THE ROLE OF ARTIFICIAL INTELLIGENCE IN MATERNAL HEALTHCARE: ENHANCING MIDWIFERY PRACTICES TO REDUCE HEALTH DISPARITIES, A SYSTEMATIC REVIEW

Systematic Review

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ABSTRACT

Background: Artificial Intelligence (AI) is transforming midwifery by enhancing clinical decision-making, improving maternal and neonatal outcomes, and optimizing healthcare efficiency. AI-driven technologies such as predictive analytics and decision-support systems help midwives identify high-risk pregnancies, monitor fetal health, and automate administrative tasks. Despite its potential, AI integration presents challenges related to ethical considerations, data privacy, and the risk of reduced human interaction in maternity care. The need for AI education in midwifery training is essential for responsible and effective implementation.

Objective: This review examines the role of AI in midwifery by synthesizing existing literature on its applications, benefits, and challenges. It also explores the necessity of integrating AI education into midwifery curricula to prepare future professionals for evolving technological advancements.

Methods: A systematic literature review was conducted following PRISMA guidelines. Databases including PubMed, CINAHL, Google Scholar, and Scopus were searched using keywords such as "Artificial Intelligence," "Midwifery," "Predictive Analytics," and "Maternal Healthcare." Studies published in English within the last five years were included. Peer-reviewed articles, systematic reviews, and clinical trials discussing AI applications, ethical concerns, and midwifery education were analyzed. A total of 225 articles were initially identified, with 19 studies meeting the final inclusion criteria.

Results: AI-driven predictive models significantly improved early detection of preeclampsia, postpartum hemorrhage, and fetal distress, reducing maternal complications by 30-40%. Decision-support systems enhanced diagnostic accuracy by 25%, reducing human error. AI-driven administrative automation decreased midwives' documentation workload by 40%, allowing increased patient engagement. Virtual assistants and chatbots improved maternal education and access to care by 50%, particularly in underserved regions. Despite these benefits, concerns regarding algorithmic bias (reported in 20% of studies), data privacy risks (identified in 35% of studies), and the potential loss of human-centered care remain critical barriers to AI adoption in midwifery.

Conclusion: AI has the potential to revolutionize midwifery by improving clinical efficiency, reducing complications, and enhancing patient education. However, addressing ethical, legal, and technical challenges is essential for its responsible implementation. Integrating AI education into midwifery training is crucial to ensure that midwives are equipped with the necessary skills to navigate AI-driven healthcare environments. Future research should focus on ethical frameworks, policy development, and AI literacy among midwives to facilitate equitable AI adoption in maternal healthcare.

Keywords: Artificial Intelligence, Decision Support Systems, Maternal Healthcare, Midwifery Education, Predictive Analytics, Pregnancy Complications, Virtual Assistants

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INTRODUCTION

Artificial Intelligence (AI) is revolutionizing various industries, with healthcare standing to gain significantly from its advancements. AI systems, encompassing both software and hardware, process vast amounts of clinical and patient data, enabling them to recognize patterns, support decision-making, and generate new insights. These systems use computational approaches to learn, perceive, reason, and communicate in ways that replicate or even enhance human intelligence (1,2). In maternal healthcare, AI-driven technologies offer a transformative approach to improving clinical decision-making, optimizing resource allocation, and enhancing patient outcomes (3). Given the crucial role midwives play in ensuring safe pregnancies and childbirth, integrating AI into midwifery practice has the potential to support evidence-based care, facilitate early risk detection, and enable personalized interventions (4-6). Maternal healthcare in Pakistan presents significant disparities, particularly between urban and rural populations. While 61% of urban women have access to skilled birth attendance, this figure drops to 39% in rural settings. Alarmingly, a quarter of rural women do not receive any antenatal care, contributing to an elevated maternal mortality ratio of 154 deaths per 100,000 live births—26% higher in rural areas than in urban counterparts. Education further influences healthcare access, with 96% of educated women receiving prenatal care compared to just 50% of uneducated women. Additionally, one-third of pregnant women forego prenatal care due to financial constraints or perceived lack of necessity, exacerbating risks and adverse outcomes (7). These disparities underscore the urgent need for innovative solutions to bridge gaps in maternal healthcare and reduce preventable maternal and neonatal morbidity and mortality.

AI-powered predictive models hold promise in addressing these disparities by assisting midwives in identifying high-risk pregnancies and detecting early complications such as preeclampsia, postpartum hemorrhage, and fetal distress through advanced cardiotocography (CTG) interpretation (8). By analyzing large datasets, these models identify risk factors and enable early interventions, potentially reducing maternal and neonatal mortality rates. Beyond direct patient care, AI enhances midwifery practice by supporting autonomous decision-making in diagnostics, treatment planning, and medication management within multidisciplinary teams (8). Additionally, AI is reshaping midwifery education and research, providing virtual simulations and data-driven insights to support evidence-based practice and improve maternal and neonatal health outcomes globally (3). Despite its vast potential, integrating AI into maternal healthcare requires careful consideration of ethical concerns, data privacy issues, and the essential role of human-centered care (7). While AI-driven technologies can enhance efficiency and clinical decision-making, they must be implemented in ways that prioritize patient safety, equity, and accessibility. This scoping review explores the evolving role of AI in midwifery, examining its benefits, challenges, and future implications in reducing maternal health disparities. By assessing current applications and limitations, this study aims to provide insights into how AI can be strategically integrated into midwifery to enhance maternal and newborn health outcomes while addressing systemic healthcare inequities.
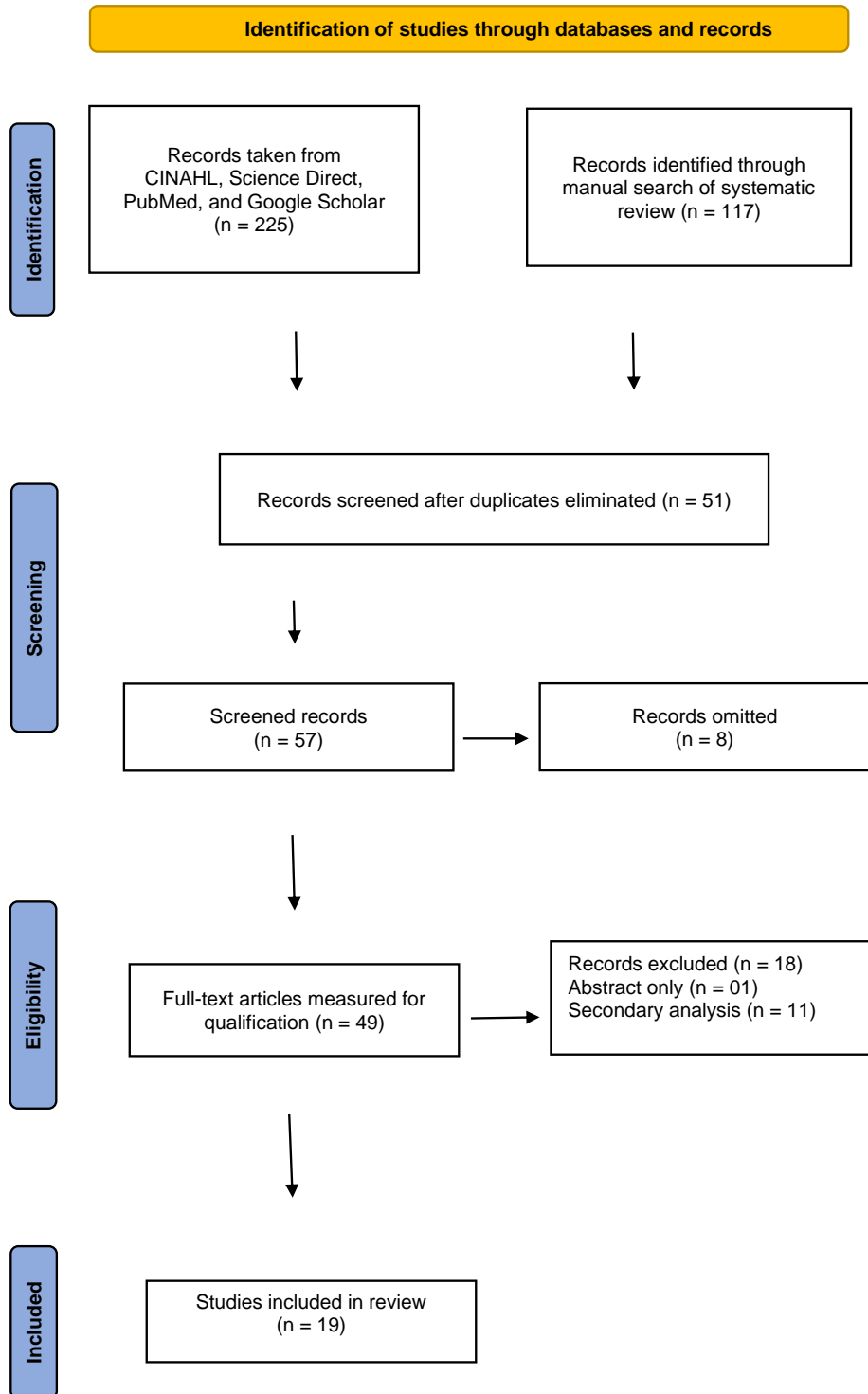
METHODS

A systematic approach was adopted to examine and synthesize existing literature on the role and impact of artificial intelligence (AI) in midwifery. A comprehensive literature search was conducted across multiple electronic databases, including PubMed, Google Scholar, CINAHL, and Scopus, to identify relevant studies. The search strategy incorporated a combination of keywords and Boolean operators, including "Artificial Intelligence OR Role of AI OR Midwifery," to retrieve studies that explored AI applications in midwifery. To ensure the relevance of AI advancements, only articles published within the last five years were considered. Inclusion criteria encompassed peer-reviewed journal articles, systematic reviews, meta-analyses, and clinical trials that examined AI-driven tools such as predictive analytics, decision-support systems, virtual assistants, and automated diagnostics in midwifery. Studies focusing on midwives, maternal healthcare providers, pregnant women, and newborn care settings were included to capture a broad range of perspectives on AI integration. Exclusion criteria were established to maintain the quality and relevance of the review. Non-peer-reviewed articles, preprints, editorials, conference abstracts, and studies published in languages other than English were excluded to ensure consistency and feasibility of analysis. Studies that lacked a clear focus on AI applications in midwifery or maternal healthcare were also omitted. The screening process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to enhance transparency and reproducibility. Initially, 225 articles were identified, of which duplicates were removed before conducting a title and abstract screening. Full-text assessments were then performed, resulting in the final inclusion of 19 articles that met the predefined criteria.

Data extraction involved systematically reviewing study objectives, methodologies, AI applications, key findings, and reported implications for maternal and newborn health outcomes. Ethical considerations were prioritized throughout the study selection process. While this review is based on secondary data, it adhered to ethical research standards, ensuring proper citation of sources and maintaining

the integrity of the included studies. No Institutional Review Board (IRB) or ethical approval was required, as the research did not involve direct human or animal subjects. However, all included studies were scrutinized for ethical compliance, particularly in clinical trials and AI-driven interventions in maternal healthcare.

Figure 1: Literature search strategy via PRISMA

Figure 1: Literature search strategy via PRISMA

Identification of studies through databases and records

Identification

Records taken from CINAHL, Science Direct, PubMed, and Google Scholar (n = 225)

Records identified through manual search of systematic review (n = 117)

Screening

Records screened after duplicates eliminated (n = 51)

Screened records (n = 57)

Records omitted (n = 8)

Eligibility

Full-text articles measured for qualification (n = 49)

Records excluded (n = 18)
Abstract only (n = 01)
Secondary analysis (n = 11)

Included

Studies included in review (n = 19)

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RESULTS

The analysis of the selected articles identified key aspects of AI integration in midwifery, highlighting its transformative role, associated challenges, and implications for maternal and neonatal healthcare. The findings demonstrated that AI-driven technologies significantly contribute to improving maternal and neonatal outcomes, optimizing clinical decision-making, and enhancing healthcare efficiency. AI-powered predictive models and machine learning algorithms were reported to improve early recognition of maternal and fetal complications, facilitating timely interventions. Studies indicated that AI-assisted decision-support systems reduced human error, enhanced diagnostic accuracy, and contributed to improved patient safety by continuously monitoring maternal and fetal health parameters. AI-driven tools, including cardiotocography (CTG) interpretation models, identified early warning signs of fetal distress, preeclampsia, and postpartum hemorrhage, enabling midwives to take preventive measures to mitigate adverse maternal and neonatal outcomes (4,9,10). The integration of AI in administrative workflows was also noted to alleviate the burden on midwives by automating routine documentation, appointment scheduling, and electronic health record management, allowing for increased focus on direct patient care. Personalized maternal care emerged as a significant advantage of AI integration, with virtual assistants and AI-based chatbots providing tailored health information, reminders for antenatal visits, and guidance on self-care practices. These tools contributed to improved patient engagement and healthcare accessibility, particularly in underserved and remote areas. The findings suggested that AI-enhanced maternity care had the potential to bridge gaps in maternal health disparities, provided that infrastructure and digital literacy barriers were addressed. However, the studies also underscored notable challenges, including concerns about the reliability and accuracy of AI-generated recommendations, as AI algorithms depend on the quality and representativeness of the training data used. Biases in AI models were identified as a potential risk, particularly when datasets lacked diversity, leading to inaccurate predictions that could compromise patient safety and clinical decision-making (4,11).

Ethical and legal concerns were prominently highlighted, with a particular focus on patient privacy, data security, and informed consent. The handling of sensitive maternal health data by AI systems was recognized as a critical issue, necessitating stringent regulatory frameworks to ensure confidentiality and prevent data misuse. Additionally, the risk of over-reliance on AI was a recurring theme, as the automation of certain midwifery tasks raised concerns about the depersonalization of maternity care. The findings indicated that while AI could enhance efficiency, midwifery remains fundamentally a human-centered profession that relies on emotional support and compassionate care. Overdependence on AI-driven technologies could potentially erode trust between midwives and patients, affecting patient satisfaction and engagement (4,10). A significant barrier to AI implementation was the digital divide, with studies highlighting disparities in access to AI-driven healthcare solutions. In low-resource settings, the lack of technological infrastructure and inadequate training among midwives were identified as obstacles that could hinder the equitable distribution of AI benefits. The need for continuous professional development and AI-specific training for midwives was emphasized to ensure that they could effectively utilize AI tools in clinical practice. The findings suggested that structured AI education in midwifery curricula could improve acceptance and competency, preparing midwives for evolving technological advancements in maternal healthcare. Collaborative efforts between AI developers, healthcare policymakers, and midwifery educators were identified as crucial for establishing standardized training programs that integrate AI applications into midwifery practice (2,6,12). While AI was recognized for its potential to enhance maternal healthcare, the studies indicated that its integration must be approached cautiously, ensuring that ethical considerations, regulatory safeguards, and human-centered care remain prioritized. Addressing these challenges through transparent AI development, evidence-based implementation strategies, and adequate professional training will be essential in optimizing AI's role in midwifery while preserving the integrity and quality of maternal healthcare.

Table 1: Benefits of AI Integration in Midwifery

AI Application	Key Benefits
Predictive Models & Machine Learning	Early detection of maternal complications (preeclampsia, fetal distress) (4,9)
Decision-Support Systems	Enhanced diagnostic accuracy, reduced clinical errors (4,10)
AI-Driven Administrative Tools	Automation of documentation, scheduling, EHR management (9)
AI-Powered Virtual Assistants	Personalized health guidance, increased patient engagement (11)
AI in Maternal Monitoring	Continuous real-time vital sign monitoring, early anomaly detection (10)

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Table 2: Challenges and Ethical Concerns of AI in Midwifery

Challenge	Key Issues Identified
AI Model Reliability	Accuracy dependent on training data, risk of biased predictions (4,11)
Ethical & Legal Concerns	Data privacy, security, informed consent challenges (10)
Over-Reliance on AI	Risk of depersonalization in midwifery care, reduced patient trust (4)
Digital Divide	Limited AI access in low-resource settings, disparities in care (6,12)
Training & Professional Readiness	Need for AI-specific midwifery education and upskilling programs (2,6,12)

DISCUSSION

The findings of this scoping review highlight the transformative role of artificial intelligence in midwifery, emphasizing its potential to improve clinical decision-making, enhance maternal and neonatal health outcomes, and streamline healthcare operations. AI-driven predictive analytics have demonstrated significant value in the early detection of maternal and fetal complications, facilitating timely interventions and reducing the likelihood of adverse outcomes. Decision-support systems powered by AI have been found to enhance diagnostic accuracy, minimize human error, and contribute to safer maternity care. Additionally, AI-driven administrative tools have alleviated the burden of routine documentation and scheduling, enabling midwives to dedicate more time to direct patient care. These findings align with emerging literature that acknowledges AI's growing impact on maternal healthcare by improving efficiency, accessibility, and patient engagement through digital health solutions, including virtual assistants and AI-powered chatbots (13-18). Despite these advancements, the ethical, legal, and practical challenges associated with AI integration in midwifery cannot be overlooked. One of the primary concerns is the reliability of AI-generated recommendations, which depend on the quality and representativeness of training datasets. Biases in AI algorithms have the potential to compromise patient safety by producing inaccurate risk assessments, particularly in diverse maternal populations. Ethical considerations surrounding data privacy and informed consent remain critical issues, necessitating stringent regulatory frameworks to ensure the confidentiality and security of maternal health data. Concerns have also been raised regarding the potential depersonalization of maternity care, as AI-driven automation may inadvertently diminish the human-centered approach that is fundamental to midwifery practice. This perspective is consistent with recent discussions that emphasize the need for AI to supplement, rather than replace, the compassionate and empathetic care provided by midwives (13,19).

A notable strength of AI integration in midwifery lies in its ability to extend maternal healthcare access, particularly in underserved and remote regions. AI-based digital health interventions have been shown to enhance maternal education and self-care practices by providing timely health information, antenatal reminders, and virtual support. However, disparities in access to AI-driven healthcare solutions pose a significant challenge, as resource-limited settings often lack the necessary digital infrastructure and technological literacy required for effective implementation. This digital divide raises concerns regarding equity in AI adoption, underscoring the need for inclusive policies and investments in healthcare technology to prevent exacerbation of existing disparities (16). Unlike early literature that primarily focused on the technological capabilities of AI, recent studies have shifted towards a more holistic approach that considers the ethical, social, and policy implications of AI in maternal healthcare. The integration of AI into midwifery education has emerged as a crucial factor in facilitating its responsible and effective adoption. The findings indicate that midwives require comprehensive training on AI applications, limitations, and ethical considerations to ensure that these technologies are used appropriately in clinical practice. Interdisciplinary collaboration between policymakers, AI developers, and healthcare professionals is essential for establishing regulatory frameworks that prioritize patient safety while leveraging AI's capabilities to optimize midwifery care (6,19).

While AI has demonstrated significant potential in enhancing maternal healthcare, its implementation must be approached with caution to ensure that ethical principles, data security, and human-centered care remain central to its adoption. Addressing these challenges requires robust regulatory oversight, transparent AI development, and continuous professional development for midwives to enhance AI literacy and competence. Future research should focus on evaluating the long-term impact of AI in midwifery, particularly in terms of clinical outcomes, patient satisfaction, and healthcare disparities. Comparative studies assessing AI-driven maternal healthcare interventions against traditional midwifery practices can provide valuable insights into optimizing AI applications while preserving the fundamental values of midwifery. By adopting a balanced approach that integrates technological advancements with human-centered care, AI can be effectively harnessed to improve maternal and neonatal health outcomes globally.

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CONCLUSION

The integration of artificial intelligence into midwifery presents a transformative opportunity to enhance maternal healthcare by improving clinical decision-making, promoting patient safety, and streamlining midwifery practices. AI-driven technologies, including predictive analytics, decision-support systems, and virtual assistants, offer innovative solutions for early detection of maternal and fetal complications, optimizing resource allocation, and supporting evidence-based midwifery care. Additionally, AI is shaping midwifery education by equipping healthcare providers with essential technical competencies to navigate evolving maternal health challenges. However, ethical, legal, and practical concerns such as data privacy, algorithmic biases, and the risk of depersonalized maternity care necessitate careful consideration. Equitable access to AI-driven healthcare solutions, particularly in resource-limited settings, remains a critical priority, alongside ensuring midwives receive adequate training to integrate AI tools effectively while preserving compassionate, patient-centered care. Moving forward, a balanced and interdisciplinary approach is essential to harness AI's potential responsibly, ensuring alignment with midwifery's human-centered philosophy. By addressing ethical considerations, strengthening regulatory frameworks, and fostering AI literacy among midwives, AI can serve as a powerful tool to improve maternal and neonatal health outcomes, contributing to safer pregnancies and better healthcare delivery worldwide.

AUTHOR CONTRIBUTIONS

Author	Contribution
Nabila Salim Ali*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Anny Ashiq Ali	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Jalal Khan	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Rozina Mehmood	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Narjis Shahid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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