

APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN OBSTETRICS: REVIEW ARTICLE

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ABSTRACT

Introduction: Artificial intelligence (AI) has emerged as a transformative technology in medicine, particularly in obstetrics and maternal–fetal medicine. By enabling automated analysis of large volumes of clinical and imaging data, AI offers new opportunities to improve screening, prediction, diagnosis, and clinical decision support. Despite the rapid growth of AI applications, concerns remain regarding methodological standardization, external validation, and real-world clinical applicability. **Objective:** To describe and critically analyze the main applications of artificial intelligence in obstetrics and maternal–fetal medicine, focusing on diagnostic and predictive performance, methodological limitations, and potential impact on clinical practice. **Methods:** A literature review was conducted using the PubMed database, including studies published between 2021 and 2025. Original research articles, systematic reviews, and meta-analyses addressing practical applications of AI in obstetrics and reporting algorithm performance metrics were included. The selected studies were categorized into four main domains: gestational age and fetal weight estimation, fetal and neonatal neurological assessment, prediction of hypertensive disorders of pregnancy, and prenatal screening for structural and genetic anomalies. **Results:** Twelve studies met the inclusion criteria. AI-based systems demonstrated performance comparable to that of experienced clinicians in gestational age estimation, particularly in low-resource settings. In fetal and neonatal neurological assessment, deep learning models showed high accuracy in detecting cerebral lesions and enabled dynamic evaluation of fetal brain activity through automated facial expression recognition. For the prediction of hypertensive disorders of pregnancy, AI models—especially those based on placental texture analysis—showed promising results, although with considerable methodological heterogeneity. AI-assisted screening for structural and genetic anomalies also achieved robust diagnostic performance, reducing operator dependency. **Conclusion:** Current evidence suggests that artificial intelligence has the potential to enhance diagnostic accuracy, reduce interobserver variability, and improve efficiency in obstetric care. However, challenges related to model interpretability, external validation, generalizability, and safe clinical integration remain. AI should be regarded as a complementary tool to clinical judgment rather than a replacement, and its successful implementation requires evidence-based guidelines and adequate training of healthcare professionals.

Keywords: Artificial intelligence, Obstetrics, Ultrasonography, Maternal–fetal medicine, Machine learning.

INTRODUCTION

Artificial intelligence (AI) refers to the ability of computational systems to perform tasks traditionally associated with human intelligence, such as reasoning, learning, adaptation, and sensory interpretation. Its conceptual foundations date back to the pioneering work of Alan Turing in 1950, when he proposed the test to evaluate whether a machine's behavior could be indistinguishable from that of a human, followed by the formalization of the term "artificial intelligence" by John McCarthy. Although the field began to be academically structured in the 1970s, it was only with advances in computational power and the availability of large volumes of data that the development of modern algorithms became possible. Unlike traditional rule-based algorithms, AI systems learn patterns directly from data, a concept famously demonstrated by historical milestones such as Deep Blue's victory in chess in 1997 and AlphaGo's success in the game of Go in 2016.¹

This technological evolution has driven widespread applications in everyday life and, more recently, has generated significant interest in clinical medicine due to AI's potential to extract meaningful information from large healthcare datasets. In the medical field, particularly in obstetrics and gynecology, AI has been successfully applied to screening, prediction, triage, diagnosis, monitoring, and image interpretation, contributing to greater accuracy and supporting clinical decision-making.^{1,2}

However, the available evidence remains limited, and further studies are needed to confirm the clinical applicability of artificial intelligence. In addition, it is essential to ensure improved physician training in the use of these systems and to develop evidence-based guidelines on the subject in order to maximize the benefits of AI technologies while minimizing their limitations.³

Therefore, the aim of this review is to describe the main modalities of artificial intelligence, their utility in daily clinical practice, and their contribution to the clinical decision-making process in obstetrics, providing a critical synthesis of recent evidence regarding the effectiveness, limitations, and transformative potential of this technology.

METHODOLOGY

This study presents a review of the scientific literature on applications of artificial intelligence in maternal-fetal medicine and obstetrics.

A search was conducted in the PubMed database for articles published between 2021 and 2025. The search terms used were "artificial intelligence in obstetrics" and "maternal-fetal medicine," combined using Boolean operators (AND, OR) to optimize the retrieval of relevant studies. The search strategy was designed to capture publications describing practical applications of AI in obstetrics, including original studies, systematic reviews, and meta-analyses.

Inclusion criteria included original research articles describing AI applications in obstetrics or maternal-fetal medicine; systematic reviews and meta-analyses on AI in obstetrics; studies published in journals indexed in PubMed; studies written in English or Portuguese; and studies reporting performance metrics of AI algorithms. Exclusion criteria included opinion articles, editorials, or commentaries; studies lacking evaluation of AI algorithm performance; studies focused exclusively on other medical specialties; and duplicate articles or studies with redundant data.

Data were extracted from each included article using a standardized form containing information on study identification (first author, year of publication, journal), study characteristics (design, setting, sample size), AI application (type of algorithm, input data), outcomes (performance measures), comparison with reference standards or human professionals, and methodological

limitations. The identified studies were categorized into four main areas of application: estimation of gestational age and fetal weight; fetal and neonatal neurological assessment; prediction of hypertensive disorders of pregnancy; and prenatal screening for structural and genetic anomalies.

RESULTS

The PubMed search identified a total of 93 records using the specified search terms. After application of the inclusion and exclusion criteria, 12 publications were included in the final analysis.

Table 1. Applications of Artificial Intelligence in Obstetric and Neonatal Ultrasound

| Author / Year | Study design | AI application | Population / Sample | Key findings |
|------------------------------|---------------------------------------|---|--|--|
| Stringer et al., 2024 | Prospective diagnostic accuracy study | AI-based estimation of gestational age from blinded ultrasound sweeps | 400 pregnant women (Zambia and USA) | The AI tool demonstrated accuracy comparable to standard biometry performed by experienced sonographers, with a similar mean absolute error (± 2 days). |
| Naz et al., 2025 | Systematic review and meta-analysis | AI models for gestational age estimation | 17 studies (10 included in the meta-analysis) | AI demonstrated good accuracy, particularly in the second trimester, with promising performance in low-resource settings. |
| Horky et al., 2025 | Prospective cohort study | AI-assisted estimation of term fetal weight | 300 term fetuses | AI showed greater variability and lower accuracy than experienced specialists, indicating the need for further optimization before routine clinical use. |
| Lin et al., 2025 | Multicenter observational study | Deep learning-based screening of neonatal brain lesions | Neonates evaluated by cranial ultrasound (China) | The model identified brain lesions with high sensitivity and specificity, outperforming conventional assessments in some scenarios. |

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|----------------------------|----------------------------------|--|--|---|
| Miyagi et al., 2021 | Observational study | Fetal facial expression recognition using 4D ultrasound | Fetuses between 27 and 37 weeks of gestation | AI was able to identify fetal facial patterns, suggesting an association with neurological activity. |
| Miyagi et al., 2023 | Analytical observational study | Dynamic analysis of fetal brain activity using AI-based facial recognition | Fetuses evaluated by 4D ultrasound | Integration of spectral and chaotic analysis with AI-based scoring revealed regular cycles and distinct states of fetal brain activity, extending beyond purely morphological classification. |
| Arora et al., 2025 | Observational study | AI-based placental texture analysis | Pregnant women evaluated by placental ultrasound | AI showed potential to predict hypertensive disorders of pregnancy. |
| Khalil et al., 2024 | Predictive study | Neural networks for preeclampsia prediction | Pregnant women with clinical data and biomarkers | The combination of biomarkers and clinical data improved the predictive performance of the AI model. |
| Malik et al., 2024 | Systematic review | Machine learning for preeclampsia prediction | Observational and predictive studies | ML models showed promising performance, although with substantial methodological heterogeneity. |
| Tang et al., 2023 | Development and validation study | Deep learning-based detection of genetic disorders | Fetuses evaluated by ultrasound | AI was able to identify both common and rare genetic disorders from fetal imaging. |
| Miyagi et al., 2024 | Observational study | AI applied to coagulation management in massive obstetric hemorrhage | Parturients with severe hemorrhage | The model defined objective fibrinogen and fibrin degradation product (FDP) thresholds, supporting clinical decision-making in time-critical settings. |
| Aoyama et al., 2024 | Methodological study | Automated assessment of the fetal pulmonary artery-to-aorta ratio | Fetuses evaluated by fetal cardiac ultrasound | AI demonstrated high accuracy in screening for congenital heart disease. |

DISCUSSION

Estimation of Gestational Age and Fetal Weight

Accurate estimation of gestational age is fundamental to prenatal care, influencing critical clinical decisions such as fetal growth surveillance, identification of prematurity, and delivery planning. The observational study conducted by Stringer et al. (2024) provides evidence that an integrated AI-based tool is capable of estimating gestational age with accuracy equivalent to fetal biometry performed by experienced sonographers, even when operated by novice users without prior training.⁴ A mean absolute error of less than four days, within the prespecified equivalence margin, demonstrates not only the algorithm's accuracy but also its consistency across different socioeconomic contexts, including low-resource settings such as Zambia. These findings reinforce the potential of AI as a supportive technology to expand access to reliable gestational dating, aligning with World Health Organization recommendations for the universalization of obstetric ultrasound.

Corroborating these results, the systematic review and meta-analysis by Naz et al. (2025) demonstrated good accuracy of AI models for gestational age estimation, particularly when applied to blind sweep videos, which showed lower mean error compared with static two-dimensional images.⁵ Subgroup analysis revealed better performance during the second trimester, a period characterized by lower fetal biological variability, which may explain the observed reduction in error. Despite the high heterogeneity among included studies, the review indicates that most studies had low or unclear risk of bias, suggesting that the findings are consistent and clinically relevant.

In contrast, when AI is applied to term fetal weight estimation, the results are more heterogeneous and warrant greater caution. The comparative study by Horky et al. (2025) demonstrated that AI-assisted algorithms performed worse than experienced sonographers, with greater variability and lower diagnostic accuracy, even after adjustment for daily fetal weight gain.⁶ Although manual estimation also failed to achieve optimal accuracy, remaining below 80%, AI models exhibited significant limitations, suggesting that, unlike gestational age dating, fetal weight estimation involves greater biological and technical complexity that is not yet fully captured by current models.

Fetal and Neonatal Neurological Assessment

The incorporation of artificial intelligence into ultrasonography has emerged as a promising strategy to enhance diagnostic capability, standardize interpretations, and optimize clinical workflows, as early and accurate assessment of fetal and neonatal neurological development and integrity remains one of the greatest challenges in medicine.

The observational study conducted by Lin et al. (2025) demonstrates the potential of AI in screening for severe neonatal brain lesions using cranial ultrasonography.⁷ The deep learning-based system showed exceptional performance, with areas under the curve (AUCs) exceeding 0.94 in both internal and external datasets, as well as high sensitivity, outperforming junior radiologists and achieving performance comparable to that of intermediate-level professionals. These findings are particularly relevant given that neonatal cranial ultrasound is highly operator-dependent and often performed in high-demand clinical settings. Automation of standard view acquisition and identification of severe lesions not only increases diagnostic efficiency - markedly reducing examination time - but may also contribute to earlier detection of conditions associated with adverse neurological outcomes, enabling timely interventions.

Complementarily, studies conducted by Miyagi et al. (2021; 2023) further expand this perspective by demonstrating that AI can explore functional aspects of the fetal nervous system through automated recognition of fetal facial expressions using four-dimensional ultrasonography.⁸ In the pilot study, the authors achieved high overall accuracy (0.985) in classifying facial expressions considered related to brain development, such as blinking, mouth movements, and yawning. These results suggest that AI may provide an objective and reproducible assessment of fetal behavioral patterns, which have traditionally been evaluated subjectively.

The methodological evolution observed in the subsequent study by Miyagi et al. (2023) reinforces this perspective by integrating spectral and chaotic analyses with the confidence scores generated by the AI classifier.⁹ The identification of regular cycles of facial activity, as well as distinct states (dense and sparse), provides quantitative evidence of fluctuations in fetal brain activity over time. These findings are particularly innovative, as they suggest that AI can transcend simple morphological classification and contribute to a dynamic understanding of fetal brain function, opening new avenues for the assessment of intrauterine neurodevelopment.

Prediction of Hypertensive Disorders of Pregnancy

Hypertensive disorders of pregnancy, particularly preeclampsia, remain among the leading causes of maternal and perinatal morbidity and mortality worldwide. The possibility of early prediction of these conditions represents a strategic opportunity for preventive interventions, such as timely initiation of low-dose aspirin, intensification of prenatal surveillance, and appropriate organization of care across different levels of the healthcare system.

The observational study by Arora et al. (2025) innovatively demonstrates the potential of deep learning-based placental texture analysis from ultrasonographic images for the prediction of hypertensive disorders of pregnancy.¹⁰ The use of different architectures—including convolutional neural networks (CNNs), transfer learning approaches, and Vision Transformers (ViT) combined with a TabNet classifier—resulted in high accuracy as early as the first trimester, with values exceeding 90% and areas under the curve (AUC) above 0.90 across the evaluated gestational periods. These findings support the hypothesis that microscopic and structural placental alterations precede clinical disease manifestation and may be detected early through texture patterns imperceptible to conventional human assessment.

These results are consistent with the pathophysiological concept of preeclampsia as a placental disorder, in which impaired spiral artery remodeling and abnormal placentation occur early in gestation. The ability of AI to capture subtle information from placental imaging therefore represents a significant advance over traditional approaches based solely on clinical risk factors or uterine artery Doppler assessment, particularly in settings where specialized examinations are not widely available.

Conversely, the multicenter study by Khalil et al. (2024) explored a different strategy, integrating routine clinical features and cell-free DNA biomarkers using artificial neural network models.¹¹ The results demonstrated similar performance between logistic regression and neural network models, with moderate AUCs for the prediction of preterm and early-onset preeclampsia. Although total cell-free DNA and fetal fraction showed statistically significant associations with preeclampsia, their incremental contribution to overall model performance was limited, especially for term disease.

The study by Malik et al. (2024) consisted of a systematic review evaluating the performance of machine learning models for preeclampsia prediction.¹² The authors analyzed various algorithms, including artificial neural networks, random forests, support vector machines, and logistic

regression, applied to clinical, laboratory, and demographic data. Overall, machine learning-based models demonstrated superior predictive performance compared with traditional statistical methods, particularly when combined datasets were used. The review concludes that artificial intelligence holds substantial potential to support early identification of preeclampsia, while emphasizing the need for methodological standardization, external validation, and prospective studies prior to widespread clinical implementation.

The importance of model interpretability and clinical validation becomes even more evident when considering applications in obstetric emergency settings. The study by Miyagi et al. (2024) illustrates a pragmatic application of AI in defining objective threshold criteria for coagulation dysfunction in cases of massive obstetric hemorrhage.¹³ By employing different machine learning algorithms to establish cutoff values for fibrinogen and fibrin degradation products, the authors demonstrate how AI can support the development of more robust diagnostic criteria that are less dependent on empirical judgment. Although not directly related to preeclampsia prediction, this study reinforces the broader potential of AI in obstetrics to support critical decision-making in high-risk situations, where speed and precision are essential for maternal outcomes.

Prenatal Screening for Structural and Genetic Anomalies

The studies by Tang et al. (2023)¹⁴ and Aoyama et al. (2024)¹⁵ demonstrate complementary approaches to the automated detection of fetal structural and genetic abnormalities, reinforcing the role of artificial intelligence as a clinical decision-support tool.

The study by Tang et al. proposes Pgds-ResNet, a fully automated deep learning algorithm capable of identifying both common and rare genetic disorders from fetal ultrasound images.¹⁴ Considering that approximately 8% of the global population is affected by genetic syndromes and that most diagnoses are made only after birth, this approach has significant clinical impact. The high sensitivity and specificity achieved for common trisomies (21, 18, and 13), as well as for rare genetic diseases, indicate that automated analysis of fetal facial features may represent an effective complementary method to traditional screening examinations. Furthermore, the algorithm's performance comparable to that of experienced sonographers suggests that AI may help reduce exclusive reliance on operator expertise, which remains one of the main limitations of conventional ultrasonography.

In contrast, the study by Aoyama et al. focuses on screening for congenital heart disease through automated assessment of the pulmonary artery-to-ascending aorta ratio in the three-vessel view (3V).¹⁵ Manual measurement of these structures is associated with substantial intra- and interobserver variability, particularly among less experienced examiners. The AI-based approach, combining YOLOv7 and UNet3+ algorithms, demonstrated performance superior to that of residents and fellows, achieving a high area under the ROC curve. These findings further support the potential of AI to standardize quantitative assessments, reduce human bias, and improve diagnostic accuracy in fetal cardiac screening examinations.

CONCLUSION

Artificial intelligence represents a transformative opportunity for obstetrics, with the potential to improve diagnostic accuracy, reduce interobserver variability, and expand access to high-quality care in resource-limited settings. However, its integration into clinical practice must be approached cautiously, with emphasis on rigorous validation, interpretability, safety, and equity.

AI should not be viewed as a replacement for clinical judgment, but rather as a complementary tool

capable of enhancing evidence-based decision-making. Only through continuous collaboration among researchers, clinicians, engineers, and policymakers will it be possible to fully realize the potential of AI in obstetrics, ultimately contributing to improved maternal and fetal outcomes on a global scale.

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