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Artificial Intelligence-Driven Innovations in Obstetric and Primary Care: Clinical Applications and Future Prospects

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ABSTRACT: Background: AI is already integrated throughout the obstetric and primary care spectrum, ranging from automated ultrasound diagnosis interpretations, foetal

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monitoring, risk stratification for obstetric complications, to diagnostic decision support in primary care.

Objectives: The aim of this review is to identify, summarize and highlight the literature on innovations in obstetric and primary care using artificial intelligence from 2020 to 2025, and to explore clinical applications, reported performance and challenges for use in daily practice.

Method: Structured search of Scopus, Web of Science and PubMed-indexed sources was conducted using combinations of the terms “artificial intelligence,” “machine learning,” “obstetrics,” “primary care,” “clinical decision support,” and specific applications (preeclampsia, gestational diabetes and ultrasound) between 2020 and 2025.

Findings: AI systems now have the ability of detecting foetal abnormalities and foetal biometry in the hospital setting and are approaching the accuracy of experts in obstetrics, with deep-learning models achieving even higher precision for foetal biometry and anomaly detection on ultrasound when compared with conventional risk-scoring methods. In the obstetrics setting, machine-learning models incorporating maternal traits, biophysical markers, and laboratory values predict preeclampsia and gestational diabetes, with areas under the receiver operating characteristic curve generally between 0.75 and 0.90, consistently outperforming traditional risk-scoring methods. AI-powered clinical decision support tools are being used in primary care to assist with diagnosis, risk stratification and documentation, but widespread adoption of these systems in the real world is more likely to be used for ambient scribing, decision support and workflow automation. In both areas, evidence quality is inconsistent, external evidence is scarce, and integration in clinical practice is inadequate compared to the development of the algorithm.

Conclusion: AI is moving beyond the realm of research focus to become a new and growing clinical tool in obstetric and primary care; to achieve the potential of better outcomes for maternal, foetal, and population health, prospective, external evidence is needed and workflow integration, equity and clinician trust must be deliberately addressed.

Keywords: *Artificial intelligence; machine learning; obstetrics; primary care; clinical decision support; preeclampsia; gestational diabetes.*\

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1. Introduction

Medical specialties routinely are integrating artificial intelligence (AI) tools, including machine learning, deep learning, computer vision and natural language processing, and obstetrics and gynaecology (OBGYN) are no exception. In obstetrics, AI is now being used to interpret ultrasound images, monitor foetal heart rate, predict complications of pregnancy like preeclampsia and gestational diabetes, and providing decision support during labour and delivery. In their review of AI use in these obstetric applications, Sarno et al. noted consistent evidence that AI can decrease inter- and intra-operator variability and enhance diagnostic accuracy, as well as the potential for it to be "not quite ready for prime time" due to its limited evidence base and the lack of a standardised clinical guidance for its use [1].

Simultaneously, there has been an increased interest in primary care, the first point of contact for most patients, and the arena where most chronic diseases are managed, in clinical decision support systems (CDSS) that leverage artificial intelligence (AI). Gomez-Cabello et al. conducted a scoping review of AI-CDSS in primary care, which highlighted the main current uses as diagnostic support, treatment recommendation, and complication prediction; and also, that implementation of AI-CDSS was still limited to a few health systems around the world. [2] This review aims to summarise the published literature between 2020 and 2025 regarding the use of AI-based innovations in the three interlinked areas of (i) AI in obstetric ultrasound and foetal monitoring, (ii) AI-based risk prediction models for major pregnancy complications, and (iii) AI-based clinical decision support in primary care, before reflecting on common challenges and future directions for both areas.

2. Methodology

This is a narrative review, not a systematic review or a meta-analysis, because of the wide-ranging applications of clinical use and technical approach and the diversity of the subjects that could be included. The search was structured by using a combination of the terms "artificial intelligence," "machine learning," "deep learning," "obstetrics," "pregnancy," "primary care," "clinical decision support," and specific terms related to the field, such as "ultrasound," "cardiotocography," "preeclampsia," and "gestational diabetes," in these databases: Scopus, Web of Science, PubMed, and IEEE Xplore. The inclusion criteria for

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this review were: (i) study publication in a peer-reviewed journal from January 2020 to 2025, (ii) empirical, systematic-review or scoping-review study design, and (iii) explicit relevance to clinical diagnosis, risk prediction, or decision support, specific to AI application in obstetrics or primary care. Eligible additional sources were retrieved by hand searching reference lists and then synthesised narratively by clinical domain.

3. AI in Obstetric Ultrasound and Foetal Monitoring

AI interpretation of ultrasounds is the most developed use of artificial intelligence in the field of obstetrics. In their review, Kim et al. highlighted the fact that deep-learning systems can be used for automated foetal biometry, standard-plane detection, and anomaly screening, a few algorithms are now becoming expert sonographer accurate in routine biometric measurements [3]. A systematic literature review conducted by Jost and colleagues of AI applications in obstetric and gynaecological ultrasound (foetal biometry, foetal echocardiogram, neurosonography and placental assessment) also reported that AI-supported image analysis was associated with reduction in examination time and inter-observer variability, with higher detection rates of structural abnormalities although most of the studies were single-centre and retrospective [4]. In addition to static image interpretation, AI has also been used in continuous foetal HR monitoring, as summarized in Sarno and colleagues' review of the obstetric AI literature [1], convolutional neural network-based systems are able to classify patterns in cardiotocography with reported accuracy that is greater than conventional visual interpretation, providing a pathway to more consistent, less operator-dependent intrapartum surveillance.

The main applications of AI in obstetric ultrasound and foetal monitoring found in the literature reviewed are summarized in Table 1. AI applications across the prenatal, intrapartum, and postpartum continuum of obstetric care is presented in Figure 1.

Table 1. Principal AI applications in obstetric ultrasound and foetal monitoring.

Obstetric AI Application	Task	AI Method	Reported Outcome	Key Source(s)
Foetal biometry	Automated measurement of head, abdomen, femur length	Deep learning (CNN)	Accuracy approaching expert sonographer level	3, 4

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Foetal anomaly/structural screening	Detection of congenital anomalies on ultrasound	Deep learning image classification	Improved detection rates; reduced inter-observer variability	4
Foetal echocardiography/ neurosonography	Cardiac and neural structure assessment	Deep learning segmentation	Reduced examination time	4
Cardiotocography interpretation	Classification of foetal heart rate patterns	Convolutional neural network	Accuracy exceeding conventional visual interpretation	1

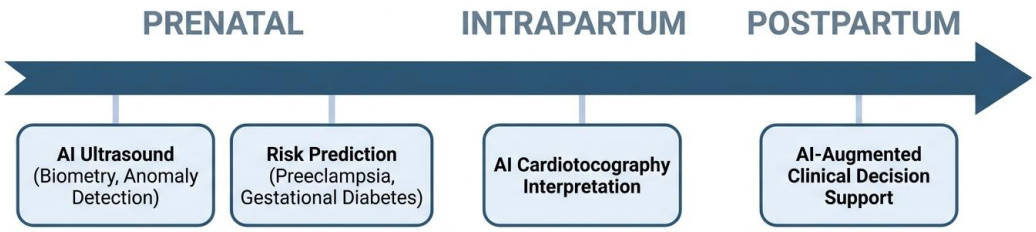

Figure 1. AI applications across the prenatal, intrapartum, and postpartum continuum of obstetric care

Sources: Adapted from references [1,3,4]

4. AI-Based Risk Prediction Models for Pregnancy Complications

Some of the best validated, obstetric AI applications so far involve machine-learning risk-prediction models for preeclampsia and gestational diabetes. Liu and colleagues created a random forest model that included 18 variables (maternal characteristics, medical history, prenatal laboratory results and ultrasound findings) to predict preeclampsia in a retrospective cohort of Chinese women, with an area under the receiver operating characteristic curve (AUROC) of 0.86 compared with the logistic regression, support vector machine, and decision-tree comparators.[5] They developed a random forest model that included 18 variables (maternal characteristics, medical history, prenatal laboratory results, and ultrasound findings) that achieved an AUROC of 0.86 in predicting preeclampsia in a Chinese retrospective cohort compared with logistic regression, support vector machine, and decision-tree comparators.

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In a population-based cohort study, Li et al. also created a competing risk machine-learning model based on first-trimester maternal characteristics and biochemical markers, confirming that the first trimester is a suitable time for developing AI models for preeclampsia prediction.[6] Kokori and colleagues' narrative review of 14 studies that used machine learning in early detection of gestational diabetes concluded that predictive algorithms combining clinical and demographic factors were able to detect high-risk pregnant women before the traditional oral glucose tolerance test (OGTT) relative to when OGTTs were used alone, and that most of these predictive algorithms would need to be population-specific and tested in external databases before they could be broadly adopted [7].

Another consistent observation in these prediction-model studies is the balance between model complexity and clinical interpretability: the more complex models (such as those based on ensemble or deep learning) tend to perform slightly better on discrimination tasks, but inevitably give up transparency, which clinicians and patients need to trust and act upon a specific risk estimate. Lin et al. conducted a systematic review of pregnancy care AI-CDS, and the findings reveal that the models developed so far have been tested only within their own institutions, and there is a significant gap between the internal test performance of these models and the actual clinical utility in real-world settings, with most models achieving only internal validation. In the systematic review of pregnancy care AI-CDS by Lin et al., most of the models developed have been internally validated, and there is a gap between the model's performance during the internal testing process and the real-world application process.[8] In table 2, the representative AI-based prediction models for various major pregnancy complications are summarized along with their reported discriminating performance. Figure 2. Reports the discriminative performance (AUROC) of machine-learning models for major pregnancy complications.

Table 2. Representative machine-learning risk-prediction models for major pregnancy complications.

Author(s), Year	Complication	Model/Method	Input Variables	Reported AUROC
Liu et al., 2022[5]	Preeclampsia	Random forest (best of 5 ML algorithms)	18 variables: maternal characteristics, history,	0.86

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			labs, ultrasound	
Li et al., 2024[6]	Preeclampsia (first-trimester)	Competing-risk machine learning model	Maternal characteristics, biophysical/biochemical markers (11-13[6] weeks)	Not pooled; population-based validation
Kokori et al., 2024[7]	Gestational diabetes mellitus	Various ML algorithms (review of 14 studies)	Clinical and demographic variables	Range approx. 0.70-0.85 across studies

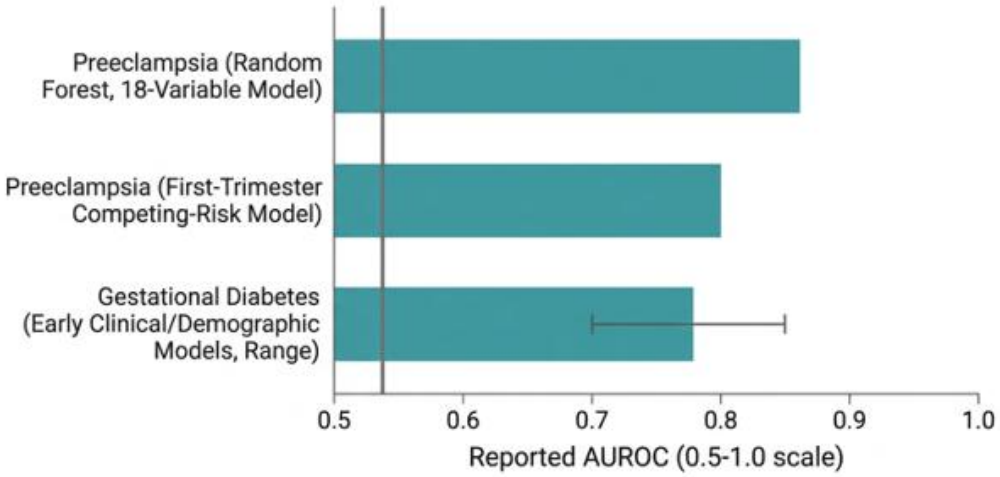

Figure 2. Reported discriminative performance (AUROC) of machine-learning models for major pregnancy complications

Sources: Adapted from references [5,6,7]

5. AI-Based Clinical Decision Support in Primary Care

AI-based clinical decision support systems (AI-CDSS) are being investigated in primary care in three areas: diagnostic support, treatment recommendations, and prediction of complications. In their scoping review, Gomez-Cabello and colleagues found implementations of AI-CDSS in the U.S., Netherlands, Spain, and China, with the majority of studies involving diagnostic support, management or treatment recommendations, and predicting complications, but with only 6 studies in an initial 421 articles that fulfilled the

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inclusion criteria, a modest number compared to the number of AI applications in hospital settings. Inconsistencies in the reporting of outcomes and the design of studies limit the ability to easily compare the performance of these different systems, however, the systematic review of Khalifa et al. found consistent evidence across six clinical domains of enhanced clinical diagnostic accuracy and efficiency when using AI to support clinical decision making.[9]

A scoping review by Iannone, Kaur and Johnson of the literature on outpatient primary care AI specifically published between January 2019 and November 2024, revealed that AI in primary care is still in a developmental phase and that its use in real-world settings is limited to ambient clinical documentation (scribing), clinical decision support, and workflow automation, but not autonomous diagnostic decision-making [10]. This is in line with the overall trend of AI in obstetrics, where the interpretation of ultrasound images and prediction of risk, which can support but not supplant the expertise of clinicians, are more advanced than autonomous decision-making applications. Table 3 details representative AI-CDSS applications, and their reported implementation status, in the literature from the reviewed primary care applications. Figure 3 shows the Relative maturity of AI applications across obstetric and primary care domains, from research-stage to routine clinical use.

Table 3. AI-Based Clinical Decision Support Applications in Primary Care and their Implementation Status.

AI-CDSS Application	Primary Care Function	Reported Implementation Status	Key Source(s)
Diagnostic support	Assist differential diagnosis from clinical data	Limited; concentrated in a small number of health systems (US, Netherlands, Spain, China)	2
Treatment/management recommendation	Suggest treatment options based on patient data	Early-stage; few studies meet rigorous inclusion criteria	2, 9
Complication/risk prediction	Flag patients at risk of deterioration or complications	Emerging; heterogeneous study designs limit comparison	9
Ambient documentation	Automate clinical note-taking during	Most mature real-world use case identified	10

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(scribing)	consultations		
Workflow automation	Streamline administrative and triage tasks	Growing but not yet routine	10

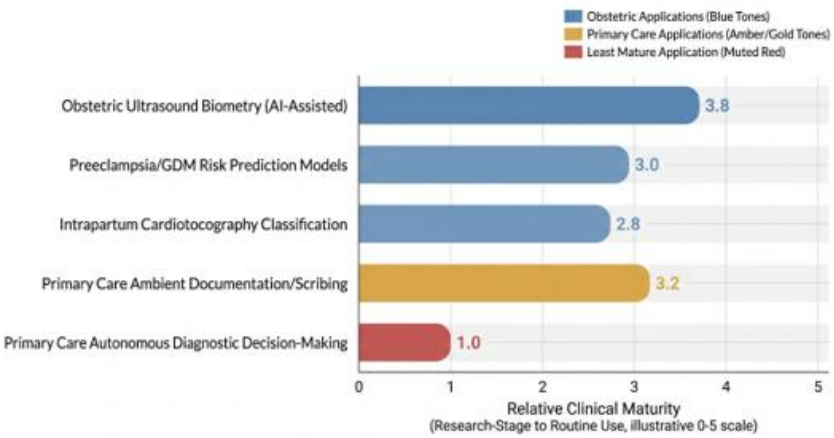

Figure 3. Relative maturity of AI applications across obstetric and primary care domains, from research-stage to routine clinical use

Source: Authors conceptual model adapted from [1,2,9,10].

6. Challenges And Future Prospects

In both obstetrics and primary care, there are common challenges that hinder the adoption of AI research into routine care. First, the ability to predict preeclampsia and gestational diabetes is limited, most prediction models reviewed here were developed and validated in single country or single centre cohorts, [5,6,7] and there are open questions about performance in more diverse populations and in healthcare settings outside of these cohorts. Secondly, the difference between the performance of the model and the real-world clinical benefit remains in both applications, as emphasized by Lin et al. for pregnancy-care CDSS [8], and reiterated by Gomez-Cabello et al. for primary-care CDSS.[2] Third, current real-world AI usage in both fields focus on augmentative use, assisting with image interpretation, automating documentation, and flagging risks, instead of fully autonomous image interpretation or treatment or diagnostic decision-making, indicating that the immediate future of medical AI is likely to involve the clinician rather than the AI itself.[10]

The future success of AI in obstetrics and primary care is likely to be influenced by several developments. The next steps in the evolution of AI in obstetrics and primary care are

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poised for significant influence by several developments. It is hoped that multimodal models integrating imaging, laboratory, genomic, and wearable-sensor data will be able to enhance the discriminative power of prediction of pregnancy complications over that obtained by single-modality models. In general, it is expected that the use of ambient documentation and decision-support tools will grow most rapidly in primary care because their regulatory and workflow obstacles are relatively low compared to autonomous diagnostic systems. In both fields, prospective multi-site validation studies and explicit attention to algorithmic bias and equity will be crucial steps toward the widespread adoption of AI, as a component of routine care for mothers and children in primary care.

7. Conclusion

The literature review carried out in the period from 2020 to 2025 has shown that the role of artificial intelligence in obstetric and primary care is changing through automated interpretation of ultrasound images, classification of cardiotocography, prediction of preeclampsia and gestational diabetes with machine learning, and the use of artificial intelligence for clinical decision support in diagnosis and documentation. Although AI for predicting preeclampsia and gestational diabetes is promising, its discriminative performance is consistently superior to traditional risk-scoring methods, and the primary-care AI-CDSS implementations so far are limited to augmentative and not autonomous functions. In both areas, the quality of evidence is variable, validation is scarce, and there is a gap between the incorporation of algorithms into clinical routine. To ensure the significant potential of AI in obstetrics and primary care is effectively translated to better maternal, foetal, and population health outcomes, future studies should prioritize prospective, external validation, multi-site investigations and calls to specific attention to equity and clinician trust.

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