

The Role of Artificial Intelligence in Antenatal Care in Africa: A Review of Literature

Olufiade P Oyerogba^{1*}, Ifeoluwa P Bolaji², Olabisi H Raheem¹, Esther P Oyesade², Khadijah F Ademola², Favour Nomeh², Rofiat A Adepoju¹, Teniola D Olowookere², Jovita C Okorom¹, Anna M Ayeni², Oluwatofunmi E Bamigboye², Joy E Okorie², Boluwatife Adenle², Damilola O Obisesan¹, Favour O Durosaro¹, Ruqayyah Olanrewaju¹, Deborah O Ebute¹, Oluwakemi V Ogbontiba² and Chisom P Obah²

¹Department of Obstetrics and Gynecology, University College Hospital (UCH), Ibadan, Nigeria

²College of Medicine, University of Ibadan, Ibadan, Nigeria

***Corresponding Author:** Olufiade P Oyerogba, Department of Obstetrics and Gynecology, University College Hospital (UCH), Ibadan, Nigeria.

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Abstract

Objective: This review aims to provide an overview of existing research on artificial intelligence in antenatal care (ANC) which is a critical component of maternal and child health with the purpose of promoting healthy outcomes for both mother and fetus and with a focus on Sub-Saharan Africa and the purpose of promoting healthy outcomes for both mother and fetus.

Methods: A systematic search of electronic databases, including PubMed, Scopus, and Google Scholar, was conducted to identify relevant articles published. A narrative approach was adopted for the literature review with findings grouped into themes which include: The applications of Artificial intelligence in ANC, the benefits, its challenges, future prospects, recommendations and conclusion.

Results: A total of 36 studies conducted across Africa were selected, related to the adoption of AI in antenatal care across Africa. The studies show that AI technologies, including machine learning, predictive analytics, natural language processing, and mobile health applications, can be integrated into ANC services to improve ANC services by supporting early risk detection, personalized care, and real-time monitoring of pregnant women.

Conclusion: Artificial intelligence has the potential to enhance the quality of care in antenatal care, reduce human error, and strengthen health system performance. AI should come to the forefront in antenatal care in Sub-Saharan Africa as it plays a pivotal role in improving maternal and fetal outcomes. Effective integration will however require addressing the related challenges.

Keywords: Artificial Intelligence; AI; Antenatal Care; Maternal Health; Digital Health; Pregnancy Outcomes; Sub-Saharan Africa

Introduction

Antenatal care (ANC) constitutes a cornerstone of modern obstetric practice, serving as a platform for risk stratification, disease prevention, early diagnosis, and timely intervention for pregnancy-related complications. The World Health Organization (WHO) now recommends a minimum of eight ANC contacts to optimize maternal and fetal outcomes [1]. Despite this, Sub-Saharan Africa continues to record the highest maternal mortality ratio (MMR) globally, accounting for approximately 70% of all maternal deaths worldwide [2].

This emphasizes deficiencies in ANC coverage, quality, and continuity across the region. Weak antenatal systems remain central to this persistent public health crisis.

AI technologies, including machine learning, predictive analytics, natural language processing, and mobile health applications, can be integrated into ANC services to support early risk detection, personalized care, and real-time monitoring of pregnant women. AI-powered tools can analyse large datasets from electronic health records, laboratory results, and wearable devices to predict pregnancy-related complications such as preeclampsia, gestational diabetes, anaemia, and preterm labour. These systems enable early intervention, timely referrals, and improved clinical outcomes. AI-driven chatbots and virtual assistants can provide health education, appointment reminders, nutrition counselling, and danger sign awareness, especially for women in rural and underserved communities [3].

Furthermore, AI can support healthcare workers by reducing workload through automated documentation, decision-support systems, and triaging tools. This is particularly relevant in sub-Saharan Africa, where the shortage of skilled maternal health professionals affects service delivery. By improving efficiency and accuracy, AI has the potential to enhance the quality of care, reduce human error, and strengthen health system performance.

Method

Search strategy

A systematic search of electronic databases, including PubMed, Scopus, and Google Scholar, was conducted to identify relevant articles published and a narrative approach was adopted for the literature review. Search terms include “Artificial Intelligence”, “Antenatal Care”, “Maternal Health”, “Africa”.

Inclusion and exclusion criteria

Quantitative studies that explored the role of antenatal care in AI were included. These included cross sectional studies, observational studies, narrative literature review and retrospective studies. A total of 36 studies were identified. Thirty studies met the inclusion criteria which are studies conducted from 2015 till date and were used for the final review.

Results and Discussion

Overview of AI

Artificial intelligence (AI) solutions, which have been identified as applications as well as hardware components created by humans that, provided any intricate objective, act in the digital or physical realm by observing their surroundings through data collection, analysing the structured or unstructured data gathered, applying knowledge, or analysing the information obtained from this data, and choosing the best course of action. AI systems may acquire a numerical model or employ symbolic rules. AI aims to replicate human cognitive functions, including independent decision-making, logical thinking, knowledge representation, learning, natural language communication, and the ability to see and engage with the natural environment [4].

One area of AI, machine learning (ML), comprises numerous statistical scales that are frequently divided into three main categories of learning: supervised, unsupervised, and reinforced. In controlled learning, a software program masters the rules necessary to produce the final outputs from the training dataset and creates a computational framework from a dataset using predetermined inputs (also known as labelled input) and predefined outcomes. To forecast a result, these variables are subsequently applied to a fresh test dataset. For example, using an electronic health record dataset from an emergency room, nurses employed a decision tree to determine patients who were susceptible to readmission to the hospital [11]. A supervised machine learning technique that processes data in layers is called an artificial neural network (ANN). With nodes being connected through connections known as edges, the software layout is similar to

that of the human brain. It is only engaged when a specific threshold is met, and each edge is weighted using an algorithm that changes as the network understands how to respond. Even though there is increasing interest in integrating AI into maternal healthcare, it is still an evolving area in antenatal care practices in Africa.

AI applications relevant to antenatal care

Artificial intelligence is an emerging field in Africa and is rapidly gaining traction in healthcare delivery. Its application enables the assessment of whether machine-learning models can effectively predict optimal antenatal care (ANC) utilization [5]. Various analytical methods, including Light Gradient Boosting Machine (LightGBM), Extreme Gradient Boosting (XGBoost), Random Forest classifiers, CatBoost, and other ensemble learning techniques, have been applied to predict outcomes across different ANC services [6-8]. These applications include high-accuracy diagnostic support, maternal risk stratification, and evaluation of adherence to clinical guidelines and standards of care [6].

Several studies have demonstrated that the Random Forest classifier consistently achieves superior overall predictive performance across multiple outcome categories, although other models, such as Decision Trees and XGBoost, have also shown good predictive accuracy [6-8].

Benefits of AI in ANC

AI presents a unique opportunity to improve healthcare access in Africa. For instance, by providing support to healthcare workers with acquiring medical images or extracting biomarkers or risk scores in the absence of the appropriate imaging modality or clinical expert [9]. A study in Nigeria demonstrated that AI-driven systems reduced ANC defaulter rates by 15% by using predictive analytics to identify women at risk of complications and sending alerts for follow-up visits [3]. A similar study conducted in Nigeria used advanced algorithms to predict the likelihood of ANC utilization, thereby enabling targeted public health interventions [9]. A study by Walle, *et al.* where he predicted home delivery by machine learning after ANC visits was analysed by different models and rain forest was the best predictive model with an accuracy of 70.60 percent [6].

Mobile applications can be used to provide health education, schedule appointments, ensure drug adherence and engage with educational resources to improve access to essential antenatal care among the disadvantaged women [10,11] An example of digital health initiative is Mum Connect that does unique registration of pregnant women; targeted communication in the form of stage-appropriate messages to pregnant and lactating women. It also has an interactive help desk for clients to provide feedback on the quality of care received [12]. A study in East Africa used AI models to predict likelihood of initiating antenatal care late and found the prevalence of late antenatal care (ANC) initiation high, at 65%, in the study area. Factors such as home delivery, low household income, a large number of household members, unemployment, being a younger woman, not using family planning methods, low educational level, and rural residence were predictors of delayed antenatal care initiation [13]. Another study across 12 East African countries used machine learning algorithms to predict the status of micronutrient supplementation among pregnant women with the use of demographic health survey (DHS) data [8]. Additionally, AI model was used to predict mosquito bed net usage among women across ten Sub-Saharan Africa African countries - Burkina Faso, Burundi, Cameroon, Madagascar, Mozambique, Rwanda, Sierra Leone, Senegal, Uganda, and Zambia which revealed several key predictors including Age above 34, being employed, frequent social media use, higher education, institutional deliveries, and female-headed households increased bed net use, while fewer ANC visits and being divorced decreased its use [14]. A large study was conducted in 26 African countries using predictive models for adverse birth outcomes among childbearing women with advanced machine learning techniques [15]. Similarly, A study in 27 countries in Sub-Saharan Africa used machine learning algorithms to predict skilled birth attendance and identify its determinants among women of reproductive age [16]. Additionally, AI driven technology was explored among disabled women, who usually have increased limitations in access to ANC and other maternal

healthcare services [17]. AI-driven technologies such as ChatGPT can provide virtual assistants and personalised pregnancy-related health education and information with specific benefit to disabled women with mobility and communication challenges. Also, AI-driven machine learning and predictive analytics have been used to predict high-risk pregnancies including risk of pregnancy loss, [11,18] allowing tailored interventions for pregnant women with disabilities and enhancing pregnancy outcomes.

Furthermore, AI models can be used to identify pregnant women at an increased risk of GDM based on short Physical Activity (PA) recordings, medical backgrounds, including mental health records, and continuous glucose monitoring (CGM) data collected from participants [19]. AI models incorporated into wearable devices provide continuous health monitoring by providing real-time data on various physiological parameters [20]. Devices such as smartwatches and fitness trackers can monitor blood glucose, heart rate, activity levels, and sleep patterns, offering insights into both maternal and fetal health [19,20].

Limitations/Challenges

The use of AI is constrained by several factors, making its application in Africa particularly challenging. In a study done in Nigeria, it emphasizes on the lack of internet, fragmented digital infrastructure and unreliable electricity in many regions. There is also a digital divide from high data costs and lack of access to smartphones in many regions [3]. Another study in Nigeria highlighted the reluctance of AI use among healthcare professionals including risk benefit analyses, convenience of use, cost, time, privacy/ security concerns, and technological familiarity [10].

In regions of east Africa, [6] explained how data collection and datasets used for AI analysis pose significant problems, he stated that most data were self reported data which can lead to recency bias and different survey years can introduce heterogeneity. Some important variables related to health care access were not available due to the reliance on secondary data [19]. In addition, in a pilot cohort study to investigate the feasibility of using diverse digital data to predict the accuracy of early prediction of biomarker values that are used in the diagnosis of gestational diabetes mellitus, there was limitations such as incomplete continuous glucose monitoring due to participant non adherence racial and ethnic disparities and sample size restriction [19].

Studies in Sub-Saharan Africa similarly talked about the drawbacks of secondary data which can cause authors to; include relevant data that can explore potential factors among the risk factors, investigate complex causal pathways underlying observations and provide a more comprehensive understanding of the determinant of adverse outcomes in Sub-Saharan Africa [8]. Additionally, AI tools have their own limitations because there can be algorithm bias ranging from the difference in managing and utilizing AI tools among health workers to AI datasets. Many AI data sets are trained on datasets from advanced countries, which may not accurately predict the outcomes for the African population [3]. There is shortage of health care workers in skilled AI literacy and data handling. There are existing or emerging risks such as AI system errors, biases, and data privacy and security breaches that could cause patient harm or propagate health inequities [21].

Most of the studies were primarily focused on a specific geographical location. Variations in population demographics, lifestyle, healthcare services, and socio-economic determinants may impact the model's performance when applied to other regions. Future research should aim to validate findings in different countries or regions, particularly within diverse African contexts.

There are also concerns in ethical consideration are privacy, confidentiality, informed consent, voluntary participation and ensuring all these components could be sometimes challenging [22].

Future Directions

AI algorithms can analyse large datasets to predict ANC defaulters and women at risk of pregnancy-related complications [6], allowing healthcare providers to institute. Machine algorithms can predict the status of macronutrient and micronutrient supplementation,

enabling policymakers and healthcare workers to design targeted strategies that improve uptake among pregnant women [8]. More targeted interventions to reduce ANC default rate and address high-risk pregnancies should be explored.

Besides, AI-driven m-health (mobile health) applications have been designed to promote consultations to facilitate client assessment and monitoring, particularly in promoted areas, thereby bridging the gap between women with disabilities and healthcare providers [11,23]. The evaluation of usability, practicability and adoption of artificial intelligence enabled smartphones-based obstetrics ultrasound in a low resource primary health care, it is recommended that there should be expansion of training and tutorials for providers and to integrate ultrasound results into broader maternal care systems [11]. AI based tools for the enhancement of obstetric ultrasound screening in rural Africa, with the aim of empowering midwives to overcome the hardware constraints in some healthcare facilities as it will be automatically interpreted [21,24].

Additionally, future models should explore methods to improve AI model interpretability and to optimize algorithm performance [7,8]. It is essential to consider cultural and religious sensitivities when designing interventions to ensure effectiveness and acceptance within specific populations [8].

Integration of machine learning models into public health systems for real time monitoring and early identification of at risk populations [9].

AI showed high contribution and risk reduction, therefore future research should focus on longitudinal studies that will impact AI and maternal health intervention on reducing maternal mortality ratio, neonatal mortality rate and institutional delivery rate [3,23]. AI systems that integrate patient health histories, genetic profiles, and current conditions can offer tailored care recommendations, improving diagnostic accuracy and customizing treatment plans [10].

Recommendations

The government should zero rate AI maternity applications to ensure its consistent use [3]. Some studies also recommend strengthening collaboration among governments, healthcare providers, AI developers, and advocacy groups [3,10]. It can also guide targeted public health action including designing interventions to reduce socioeconomic and educational disparities [16]. Development of an interactive, user-friendly interface for real-time exploration of data, coupled with regular updates to maintain relevance, is recommended [25], along with strategic investments, policy reforms, and collective action, for the adoption of digital health innovations [10]. Enhance healthcare accessibility and promote educational attainment to improve maternal health service uptake [9]. Expansion of mobile clinics, youth friendly campaigns and health literacy campaigns can improve timely ANC initiation [13]. Poor compliance and large drop outs from training on the use of mobile and digital technology for global maternal health was noted in South Africa complaining due to lack of mobile phones [26].

Future interventions should focus on improving delivery practices to enhance normal delivery rates and addressing broader social determinants of health for sustainable impact [27]. Continuous research and development are needed to improve the effectiveness of AI in the management during the antenatal period [10].

Conclusion

The integration of AI applications in antenatal care could promote inclusivity and easy access to ANC including women with disabilities, enhance monitoring and support, and predict risk factors during pregnancy, thereby enhancing maternal and child outcomes among women in Africa. With concerted efforts from governments, international organizations, and the private sector, and by addressing significant challenges, AI can become a powerful tool to advance maternal health services across the continent, improving access to antenatal, skilled birth, and postnatal care [3,23].

Although AI faces challenges, such as limited data and gaps in healthcare professional training, machine learning has uncovered crucial insights that can guide targeted actions and improve maternal morbidity and mortality in Africa [8]. These innovations can address critical healthcare challenges in our regions. However, their success depends on overcoming barriers such as poor infrastructure, high costs, limited literacy, and policy gaps. Strategic investments in infrastructure, affordability, digital literacy, and comprehensive policy frameworks are important considerations.

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