Buletin Ilmu Kebidanan dan Keperawatan (BIKK) **E-ISSN 2962-4142**
DOI: 10.56741/bikk.v4i02.915 **P-ISSN 2962-5734**



The Role of Artificial Intelligence in Midwifery

A Scoping Review of Benefits, Challenges, and Ethical Implications

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Article submitted: 5 April 2025 **Revised:** 7 May 2025 **Accepted:** 19 May 2025

Abstract

Artificial Intelligence (AI) is rapidly transforming healthcare and holds significant potential to improve maternal and neonatal outcomes through its application in midwifery. This scoping review investigates the role of AI in midwifery, emphasizing its benefits, challenges, and ethical implications. Guided by the Arksey and O'Malley framework, a systematic literature search was conducted using Google Scholar (2014–2024) via the Publish or Perish software, with keywords including "Artificial Intelligence in Midwifery," "AI and Maternal Health," and "Machine Learning in Obstetrics." A total of 15 articles were reviewed. The findings reveal five key areas where AI contributes to midwifery practice: (1) early detection of pregnancy complications such as preeclampsia and gestational diabetes using predictive machine learning models; (2) remote monitoring of pregnancy through wearable devices and mobile applications; (3) use of virtual assistants and chatbots for patient education and psychological support; (4) optimization of healthcare facility management, including electronic health records and resource allocation; and (5) AI-based training simulations for midwives to enhance clinical competencies. While these advancements offer promising improvements, challenges remain, including high implementation costs, limited infrastructure, and data privacy concerns. Ethical considerations stress the importance of ensuring AI complements—rather than replaces—the empathetic, human-centered care that is central to midwifery. This review highlights the transformative potential of AI in midwifery and advocates for its ethical and balanced integration to maximize benefits for maternal and neonatal health.

Keywords: *Artificial Intelligence, Ethical Implications, Midwifery, Pregnancy Complications, Remote Monitoring, Virtual Assistants*

Introduction

Artificial Intelligence (AI) has rapidly evolved into one of the most groundbreaking technological advancements of the 21st century, reshaping industries and revolutionizing the way tasks are performed. In the realm of healthcare, AI is proving to be a game-changer, offering innovative solutions to longstanding challenges and opening new avenues for improving patient care. Among the various medical disciplines, midwifery stands to benefit significantly from the integration of AI technologies. From prenatal care to childbirth and postpartum support, AI has the potential to enhance the quality, efficiency, and accessibility of maternal healthcare services, ultimately contributing to better outcomes for both mothers and infants [1], [2].

The application of AI in midwifery is multifaceted, addressing critical areas such as early detection of pregnancy complications, remote monitoring of maternal and fetal health, and the optimization of healthcare management systems. For instance, advanced AI algorithms can analyze vast amounts of patient data to identify risks such as preeclampsia, gestational diabetes, or fetal

abnormalities with greater speed and accuracy than traditional methods [1], [3], [4]. Additionally, AI-powered tools, including wearable devices and mobile applications, enable continuous remote monitoring of vital signs, allowing healthcare providers to track the health of expectant mothers in real-time, even from a distance [5], [6]. This is particularly beneficial for women in remote or underserved areas who may face barriers to accessing regular in-person care [6], [7].

Beyond clinical applications, AI also serves as a valuable resource for education and training in midwifery. Through computer-based simulations and virtual reality (VR) technologies, aspiring midwives can gain hands-on experience in managing complex or emergency situations without the need for direct patient interaction [7], [8]. This not only enhances their skills but also ensures that they are better prepared to handle real-life scenarios. Furthermore, AI-driven virtual assistants and chatbots provide reliable, on-demand information to pregnant women, offering guidance on nutrition, childbirth preparation, and newborn care, thereby empowering them to make informed decisions about their health [6], [9].

However, the integration of AI into midwifery is not without its challenges. Issues such as the high cost of implementation, the need for robust technological infrastructure, and concerns about data privacy and security must be carefully addressed [1]. Moreover, the ethical implications of relying on AI in such a sensitive and human-centric field cannot be overlooked. While AI can augment the capabilities of healthcare providers, it is crucial to ensure that it complements, rather than replaces, the empathetic and personalized care that midwives are known for [10]. Striking the right balance between technological innovation and the human touch is essential to harnessing the full potential of AI in midwifery.

This article aims to provide a comprehensive exploration of the role of AI in midwifery, highlighting its transformative benefits, addressing the challenges it presents, and examining the ethical considerations that must guide its implementation. By delving into topics such as early complication detection, remote monitoring, virtual assistance, and training simulations, we will illustrate how AI is poised to revolutionize maternal healthcare. At the same time, we will emphasize the importance of maintaining a patient-centered approach, ensuring that the integration of AI into midwifery ultimately serves to enhance, rather than diminish, the quality of care provided to mothers and their babies. Through this discussion, we hope to shed light on the immense potential of AI as a tool for advancing midwifery while underscoring the need for thoughtful and responsible adoption of this technology.

Materials and Methods

This scoping review was conducted following the methodological framework developed by Arksey and O'Malley, which provides a structured approach for comprehensively mapping existing literature on a topic. The framework consists of five key stages: (1) identifying the research questions, (2) identifying relevant studies, (3) selecting studies, (4) extracting and synthesizing data, and (5) reporting the findings.

To ensure a thorough and systematic search, the literature review was conducted using the Google Scholar database, accessed via the Publish or Perish software. The search covered publications

from 2014 to 2024, ensuring the inclusion of recent and relevant studies. The search strategy employed specific keywords, including *"Artificial Intelligence in Midwifery," "AI and Maternal Health,"* and *"Machine Learning in Obstetrics,"* to capture studies that explore the application of AI technologies in midwifery and maternal healthcare. These keywords were chosen to align with the study's focus on understanding the role, benefits, and challenges of AI in this field.

The inclusion criteria for study selection were based on: relevance to the research questions, publication in peer-reviewed journals, publication within the specified timeframe (2014–2024), and availability of full-text articles. Studies that did not directly address the use of AI in midwifery or maternal health were excluded.

A total of 15 articles were retrieved and included in the final analysis after a two-step screening process: an initial review of titles and abstracts, followed by a full-text review to confirm eligibility. Data from the selected studies were then extracted and synthesized thematically to identify key patterns, insights, and gaps in the existing literature.

To ensure transparency in the selection process, a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram was developed to document the identification, screening, eligibility, and inclusion stages. This methodological approach ensures a rigorous and transparent process for mapping the current state of knowledge on AI in midwifery, providing a solid foundation for understanding its potential applications and implications in maternal healthcare.

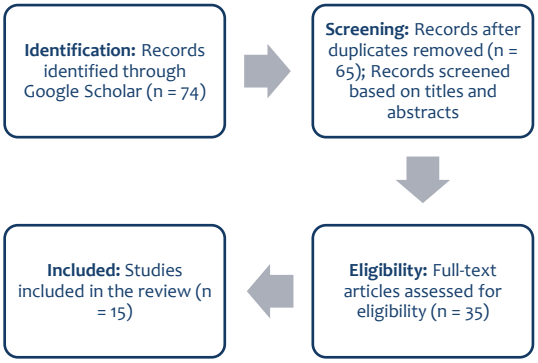


Fig. 1. Article Selection Process

A total of 74 records were initially identified through a Google Scholar search using the Publish or Perish software and relevant keywords related to artificial intelligence and midwifery. After the removal of 9 duplicate entries, 65 records remained for title and abstract screening. Following this initial screening, 30 articles were excluded for not meeting the inclusion criteria, leaving 35 full-text articles for further assessment. Of these, 20 articles were excluded due to a lack of relevance or insufficient focus on AI applications in midwifery and maternal health. Ultimately, 15 articles published between 2014 and 2024 were included in the final scoping review.

Results and Discussions

The findings of this scoping review highlight the transformative potential of Artificial Intelligence (AI) in midwifery, particularly in enhancing maternal healthcare services. The results are

organized into five key areas where AI has demonstrated significant contributions, along with a discussion of the challenges and ethical implications associated with its implementation.

Table 1. Five key areas where AI has demonstrated significant contributions

No.	Themes	Title	
1	Early Detection of Pregnancy Complications	Artificial Intelligence in Early Diagnosis of Preeclampsia [8]	Bülez et al.
		Cardiotocographic Diagnosis of Fetal Health based on Multiclass Morphologic Pattern Predictions using Deep Learning Classification [7]	Miao and Hao
		Deep learning to estimate gestational age from fly-to cineloop videos: a novel approach to ultrasound quality control [10]	Viswanathan et al.
		Development of Machine Learning-Based Model for Quality Measurement in Maternal, Neonatal and Child Health Services: A Country Level Model for Tanzania [11]	Nyanjara et al.
		Artificial Womb Technology: Analyzing the Impact of Lab-Grown Infants on Global Society [12]	George
		AI-Driven Early Diabetes Prediction [13]	Sehgal et al.
		Transforming maternal healthcare: Harnessing the power of artificial intelligence for improved outcomes and access [3]	Panda and Sharma
2	Remote Pregnancy Monitoring	Artificial intelligence to understand the fluctuation of fetal brain activity by recognizing facial expressions [6]	Miyagi et al.
		Users' perceptions toward mHealth technologies for health and well-being monitoring in pregnancy care: qualitative interview study [14]	Li et al.
3	Virtual Assistants for Consultation	Artificial intelligence in obstetric anaesthesia: How the next decade may unfold [5]	Barbounaki and Vivilaki
		Rosie, a health education question-and-answer chatbot for new mothers: randomized pilot study [15]	Nguyen et al.
4	Optimization of Hospital and Clinic Management	Using machine learning to identify quality-of-care predictors for emergency caesarean sections: a retrospective cohort study [1]	Andersen et al.
		Maternal and Child Health Services amid COVID-19 and Lockdown Distresses [4]	Diara
5	Training and Simulation for Midwives	Intelligent systems in obstetrics and midwifery: Applications of machine learning [5]	Barbounaki and Vivilaki
		Simulation-based training in obstetric anaesthesia [16]	Duffy and Kearsley

A. Early Detection of Pregnancy Complications

Studies indicate that AI, particularly through machine learning models, can significantly improve the early detection of pregnancy complications such as preeclampsia, gestational diabetes, and fetal abnormalities [5], [10]. These predictive models analyze vast datasets, including patient history, genetic information, and real-time health metrics, to identify risk factors earlier and with greater accuracy than conventional methods. For example, AI algorithms can detect subtle patterns in blood pressure trends or glucose levels that may indicate the onset of preeclampsia or gestational diabetes long before clinical symptoms manifest [10], [11]. This early detection enables timely interventions, potentially reducing maternal and neonatal morbidity and mortality. However, the effectiveness of these models depends on the quality and diversity of the data used for training, which raises concerns about bias and generalizability across different populations.

B. Remote Pregnancy Monitoring

AI-powered technologies, such as mobile health applications and wearable devices, have revolutionized remote pregnancy monitoring [6], [17]. These tools allow healthcare providers to track vital signs, fetal heart rates, and other health parameters in real-time, even from a distance. Research shows that remote monitoring not only improves patient adherence to prenatal care but also reduces the risk of complications by enabling early identification of abnormalities [18], [19]. For instance, wearable devices that monitor uterine activity or fetal movements can alert healthcare providers to potential issues, facilitating prompt medical attention [14], [20]. This is particularly beneficial for women in rural or underserved areas who face barriers to accessing regular in-person care. However, the widespread adoption of these technologies requires reliable internet connectivity and digital literacy, which may not be available in all regions.

C. Virtual Assistants for Consultation

AI-driven virtual assistants and chatbots have emerged as valuable tools for providing education and support to pregnant women [5], [21]. These platforms offer information on topics such as prenatal nutrition, childbirth preparation, and newborn care, empowering women to make informed decisions about their health. Studies have shown that virtual assistants can improve health literacy and provide psychological support, particularly for first-time mothers who may feel overwhelmed by the complexities of pregnancy [15], [19]. For example, chatbots can offer personalized advice based on individual health profiles, answering questions and addressing concerns in real-time. While these tools are highly accessible and cost-effective, they must be carefully designed to ensure the accuracy of information and avoid replacing the empathetic guidance that midwives provide.

D. Optimization of Hospital and Clinic Management

The implementation of AI in hospital and clinic management has proven to enhance operational efficiency in maternity care settings [22], [23]. AI systems streamline processes such as electronic health record (EHR) management, appointment scheduling, and inventory control for medications and medical supplies. For instance, AI algorithms can predict patient flow and optimize staff allocation, reducing wait times and improving resource utilization [1], [4], [7]. Additionally, AI-powered tools can automate routine administrative tasks, allowing healthcare providers to focus more on patient care. Despite these benefits, the high costs of implementing AI systems and the need for staff training pose significant challenges, particularly for smaller clinics with limited budgets [6], [9].

E. Training and Simulation for Midwives

AI-based training tools, including computer simulations and virtual reality (VR) platforms, are transforming midwifery education [3], [5]. These technologies enable midwives to practice clinical skills and manage emergency scenarios in a risk-free environment. Research demonstrates that such simulations improve clinical competence and confidence, preparing midwives to handle complex situations more effectively [6], [7], [16]. For example, VR simulations can replicate high-risk delivery scenarios, allowing midwives to refine their decision-making and technical skills without endangering

patients. However, the development and maintenance of these advanced training tools require substantial investment, which may limit their accessibility in resource-constrained settings.

While AI offers numerous benefits, its integration into midwifery is not without challenges. Key barriers include the high costs of implementation, inadequate technological infrastructure, and the need for stringent data privacy regulations [9]. The sensitive nature of maternal health data necessitates robust security measures to protect patient confidentiality and prevent misuse. Additionally, there is a risk of over-reliance on AI, which could undermine the human-centered approach that is central to midwifery care. It is crucial to ensure that AI remains a supportive tool, complementing rather than replacing the empathetic and personalized care provided by midwives. Ethical considerations must also address potential biases in AI algorithms, which could disproportionately affect marginalized populations if not properly addressed.

Conclusion

The findings of this scoping review highlight the significant potential of AI to transform midwifery and maternal healthcare. From early detection of complications to remote monitoring, virtual assistance, and enhanced training, AI offers innovative solutions to improve outcomes for mothers and infants. However, realizing this potential requires addressing significant challenges, including cost, infrastructure, and ethical concerns. By adopting a balanced approach that leverages the strengths of AI while preserving the human touch in midwifery care, healthcare systems can harness this technology to create a more efficient, accessible, and equitable future for maternal health.

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E-ISSN 2962-4142
DOI: 10.56741/bikk.v4i02.915
P-ISSN 2962-5734



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