

# Exploring the Impact of Artificial Intelligence on Healthcare Delivery: Applications, Challenges, and Ethical Implications in Resource-Limited Settings

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## ABSTRACT

Artificial Intelligence (AI) has the potential to revolutionize healthcare delivery, particularly in resource-limited settings where there is often a shortage of healthcare professionals, diagnostic tools, and infrastructure. This systematic review explores the applications, challenges, and ethical implications of AI in healthcare in low-resource environments. The review highlights several promising AI applications, including disease diagnosis, telemedicine, patient monitoring, and decision support systems, which can help bridge gaps in healthcare access. However, challenges such as inadequate infrastructure, lack of trained personnel, high costs, and data privacy concerns hinder the widespread adoption of AI in these settings. Ethical issues, including algorithmic bias, transparency in decision-making, and the protection of patient data, also need to be addressed. This review concludes by recommending strategies for overcoming these barriers, such as improving infrastructure, enhancing training, and ensuring ethical AI implementation, to realize the full potential of AI in healthcare delivery in resource-limited settings.

## INTRODUCTION

The integration of Artificial Intelligence (AI) in healthcare is revolutionizing the way medical services are delivered, improving diagnostic accuracy, patient care, and operational efficiency (Alowais et al., 2023; Qayyum et al., 2023; Qureshi et al., 2024). AI technologies such as machine learning, natural language processing, and image recognition have demonstrated significant potential in enhancing healthcare delivery across various settings. In resource-limited environments, where access to quality care and medical professionals may be limited, AI offers transformative solutions that can bridge these gaps (Batool & Lopez, 2023; Omar et al., 2024; Strika et al., 2024). AI-driven tools

can aid in early disease detection, remote patient monitoring, and personalized treatment plans, potentially reducing the burden on overstretched healthcare systems (Kalra et al., 2024; Nordlinger et al., 2020; Saxena et al., 2024).

Previous studies have explored AI's applications in healthcare, highlighting its benefits, such as improving diagnosis accuracy and providing decision support for clinicians. For instance, a study by (Rajpurkar & Lungren, 2023) demonstrated the potential of deep learning models in interpreting medical images, while researchers highlighted the efficacy of AI in diagnosing skin cancer from dermatological images (Brancaccio et al., 2024; Gohil & Desai, 2024). These applications hold immense promise

for low-resource settings, where shortages in healthcare professionals and diagnostic infrastructure often delay timely interventions.

However, despite these advancements, the implementation of AI in resource-limited settings presents several challenges. Key barriers include technological infrastructure deficits, lack of trained personnel, data privacy concerns, and the high costs associated with adopting AI technologies. Additionally, ethical considerations, such as the potential for algorithmic biases, and the need for informed consent in AI-driven decision-making processes, further complicate the integration of AI in healthcare.

## METHODOLOGY

The methodology for this study involves a systematic review of existing literature, focusing on the applications, challenges, and ethical implications of Artificial Intelligence (AI) in healthcare delivery within resource-limited settings. The following steps outline the approach used to gather and analyze relevant studies. A comprehensive search was conducted across multiple electronic databases, including PubMed, Google Scholar, Scopus, and IEEE Xplore. The search terms used included "Artificial Intelligence in healthcare," "AI applications in low-resource settings," "AI healthcare challenges," "ethical implications of AI in healthcare," and "AI in resource-limited environments." Studies published in peer-reviewed journals between 2010 and 2024 were included, with a particular focus on articles discussing AI's role in improving healthcare delivery in developing countries or under-resourced regions.

The inclusion and exclusion criteria for this study were clearly defined to ensure relevance and quality of the selected literature. **Inclusion criteria** encompassed studies specifically focusing on the applications of artificial intelligence (AI) in healthcare delivery within resource-limited settings. Research that explored challenges or barriers to implementing AI in low-resource environments, as well as articles addressing the ethical implications of AI in healthcare, were considered. Eligible sources included peer-reviewed articles, case studies, and systematic reviews. Conversely, the **exclusion criteria** ruled out studies that concentrated on high-income countries or well-resourced healthcare settings. Articles that did

not discuss AI applications in healthcare or healthcare delivery were excluded, as were publications not available in English or those that were not fully accessible. Additionally, non-peer-reviewed sources, such as opinion pieces or news articles, were not included in the analysis.

The study employed a systematic methodology encompassing data extraction, synthesis, quality assessment, and ethical considerations to explore the role of artificial intelligence (AI) in healthcare delivery within resource-limited settings. During **data extraction**, key information was gathered from the selected studies, including study characteristics such as title, authors, publication year, and journal details. The types of AI technologies implemented in healthcare, such as machine learning, natural language processing, and image recognition, along with their specific uses in low-resource environments like diagnostic tools, telemedicine, and patient monitoring, were documented. Challenges to implementation, including technological, infrastructural, financial, and human resource barriers, were identified. Additionally, ethical implications, such as concerns around data privacy, algorithmic bias, transparency, and accountability in AI-driven healthcare decisions, were critically examined.

In **data synthesis**, the extracted data were thematically organized into three primary categories: applications of AI, challenges in implementing AI, and ethical considerations. These themes were analyzed to identify recurring patterns, gaps in the literature, and significant findings, which were then compared and contrasted across studies to provide a comprehensive overview of the state of AI in resource-limited healthcare settings.

The **quality assessment** of included studies was conducted using established criteria like the Critical Appraisal Skills Programme (CASP) checklist. This evaluation ensured the methodological rigor of the studies by assessing sample size, data collection methods, and their relevance to the research question. The methodology also recognized potential **limitations**, such as the exclusion of non-English studies and the reliance on published research, which may not capture the full spectrum of AI applications in low-resource settings. Furthermore, the rapid pace of AI advancements posed a challenge in ensuring the findings remained up-to-date.

Regarding **ethical considerations**, while the study involved secondary data analysis and thus did not raise direct ethical concerns, it critically analyzed ethical issues highlighted in the reviewed studies, particularly those related to AI's implications in healthcare.

By employing this comprehensive methodology, the study aims to provide a balanced assessment of how AI can enhance healthcare delivery in resource-limited settings, address the challenges encountered, and navigate the ethical dilemmas arising in this context.

## RESULTS

The results chapter provides a synthesis of the findings from the systematic review of literature on the applications, challenges, and ethical implications of Artificial Intelligence (AI) in

healthcare delivery within resource-limited settings. The studies included in this review highlighted various ways AI is being applied to improve healthcare, the barriers to its successful implementation, and the ethical considerations that must be addressed. The findings are categorized into three main themes: Applications of AI, Challenges in Implementation, and Ethical Implications.

### Applications of AI in Healthcare

AI applications in healthcare within resource-limited settings primarily focus on diagnostic tools, telemedicine, patient monitoring, and decision support systems. These applications have demonstrated the potential to overcome challenges such as shortages in healthcare professionals and limited access to advanced diagnostic tools.

**Table 1**

*AI Applications in Healthcare*

Application Area	AI Technology Used	Description of Application	Examples from Studies
Disease Diagnosis	Machine Learning, Deep Learning, Image Recognition	AI systems trained to analyze medical images (e.g., X-rays, CT scans) and diagnose diseases.	(Brancaccio et al., 2024; Gohil & Desai, 2024). used deep learning to detect pneumonia.
Telemedicine	Natural Language Processing, Chatbots	AI-driven platforms enable remote consultations and follow-ups, especially in rural areas.	AI telemedicine platforms in India providing consultations remotely.
Patient Monitoring	IoT, Wearable Devices, Machine Learning	Continuous monitoring of vital signs and predicting potential health issues.	Wearable devices in Kenya monitoring chronic diseases.
Decision Support Systems	Machine Learning, AI Algorithms	AI systems that support healthcare providers in making data-driven treatment decisions.	AI system for malaria diagnosis in sub-Saharan Africa

These applications are particularly beneficial in low-resource settings, where limited access to healthcare professionals and diagnostic tools is a persistent challenge.

### Challenges in Implementing AI in Resource-Limited Settings

Despite the promise of AI, the implementation of these technologies in resource-limited settings faces several significant barriers. These barriers can range from technological limitations to ethical and cultural factors.

**Table 2**

*Challenges in Implementing AI in Resource-Limited Settings*

Category	Challenge	Description	Examples from Studies
Infrastructure	Lack of technological infrastructure	Limited access to high-speed internet, computing resources, and electricity in many regions.	Limited AI usage in rural Africa due to electricity shortages.

Skilled Workforce	Shortage of trained personnel	There is a shortage of AI experts and healthcare professionals trained to work with AI tools.	AI platforms in Southeast Asia struggling with lack of training.
Data Privacy & Security	Concerns over data protection	The lack of secure platforms and clear data privacy laws in low-resource settings.	Data security issues in AI-powered clinics in Latin America.
Cost of Implementation	High costs of AI adoption	The cost of acquiring AI technology and training personnel can be prohibitive.	High initial costs of AI telemedicine platforms in rural India.
Cultural and Regulatory	Ethical and cultural resistance to AI adoption	Hesitancy or resistance to AI due to cultural beliefs or lack of understanding about AI.	Resistance in rural communities in Africa to AI in healthcare.

Addressing these challenges requires a multi-faceted approach that involves not only technological advancements but also social, economic, and cultural considerations. Several studies emphasize the need for international partnerships and local involvement in AI adoption strategies.

### Ethical Implications of AI in Healthcare

The integration of AI in healthcare raises significant ethical concerns, particularly in low-resource settings where regulatory frameworks may be weak or absent. These concerns primarily revolve around data privacy, algorithmic bias, informed consent, and transparency in AI-driven decisions.

**Table 3**

#### *Ethical Implications of AI in Healthcare*

Ethical Concern	Description	Examples from Studies
Data Privacy	AI requires access to sensitive patient data, raising privacy concerns.	Concerns over patient data misuse in AI-driven healthcare platforms in East Africa.
Algorithmic Bias	AI models may perpetuate or amplify existing biases in healthcare.	Bias in AI models used for diagnosing skin cancer, favoring lighter skin tones
Informed Consent	Patients may not fully understand AI's role in decision-making.	Lack of informed consent in AI telemedicine applications in Asia.
Transparency	Difficulty in explaining AI decision-making to patients and clinicians.	AI systems in remote areas not providing explainable results, leading to mistrust.

These ethical concerns underline the importance of developing AI systems that are not only technically advanced but also ethically sound. Studies stress the need for ethical guidelines, transparency, and community engagement in the implementation of AI in healthcare.

### Summary of Key Findings

The systematic review reveals that AI has

substantial potential to improve healthcare delivery in resource-limited settings. However, several challenges—such as infrastructure limitations, lack of skilled personnel, data privacy issues, and the high costs of implementation—remain significant barriers. Ethical concerns, particularly regarding data privacy and algorithmic biases, also need to be addressed to ensure that AI technologies are used responsibly.

**Table 4**

#### *Summary of Findings*

Theme	Key Findings
Applications of AI	AI shows promise in diagnostics, telemedicine, patient monitoring, and decision support.
Challenges	Major barriers include infrastructure deficits, lack of trained personnel, high costs, and data privacy concerns.
Ethical Implications	Ethical concerns include data privacy, algorithmic bias, and the need for transparency in AI decision-making.

AI has significant potential to address healthcare delivery challenges in resource-limited settings. However, successful implementation requires overcoming substantial barriers related to infrastructure, cost, and ethics. Further research and investment are needed to tailor AI applications to these environments and ensure that ethical standards are maintained.

The next steps involve formulating strategies to address these challenges, such as establishing international collaborations, developing affordable AI solutions, and creating robust regulatory frameworks to ensure AI is used ethically and equitably.

## DISCUSSION

The integration of Artificial Intelligence (AI) into healthcare systems in resource-limited settings has garnered significant attention due to its potential to address critical challenges such as inadequate access to healthcare professionals, diagnostic delays, and inefficient resource allocation. As this systematic review has shown, AI technologies such as machine learning, deep learning, natural language processing, and image recognition offer substantial promise in improving healthcare delivery, particularly in remote or underserved areas.

### Applications of AI in Healthcare

AI's applications in healthcare are diverse, ranging from disease diagnosis to telemedicine, patient monitoring, and decision support systems. The ability of AI to enhance diagnostic accuracy, particularly in medical imaging, is one of its most celebrated applications. Studies like those by (Ghaffar Nia et al., 2023; LA SALVIA, 2023) demonstrate that AI systems can match or even exceed the diagnostic performance of human clinicians in areas like pneumonia detection and skin cancer diagnosis. This has significant implications for resource-limited settings, where there is often a shortage of skilled medical professionals and access to advanced diagnostic tools (Al-Worafi, 2024).

Additionally, AI-powered telemedicine platforms provide much-needed healthcare services to remote areas, bridging the gap between patients and clinicians (Abbasi, 2024). This has been particularly important in developing countries, where AI is utilized to

facilitate remote consultations, monitor chronic diseases, and offer follow-up care. Such applications have the potential to reduce healthcare disparities in underserved regions, making quality healthcare more accessible.

### Challenges in Implementation

Despite the promising applications of AI in healthcare, several challenges hinder its widespread adoption in low-resource settings. One of the most significant barriers is the lack of adequate infrastructure, including unreliable internet access, limited electricity, and insufficient computing power. These factors often prevent the successful implementation of AI technologies, which typically require robust digital infrastructure to function effectively. In some regions, such as parts of sub-Saharan Africa and Southeast Asia, these infrastructural deficits severely limit the potential of AI to improve healthcare delivery.

Moreover, the shortage of skilled personnel, both in healthcare and in AI development, further complicates the situation. The lack of trained healthcare professionals capable of utilizing AI tools and the absence of AI experts to develop and maintain these technologies in low-resource settings are significant hurdles. A recent study from Southeast Asia highlighted that the adoption of AI platforms in healthcare settings faced delays due to the insufficient training of healthcare providers and the lack of technical expertise in local communities.

Another challenge identified in this review is the high cost of AI adoption. Implementing AI in healthcare requires significant financial investment for both acquiring the technology and training personnel. For many resource-limited countries, this cost remains prohibitive, especially when faced with other pressing healthcare needs. In addition, the affordability of AI-based solutions remains a concern, as many AI applications are developed and priced for high-income settings, which are often inaccessible to low- and middle-income countries.

### Ethical Implications

The ethical considerations surrounding AI in healthcare are equally crucial, particularly in resource-limited settings where regulatory frameworks are often weak or non-existent. Data

privacy remains a major concern, as the collection and analysis of sensitive patient information through AI systems may expose individuals to risks of data breaches or misuse. This is particularly problematic in regions where healthcare data protection laws are either underdeveloped or poorly enforced.

Algorithmic bias is another ethical issue that needs to be addressed. AI systems are only as good as the data they are trained on, and if the data is not representative of diverse populations, the algorithms may produce biased results. For instance, AI models trained on data from high-income countries may not perform as well in resource-limited settings with different demographic profiles. This bias could lead to misdiagnosis or inadequate treatment recommendations, further exacerbating health inequalities.

Transparency in AI decision-making is also an ethical concern. Patients and healthcare providers need to understand how AI algorithms arrive at their conclusions, particularly when these systems are used to guide medical decisions. Lack of transparency can undermine trust in AI-driven healthcare solutions, which is crucial in settings where patients may already be skeptical of new technologies.

## CONCLUSION

This study highlights the transformative potential of AI in improving healthcare delivery in resource-limited settings, but it also underscores the challenges that must be addressed to ensure successful implementation. While AI can offer

solutions to critical issues such as diagnostic accuracy, remote healthcare access, and decision support, these technologies will not reach their full potential unless significant barriers are overcome.

## Key Recommendations

**Infrastructure Development:** Governments and international organizations should prioritize the development of the digital infrastructure needed to support AI applications in healthcare, including reliable internet, electricity, and computing resources.

**Training and Capacity Building:** Efforts should be made to train healthcare providers and AI professionals in resource-limited settings, ensuring that they are equipped to use and maintain AI technologies effectively.

**Affordable AI Solutions:** AI developers should work towards creating more affordable, scalable solutions that are tailored to the unique needs of low- and middle-income countries.

**Addressing Ethical Concerns:** Governments, healthcare institutions, and AI developers must collaborate to establish ethical guidelines that ensure data privacy, prevent algorithmic bias, and promote transparency in AI decision-making.

In summary, while AI holds the potential to revolutionize healthcare delivery in resource-limited settings, its successful integration requires addressing infrastructural, financial, and ethical challenges. With careful planning, international collaboration, and a focus on equity, AI can be a powerful tool for improving healthcare access and outcomes in underserved regions.

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