021; Panch et al., 2018). In contrast, many developing countries face structural challenges such as limited funding, weaker PHC organization, and fragmented digital infrastructure. Moreover, the global digital divide significantly affects the adoption of AI in healthcare. A substantial share of the world's population still lacks stable internet access, which further constrains the deployment of eHealth and AI-based solutions and may exacerbate existing health disparities (Jocelyn Chew, Achananuparp, 2022). These inequalities highlight the difficulty of leveraging AI to enhance PHC quality in low-resource settings and also explain the strong geographical concentration of research in high-income regions. In addition to these developmental differences, countries also vary significantly in how their healthcare systems are organised and financed. These structural differences including national health service models, social health insurance systems and market-based arrangements shape the role and strength of primary healthcare, the scope of available benefits and the potential pathways for integrating AI tools into clinical practice.

As the initial point of contact for most patients, primary health care stands to gain considerably from AI-driven solutions. Nevertheless, successfully integrating AI into this setting requires a deeper understanding of how it influences the essential dimensions of care quality. Despite the growing body of evidence, to the bets of the author's knowledge, no systematic review has established the impact of AI on the quality of primary health services across all key dimensions. This article seeks to address this gap by examining how AI affects access, efficiency, communication, coordination, and continuity of primary healthcare.

The purpose of this article is to provide a comprehensive and structured synthesis of existing evidence on the role of artificial intelligence in improving the quality of primary healthcare. As such, it responds to the gap identified in the literature, where quality dimensions are rarely analysed within an integrated framework. Specifically, this study systematically reviews empirical evidence to determine how AI affects five core dimensions of primary care quality: access to care, efficiency, communication, coordination, and continuity. In doing so, it adopts a management and health systems perspective, examining not only clinical outcomes but also how AI interacts with organisational structures, financing models, and socio-economic context.

To achieve this objective, the following research questions were formulated:

RQ1: What types of AI applications are used in primary healthcare?

RQ2: How does AI influence the five dimensions of primary care quality?

RQ3: Which areas benefit most from AI integration, and where do the most significant evidence gaps remain?

RQ4: How do differences in healthcare system models and socio-economic development shape the implementation and effectiveness of AI in PHC?

What distinguishes this study from previous reviews and bibliometric analyses is its explicit focus on the quality of primary healthcare as a multidimensional construct and its integration of AI applications into a management and health systems perspective. While earlier publications have examined trends in AI research in healthcare or mapped general applications of AI in medicine, they have rarely analysed how specific AI tools influence well-established dimensions of PHC quality and how these effects are shaped by health system organisation, financing and socio-economic context. By combining a scoping review of empirical evidence with a framework grounded in management and health system sciences, this article offers a novel synthesis that links AI adoption not only to clinical outcomes, but also to access, efficiency, coordination, continuity and communication in primary care.

To guide the reader through the study, the structure of this article is organized as follows: Section 2 provides a theoretical background on the role of AI in healthcare and its potential influence on the key dimensions of primary care quality. Section 3 presents the methodology, including the search strategy, eligibility criteria, and data extraction framework. Section 4 reports the results of the scoping review, providing details of the characteristics of studies included and the identified impacts of AI on access, efficiency, communication, coordination, and continuity. Section 5 discusses the findings in relation to the existing literature, highlights differences in AI adoption across healthcare system models and socio-economic contexts, and identifies research gaps. Finally, Section 6 concludes the article by outlining the main contributions, practical implications, and directions for future research.

2. LITERATURE ANALYSIS

2.1. Financing primary healthcare models and their relevance to AI adoption

Primary healthcare functions differently across countries, reflecting the underlying organisation and financing of national health systems. Classic typologies distinguish several major models of healthcare. In tax-funded national health service (NHS) systems, such as the UK's National Health Service, PHC acts as a strong gatekeeper and ensures equitable access through universal coverage and publicly financed services (Roland et al., 2012). The principles underlying these systems prioritise equity, comprehensive benefits and minimal financial barriers for patients.

In social health insurance (SHI) systems, healthcare is funded through compulsory contributions from employers and employees. Primary care is provided by a mix of public and private providers, with regulated competition and cost-sharing mechanisms designed to enhance accessibility while limiting out-of-pocket payments (Odeyemi, Nixon, 2013; Ogbodo, 2023). SHI systems play a particularly crucial role in expanding access to healthcare in middle-income countries, where high out-of-pocket costs traditionally deter individuals from seeking care (Sundays et al., 2015).

National health insurance (NHI) models, such as those in Canada, combine a single public payer with predominantly private delivery of services, enabling universal coverage and relatively low administrative costs (Blewett, 2009; Woolhandler, Himmelstein, 2019). In contrast, market-oriented systems, exemplified by the United States, rely more heavily on voluntary private insurance and out-of-pocket payments, resulting in substantial variability in insurance coverage, higher financial barriers to care, and greater health disparities (Angeles et al., 2023).

These structural disparities in financing, governance and organisation shape the strength of primary healthcare, the degree of care coordination and the scope of benefits available to patients. They also influence the feasibility and direction of AI integration into PHC, whether through centralised national programmes (typical of the NHS and NHI models), insurer-driven initiatives (in SHI systems), or fragmented, provider-level innovations (in market-based systems) (Noknoy et al., 2021; Reid et al., 2022; Riegler, 2023).

2.2. AI and improving access to primary care

By analysing patient flow trends, AI systems can save healthcare providers time, optimise appointment scheduling, and accelerate patients' access to care. By analysing providers' current appointment calendars, AI can communicate with patients to schedule appropriate appointments. This can enable more efficient appointment scheduling, reduce waiting times for treatment, and improve primary care provider throughput. Additionally, automating administrative tasks, such as complex medical record management, can save physicians valuable time, allowing them to focus on patient care (Feldman et al., 2014).

AI has the potential to enhance access to primary care by enabling more efficient allocation of scarce resources. It can also play a crucial role in managing public health crises, as demonstrated during the COVID-19 pandemic (Wu et al., 2023). In regions where access to specialist care is lacking, these tools in the hands of primary care physicians can provide significant benefits to patients. For example, AI has the ability to predict the complexity of patient encounters and, based on this, adjust the number of patients to the capacity of individual family doctors within a given time frame (Rajkomar et al., 2016). Additionally, automating administrative tasks using AI technology can streamline processes such as appointment

scheduling, reducing the administrative burden on healthcare workers and increasing overall accessibility (Rajpal, 2024).

The extensive patient network of primary care makes it a prime target for AI integration. Primary care physicians now spend a large part of their day interacting with vast amounts of data, for example, from electronic health records (EHRs) (Sarkar, Bates, 2024). The integration of AI into PHC presents a valuable opportunity to enhance and streamline service delivery. This potential is driven in part by the ongoing shortage of primary care physicians and is further supported by the increasing availability of data within electronic health records, alongside significant progress in computational technologies.

AI is increasingly recognised as a tool with potential implications for primary care delivery (Terry et al., 2022). It can be used as a potential solution for data triage, which can reduce the workload of primary care providers and improve the safety and availability of primary care (Jordan et al., 2023; Siira et al., 2024).

Conversely, concerns have been raised that the use of AI in healthcare may negatively impact access to services. In fact, evidence from high-income countries suggests that emerging technologies can contribute to health inequities (Vidal-Alaball et al., 2024), for example, due to algorithms that overvalue certain racial groups at the expense of others (Smallman, 2022).

2.3. AI and improving the efficiency of primary care

A key application of AI in healthcare is its potential to enhance the operational effectiveness of primary care. The performance of primary care services is closely tied to the precision of diagnostic and therapeutic processes, and numerous studies highlight how AI technologies can improve outcomes in these domains (Jiang et al., 2017). AI systems are capable of continuously integrating up-to-date clinical knowledge derived from the research literature and practical settings, offering recommendations for patient management, and facilitating the forecasting of health trajectories (Tran et al., 2019).

In the field of diagnostics, AI contributes by interpreting electrocardiograms and converting spoken clinical notes into written form using voice recognition technology. It also functions as a support tool in analysing medical images, including retinal scans, radiographs, and dermatological photographs (Ávila-Tomás et al., 2021). By leveraging sophisticated algorithms and machine learning techniques, AI can process a wide array of patient data, such as clinical history and lab findings, to assist healthcare professionals in making quicker and more accurate diagnostic decisions (Rajpal, 2024).

In therapeutic care, AI enables individualised treatment strategies and can anticipate a patient's likelihood of following prescribed regimens, thus enhancing both the efficacy and efficiency of care. Moreover, it can identify potential adverse drug effects before they occur, thereby contributing to safer treatments (Ávila-Tomás

et al., 2021). AI is also valuable in risk stratification, supporting clinicians in determining which patients require more immediate attention based on clinical urgency (Vidal-Alaball et al., 2024).

AI has the potential to surpass human ability to establish new connections across large volumes of data and is already on the verge of revolutionising the way we understand disease by finding new patterns for classifying medical information (Rajpurkar et al., 2022). The exponential and continuous growth of health-related data, spanning electronic medical records, diagnostic imaging, and data from wearable technologies, presents significant opportunities to enhance data collection and analysis processes aimed at improving the efficiency of primary healthcare (Yu et al., 2022).

Studies indicate that the ability of AI to increase the efficiency of the healthcare system depends on the AI use being accepted by doctors, patients and policymakers. However, it remains unclear whether awareness of AI would change this acceptance rate (Ranjbari, Abbasgholizadeh Rahimi, 2024).

2.4. AI and improving continuity of primary care

AI-based patient monitoring systems have the potential to transform primary care by enabling continuous and real-time data analysis. As such, AI can contribute to a more personalised and evidence-based continuum of treatment planning in primary care. The ubiquity of wearable technologies powered by AI has opened up the possibility of continuous monitoring of patient's health. These devices vigilantly track basic metrics, flagging any deviations from the norm and ensuring that primary care providers can intervene quickly (Dunn et al., 2018). Through these capabilities, AI in primary care thus represents the essence of improved, data-driven, patient-centric care (Lin et al., 2019).

By taking into account individual patient characteristics and evidence-based guidelines, AI algorithms can help formulate patient-specific treatment plans over time that optimise health outcomes and quality of care (Char et al., 2020). Such personalised care can be particularly beneficial in the treatment of chronic conditions and complex medical cases. AI systems can detect early signs of deterioration in a patient's health and send alerts to healthcare providers, thereby enabling timely medical interventions (Rajpal, 2024; Ravi et al., 2017).

A significant primary care challenge that impacts continuity of care is the delivery of care between visits, including timely ordering and monitoring of necessary diagnostic tests and ongoing monitoring of chronic conditions. AI can support GPs in this process by analysing diagnosis-specific feedback from patients, suggesting specific diagnostic tests, and making the whole process more continuous for patients. AI tools can also summarise a patient's clinical course between visits, allowing primary care doctors to efficiently keep up with evolving disease processes and life circumstances. Additionally, more advanced AI models may be able to provide

more personalised decision support at the point of care tailored to the patient's individual history and needs (Sarkar, Bates, 2024).

2.5. AI and improving coordination in primary care

Effective coordination of clinical care is closely linked to the quality of decision-making, which is increasingly shaped by incorporating AI into routine medical workflows (Lin et al., 2019). Applications of AI in this context include tools for assessing patient risk levels and forecasting the likely course of diseases through predictive modelling techniques (Oude Nijeweme-d'Hollosy et al., 2018), decision support applications, and population health management tools for screening for cancer, diabetes, cardiovascular disease, and other chronic conditions (Clark et al., 2021).

By identifying patients' health concerns, AI can direct them to the appropriate healthcare provider or specialist. This can provide patients with comprehensive treatment and medical care (Lin et al., 2019).

2.6. AI and improving communication in primary care

Family physicians often make shared decisions about care with their patients. When involving AI in patient care, it is important to consider cases where AI could communicate with patients independently of the family physician (Ranjbari, Abbasgholizadeh Rahimi, 2024). This may have the potential to improve the patient-family doctor communication process and to influence the scale of direct provision of evidence-based information to patients about their health status and about treatment alternatives tailored to their needs (Abbasgholizadeh Rahimi et al., 2022). Algorithms for speech recognition and text generation can streamline and reduce administrative burdens during consultations by enabling real-time electronic documentation of medical records and assisting in the preparation of medical reports. Moreover, AI-powered chatbots offer patients an accessible resource for symptom assessment and personalised health advice, thereby supporting health promotion efforts. These chatbots can also help manage patient inquiries by sorting messages and responding to frequently asked questions. By automating certain routine tasks within primary care, more time can be dedicated to building patient relationships and delivering personalised care. Additionally, in both clinical practice and medical education, natural language processing tools can enhance healthcare professionals' communication abilities (Vidal-Alaball et al., 2024).

On the other hand, overreliance on AI can undermine the direct doctor-patient relationship based on human touch and empathy. The risk also exists that physicians who over-rely on AI will fail to pay attention to patient-specific subtleties that may not be apparent in cold, hard data (Lin et al., 2019).

For AI to bring the most value to patient-physician communication, it should support and not replace the patient-physician relationship. Healthcare is a social

issue fuelled by engaged, caring, and collaborative relationships among engaged people. AI, if poorly implemented, risks marginalizing physicians; conversely, if AI is implemented wisely, it can free up doctors' cognitive and emotional space for their patients and, therefore, help them communicate better with their patients (Lin et al., 2019).

3. METHODOLOGY

3.1. Search strategy

This review followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines as outlined by Tricco et al. (Tricco et al., 2018). The primary goal was to gather evidence on how AI influences the quality of primary care.

The literature search was conducted across three major scientific databases: PubMed, Scopus, and Web of Science (WoS). The review included peer-reviewed journal articles published between 1 January 2020, and 31 March 2025. This time frame was selected to capture the most recent empirical evidence on the use of artificial intelligence in primary healthcare, in accordance with the goals of a scoping review rather than a bibliometric trend analysis. Conference proceedings, books, and book chapters were excluded. Only studies published in English were considered.

The search strategy was carefully designed to capture all relevant studies. It used broad umbrella terms to maximise sensitivity and included a combination of keywords related to AI and the specific dimensions of primary care quality. Full-text screening ensured the inclusion of studies employing specific AI techniques (e.g., deep learning, neural networks, NLP) as well as diverse PHC terminologies used across different health systems. Keywords were combined using Boolean operators, and wildcards and abbreviations were applied where appropriate. The full search string is presented in table 1, and the strategy was tailored to the specific syntax requirements of each database.

Table 1. Comprehensive search strategy

No.	Search terms
1	"Artificial Intelligence" OR "AI" OR "Machine Learning"
2	"Primary Health Care" OR PHC OR "Primary care" OR "Family Practice" OR "General Practice"
3	"Continuity" OR "Coordination" OR "Communication" OR "Efficiency" OR "Access to" OR "Availability"
4	1 AND, 2 AND 3

3.2. Inclusion criteria and exclusion criteria

The systematic review methodology was developed in accordance with international trends and includes standard and practical methods for protocol writing, literature searching and data synthesis. The bibliographic database search strategy was defined using the PICOS project components (Population, Intervention, Comparison, Outcomes) (Stone, 2002). The eligibility criteria based on the PICOS framework are presented in table 2.

Table 2. Eligibility criteria based on the PICOS framework

PICOS	Inclusion criteria	Exclusion criteria
Population	Studies used primary care data and/or the study was conducted in a primary care setting and/or explicitly mentioned the applicability of the study to primary care.	Studies were not conducted in primary care settings and didn't use primary care data.
Intervention	Only studies that tested the use of AI and/or machine learning	Articles not describing AI and/or machine learning
Comparison	No inclusion or exclusion criteria were considered.	
Outcomes	The primary focus was on studies that demonstrated the impact of AI on one or more dimensions of primary care quality, such as continuity, coordination, efficiency, access, and communication.	The research did not address the impact of AI on one or more dimensions of primary care quality, such as continuity, coordination, efficiency, access, and communication.

The retrieved articles were imported into "Rayyan", an open-source, web-based application for managing the search and screening of systematic reviews. To be selected, a study had to propose the use of AI-based techniques in primary care. The study was required to report the impact of AI on one of the five dimensions of primary care quality examined. In addition, only articles published in peer-reviewed journals were considered eligible. Studies had to be available in English. These criteria were established to maintain consistency and focus on high-quality studies.

Studies not directly related to primary care or AI were excluded from the review. Reviews, conference proceedings, proposals and popular science articles, books/book chapters were likewise removed. Other types of excluded documents included those with anonymous authors. It was important to ensure that only studies with rigorous evaluation and quality control were included in the analysis. Additionally, articles not available in English were excluded because language barriers may limit understanding and interpretation. The review considered all types of research

methodologies, including qualitative, quantitative, and mixed methods approaches. Specifically, eligible studies comprised experimental and quasi-experimental designs such as randomised controlled trials, quasi-randomised trials, nonrandomised clinical trials, interrupted time series, and controlled before-and-after studies. Observational studies – including cohort, case-control, cross-sectional, and case series designs were also included. Additionally, qualitative research approaches like ethnography, narrative analysis, phenomenology, grounded theory, and case studies, as well as mixed methods designs (both sequential and convergent), were eligible for inclusion. However, secondary studies, such as literature reviews, were excluded.

The study screening process was conducted in three stages, starting with study identification, title and abstract screening, and full-text screening. In the first stage, duplicate studies were removed, with the most recent version being preferred in the case of multiple similar publications. In the second stage, titles and abstracts from all returned studies were screened. In the third stage, the remaining articles were read in full, and the reasons for exclusion were recorded.

3.3. Data extraction and analysis

Full-text articles that met the inclusion and exclusion criteria were further assessed to extract relevant data for analysis. In addition to the metadata automatically extracted by the computational tool (e.g. title, journal name, author names, year of publication, keywords), a full reading of each article was conducted to collect key information presented in table 3.

Table 3. Data extraction form

Concept	Definition
Characteristics of AI technique	Number and types of AI algorithms used. Specific AI tools or algorithms used (e.g. decision tree, random forest, convolutional neural network).
Geographic distribution	The country where the study was conducted
Primary care quality dimensions	dimensions of quality that were affected by AI techniques in primary care.

The dimensions we considered were accessibility, coordination, continuity, efficiency, and communication. We conducted a descriptive synthesis to describe the studies in terms of geography (country where the study was conducted), interventions (AI systems), and outcomes (assessed dimensions of primary care quality). Studies addressing comparable quality dimensions were grouped together and summarised using a narrative synthesis approach. The findings were structured

following the PICOS framework. To develop the initial synthesis, methods such as descriptive text summaries, grouping and clustering of studies, and tabular presentations were employed.

4. RESULTS

4.1. Study selection

The search across three selected bibliographic databases initially retrieved 1,237 articles. After removing 431 duplicate records, the titles and abstracts of the remaining studies were screened. Subsequently, 736 publications were excluded due to being non-English, not original research or review articles, or irrelevant to the study objectives.

The remaining 70 items were searched in full text, and 36 items were removed for the following reasons: one study did not use AI/ML techniques, eight studies were not applicable to primary care, 19 studies did not address the impact of AI on the quality of primary care in the analysed dimensions, eight publications were literature reviews. A total of 34 articles were included in this scoping review.

The different steps of the systematic review are summarised in figure 1. This filtering process followed the PRISMA guidelines, which provide a transparent and systematic approach to the selection of studies, including eligibility criteria and the removal of duplicates.

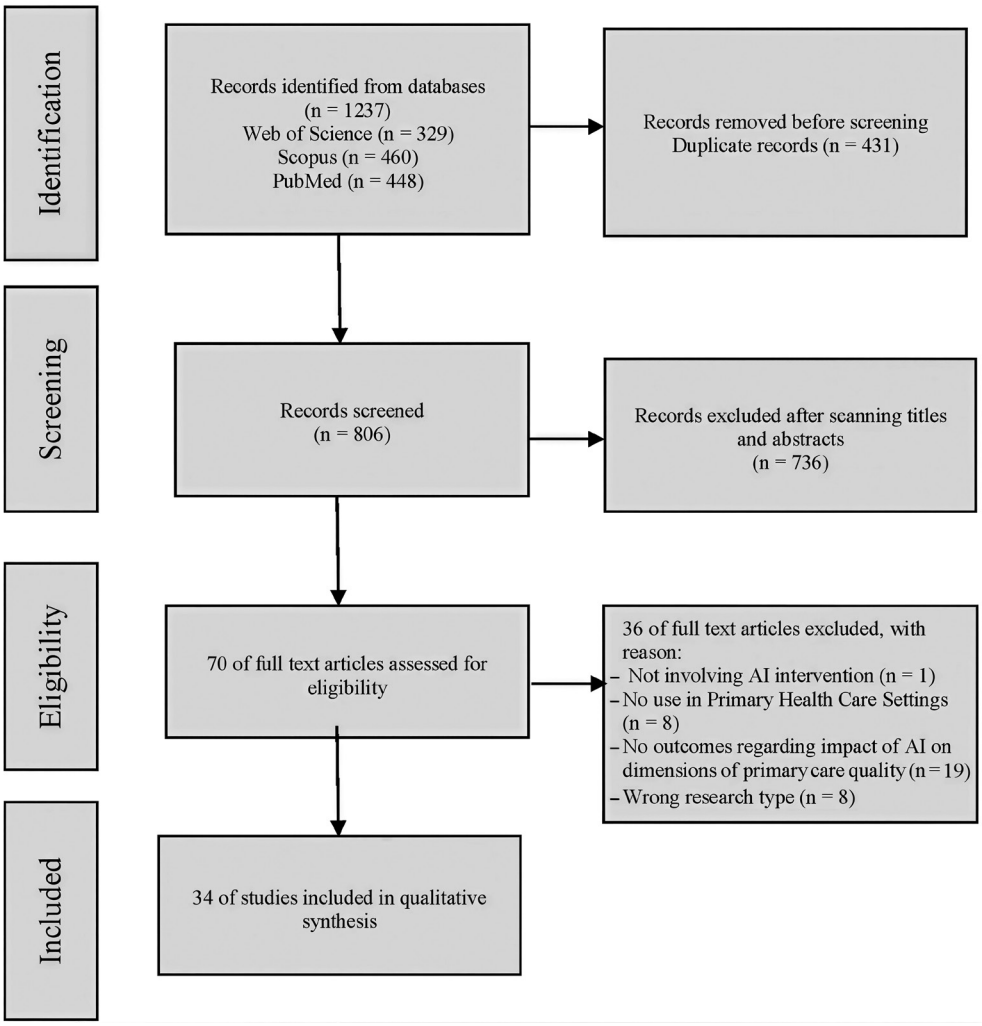

Fig. 1. PRISMA flowchart of the selection procedure

4.2. Study range and characteristics

All publications were between 2019 and 2025. The most studies were published in 2024 (n = 18), and the fewest in 2019 (n = 3). The most common country of origin of studies was the USA (n = 13), followed by the Netherlands (n = 3), the UK, Canada, China, Denmark, and Sweden (n = 2). There were also individual studies from Korea, Japan, Brazil, Portugal, Norway, Spain, the United Arab Emirates, and one international study. There is, therefore, a noticeable gap in research from lower-income countries, which may reflect disparities in resources and infrastructure for AI research.

The majority of the 34 included studies examined the application of AI concerning a particular medical condition, while 11 studies addressed primary care at a general level. The health problems studied were metabolic problems, including diabetes (n = 4), dermatology, ophthalmology and cardiology (n = 3), pulmonology (n = 2), orthopaedics, oncology, rheumatology, hepatology, urology, otolaryngology, endocrinology and administration (n = 1).

The most frequently employed methods were machine learning, natural language processing (NLP) (n = 14), and various single or integrated AI tools (n = 12). Some studies concerned the general application of AI (n = 6), and two studies of Chat GPT.

Of the research methods used, thirteen concerned the experimental use of AI tools in diagnosing various health problems. The most common participants in the studies were family doctors, primary care patients and IT experts.

Most studies (n = 21) found AI to have an impact on the effectiveness of diagnosing various health problems in primary care. The second most common dimension of primary care quality was access to care (n = 12), followed by communication (n = 7). Two studies included the dimension of coordination and continuity, with only one finding a positive effect of AI on coordination. No studies found a positive effect of AI/ML on the continuity of primary care.

5. DISCUSSION REGARDING THE IMPACT OF AI ON DIMENSIONS OF PRIMARY CARE QUALITY

Studies using AI in primary care included in the systematic review for this study were broadly divided into five dimensions: continuity, coordination, communication, access to care, and efficiency.

Earlier research has demonstrated that AI can enhance both managerial and clinical decision-making and workflows. The studies have recognised the purpose and functionality of the AI tool and the potential value in more accurate and faster diagnoses. However, two dimensions of primary care quality were identified that require improvement: coordination and continuity of care. When assessing the area of coordination, primary care physicians questioned whether the results of AI across specialities were within their scope of responsibility. They believed that the AI tool could be perceived as not logically coordinated within the care pathway (Dos Santos et al., 2025). Consequently, evaluating the effects of AI-driven applications on care continuity and coordination remains challenging. However, researchers believe that the use of these tools in primary care constitutes an investment in the continuity of care by fostering faster diagnosis across conditions in the future for the development of a more integrated, cost-effective, and patient-centred approach (Barry et al., 2022).

The aims of research exploring the use of AI in automatically evaluating communication and feedback during primary care consultations include raising clinicians'

awareness of potential biases in patient interactions. Findings highlight the advantages of AI models in detecting social signals such as dominance, warmth, engagement, and interactivity within nonverbal communication between patients and providers. Additionally, a Canadian study focused on identifying priority areas for AI emphasised the need to enhance communication among primary care providers, AI developers, and patients. Participants underscored the importance of fostering dialogue between these groups to reduce misunderstandings (Kueper et al., 2022). Studies of AI patient communication tools have indicated that AI-generated responses (e.g., GenAI) were rated higher than primary care providers in terms of communication style and empathy. GenAI responses were longer, more complex in language, and less readable than physician responses. They were also rated as more empathetic and included more subjective and positive language. However, these could be problematic for patients with poor health or poor English proficiency (Small et al., 2024). Later research demonstrates that large language models (LLMs) are particularly promising in supporting communication between patients and healthcare professionals by generating responses to patient messages. These models can assist in drafting initial replies for providers. Furthermore, by fine-tuning LLMs with local data and expanding training with open-source datasets, the empathy, accuracy, responsiveness, and overall quality of generated replies can be enhanced. Such locally adapted open-source models have been shown to produce responses to patient inquiries that outperform those crafted by human providers (Liu S. et al., 2024). Machine learning models that can predict the emotional ratings of physicians and patients have the potential to be applied in primary care settings to support larger-scale quality improvement efforts focused on empathetic patient-physician communication. Work on AI's impact on communication in primary care provides valuable reference points for future applications that could help monitor patients' emotional signals, support clinicians in empathetic communication, or explore the role of emotions in patient-centred care (Park et al., 2021). In terms of communication challenges, primary care providers have reported issues with the unexpected nature of results generated outside the context of a visit, a lack of explanation for deep learning, and a lack of guidelines for reporting false positives. All of these can make communicating results to patients both difficult and time-consuming (Barry et al., 2022). Additionally, some perceive communication limitations based on the belief that skills such as empathy and effective communication are inherently human, while clinical reasoning and delivering value-based care depend on the physician's judgment. Consequently, in-person interactions between doctors and patients remain crucial for thorough medical information gathering, as clinical insight is considered a distinctly human ability. General practitioners tend to see communication as a personal interaction that is unlikely to be replaced or diminished by automation (Blease et al., 2019).

Machine learning data analysis in the area of improving accessibility was used in primary care clinic appointment scheduling systems, taking into account individual

patient absence rates. This helped to increase the number of patients served due to a significant decrease in absence rates (Topuz et al., 2024). This study shows that integrating AI into a data analytics platform and electronic health record systems can significantly improve patients' access to primary care. The AI model facilitated daily waiting time assessments and enabled real-time changes, such as reallocating patients to different doctors, reducing waiting times and optimising resources (Topuz et al., 2024). It is also believed that AI-based tools can solve the problem of poor access to specialist care, e.g. ophthalmology (Choi et al., 2025), oncology (Helenason et al., 2024), and diabetology (Liu T.Y.A. et al., 2024) by improving the quality of diagnosis at the primary care level. For example, the use of computer-aided diagnosis (CAD) by primary care physicians (PHCPs) to diagnose skin cancer can significantly improve timely access to specialist care for those requiring urgent attention (Giavina-Bianchi et al., 2021). The results also show that AI tools can reduce the time needed to read images, allowing significantly more patients to be screened for DR per year. Implementing these tools in primary care would enable nurses and family physicians to quickly refer patients at risk of vision loss to a specialist, improving their visual prognosis (Baget-Bernaldiz et al., 2024). The analysis of results from an AI-assisted diabetic retinopathy screening (DRS) in a family practice setting shows that performing DRS in general practice can increase patient attendance, reduce unnecessary ophthalmology referrals, and thereby improve access to treatment (Krogh et al., 2025). The results of implementing autonomous AI technology in a large integrated health system show that autonomous AI improved patient access and equity in healthcare for patients with diabetes – particularly in historically disadvantaged patient populations (Liu T.Y.A. et al., 2024). Potential benefits of this innovative tool in diabetes care include improved access to retinopathy screening and support for broader detection of sight-threatening retinopathy (Nolan et al., 2023). AI/ML is also expected to improve diagnostic accuracy rates and increase access to primary care in the US over the next decade (Blease et al., 2020).

The majority of AI/ML studies show the beneficial impact of these tools on the effectiveness of medical diagnosis at the primary care level. The diagnostic effectiveness of AI tools supporting clinical decision-making has been confirmed for such aspects as detecting or rejecting melanoma (Helenason et al., 2024), predicting the risk of diabetic retinopathy (DR) and macular edema (DME) in patients with diabetes (Choi et al., 2025), improving the diagnosis and treatment of heart failure (Dos Santos et al., 2025), for early detection of patients with asymptomatic chronic liver diseases, detecting urinary tract stones, diagnosing low ejection fraction (EF) at an early stage (Rushlow et al., 2022), identifying suspected glaucoma (Kaskar et al., 2022), diagnosing oesophageal cancer imaging, improving the accuracy and efficiency of early screening for rheumatoid arthritis (RA), differentiating asthma from chronic obstructive pulmonary disease (COPD), and detecting infant hip dysplasia (DDH) (Libon et al., 2023). The researchers have also presented an automated ML pipeline designed for a real-world primary care patient dataset and compared

the performance of different predictive models to assess different clinical parameters, design interventions, and define diagnoses. Researchers believe that such AI techniques can help physicians develop the correct diagnosis and design the most appropriate clinical pathway for specific patient conditions (Mariani et al., 2021).

While several recent reviews have examined AI in healthcare or in primary care more broadly, none have assessed the technology's impact across all core dimensions of primary care quality. For example, a recent meta-analysis demonstrated generally positive effects of AI on overall healthcare quality but focused exclusively on randomised trials across diverse care settings and did not analyse PHC-specific dimensions such as continuity or coordination (Alzghoul, 2024). Other narrowly focused reviews have examined community-based PHC or specific clinical domains but do not provide a cross-dimensional assessment of quality (Matmi et al., 2023). Importantly, none of the existing reviews evaluate AI through a comprehensive PHC quality framework. Earlier studies either examined isolated dimensions (e.g., diagnostic accuracy or workflow efficiency) or focused on implementation experiences, but no prior work mapped evidence across all five quality dimensions simultaneously. In contrast, the present review is the first to systematically assess AI applications across the full set of primary care quality dimensions – continuity, coordination, communication, access, and efficiency – offering an integrated perspective absent from previous analyses. This approach reveals both well-established areas of AI's contribution (diagnostic efficiency, access improvement) and previously unrecognised evidence gaps, particularly in terms of the continuity and coordination of care.

Beyond its clinical relevance, the findings of this review contribute to management and health system sciences. By mapping AI applications onto the core dimensions of PHC quality, the study provides a structured view of where AI currently reinforces managerial functions – such as resource allocation, workflow optimisation, triage and risk stratification – and where its potential remains underdeveloped, particularly in care coordination and continuity. The strong geographical concentration of studies in high-income countries and in specific health system models further underlines that AI adoption is not a purely technical issue, but a strategic management and governance challenge linked to financing arrangements, organisational capacity and digital maturity. From a management perspective, AI in primary care should therefore be seen as an instrument for redesigning care pathways, improving process efficiency and supporting equity-oriented decision-making, rather than as an isolated technological innovation.

Despite these benefits, this review identifies two major gaps that remain insufficiently explored in current scientific literature: 1) the limited evidence on AI's impact on the continuity and coordination of care; 2) the significant inequalities in AI implementation between high-income and low-income countries, driven primarily by disparities in digital maturity, infrastructure readiness and health system financing models.

These gaps reveal important directions for future research. Studies should focus on the development and evaluation of AI solutions that strengthen continuity and coordinated care pathways, particularly in chronic disease management. Further investigation is also needed to assess AI adoption across diverse healthcare system models and to understand the ethical and equity implications of AI use in marginalised or low-resource populations. Future research may also explore the integration of AI tools into long-term population health management, including preventive care, risk stratification and tailored interventions at the community level.

6. CONCLUSIONS

The use of AI in primary care is expected to have a positive impact on various dimensions of quality of care. AI/ML can primarily improve the efficiency of primary care in various areas, from predicting the prescription of medications and existing treatments to monitoring health status and preventing diseases. Above all, it can help in diagnosing various health problems by supporting the assessments of healthcare professionals. Digital healthcare, through detailed analysis of medical data, can complement existing diagnostic methods and contribute to more effective treatment of various conditions.

Furthermore, AI can have a positive impact on access to healthcare. It can accelerate access to specialist services and help alleviate the burden of care through data-driven risk prediction and demand-capacity alignment. In the administrative area, AI can optimise access by managing service queues and reducing waiting times. There is also growing evidence of AI support in the area of GP – patient communication, although findings in this dimension remain diverse.

From the perspective of management sciences, the review highlights AI as a lever for redesigning primary care processes, strengthening data-informed decision-making, and addressing inequities in access to high-quality PHC. At the same time, the findings clearly show that continuity and coordination of care remain areas where managerial and organisational innovations are still required, as current AI applications provide little evidence of supporting these dimensions.

This review demonstrates that AI has a consistently positive effect on diagnostic efficiency and access to primary care services, while evidence regarding communication support is growing but still heterogeneous. In contrast, the dimensions of continuity and coordination remain significantly under-explored, revealing a critical gap in current empirical work. The analysis also shows that the implementation and effectiveness of AI tools are closely linked to differences in digital readiness, infrastructure, and financing models across healthcare systems, which explains the heavy concentration of evidence from high-income countries.

For policymakers and primary care leaders, these findings indicate that AI adoption strategies must be aligned with system-level capacities and should prioritise

tools that strengthen diagnostic accuracy and access while supporting – not replacing – human-mediated communication. Future research should focus on the role of AI in integrated care pathways, long-term management of chronic diseases, and equity-oriented implementation in resource-constrained settings.

Looking to the future, AI should also facilitate more continuous and coordinated care for patients with different health problems. At present, however, no empirical evidence confirms a beneficial effect of AI in these two dimensions. The right combination of AI and human clinical judgement offers the potential to improve the quality of primary care by making it more accessible, more efficient and more tailored to the personal needs of patients. AI-enabled primary care thus creates an opportunity for a system that is not only highly efficient and effective, but also patient-centred and better aligned with contemporary health system challenges.

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ROLA SZTUCZNEJ INTELIGENCJI W POPRAWIE JAKOŚCI PODSTAWOWEJ OPIEKI ZDROWOTNEJ

Streszczenie

Sztuczna inteligencja (AI) jest coraz częściej stosowana we wspieraniu różnych aspektów opieki zdrowotnej. Wdrożenie AI w podstawowej opiece zdrowotnej (POZ) wymaga jednak lepszego zrozumienia jej wpływu na podstawowe aspekty jej jakości. Niniejszy przegląd systematyczny ma na celu zbadanie roli AI w poprawie najważniejszych wymiarów jakości POZ, w szczególności dostępu, ciągłości, wydajności, komunikacji i koordynacji. Do wyszukiwania wykorzystano trzy bazy danych, a mianowicie: PubMED, Scopus i WoS. Analiza obejmowała artykuły opublikowane od 1 stycznia 2020 r. do 31 marca 2025 r. w recenzowanych czasopismach. Strategia wyszukiwania bazowała na kombinacji

słów kluczowych związanych z AI i określonymi wymiarami jakości podstawowej opieki zdrowotnej. Po uwzględnieniu wszystkich kwalifikowalności opartych na strukturze PICo do analizy zakwalifikowano 34 badania. Badanie wykazało, że zastosowanie AI w POZ wpływa przede wszystkim na efektywność opieki, głownie poprzez wsparcie diagnozowania różnych problemów zdrowotnych. Po drugie, AI może mieć pozytywny wpływ na dostęp do opieki zdrowotnej poprzez poprawę dostępu do usług specjalistycznych i dostosowanie tej opieki do potrzeb pacjentów. W obszarze administracyjnym może optymalizować dostęp poprzez zarządzanie kolejkami usług. Coraz więcej dowodów wskazuje również na wsparcie AI w obszarze komunikacji lekarz rodzinny–pacjent. Obecnie nie ma dowodów na korzystny wpływ AI na poprawę koordynacji i ciągłości w POZ.

Słowa kluczowe: podstawowa opieka zdrowotna, komunikacja, efektywność, dostępność, sztuczna inteligencja, koordynacja, ciągłość