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Contribution of Artificial Intelligence in Pregnancy: A Scoping Review

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Abstract. For the past ten years, the healthcare sector and industry has witnessed a surge in Artificial Intelligence (AI) technologies being used in many different medical specialties. Recently, AI-driven technologies have been utilized in medical care for pregnancy. In this work, we present a scoping review that explores the features of AI-driven technologies used in caring for pregnant patients. This review was conducted using the Preferred Reporting Items for Systematic review and Meta-Analyses extension for Scoping Reviews. Our analysis revealed that AI techniques were used in predicting pregnancy disorders such as preeclampsia and gestational diabetes, along with managing and treating ectopic pregnancies. We also found that AI technologies were used to assess risk factors and safety surveillance of pregnant women. We believe that AI-driven technologies have the potential to improve the healthcare provided to pregnant women.

Keywords. Artificial intelligence, machine learning, pregnancy

1. Introduction

Mothers pass through much anxiety during their pre-and post-pregnancy periods [1]. During this challenging time, the mother's health should be managed and monitored for her and the fetus's safety. Pregnant women should seek well-designed prenatal care that considers a comprehensive view of the clinical data, regular laboratory tests, ultrasound images, and any other related data that can help practitioners in making the correct clinical decisions for a healthy delivery [1]. The data provided by the clinical readings during a women's pregnancy, such as ultrasound images, laboratory tests, and Electronic Health Records, present complex, contemporary challenges in analyzing these divergent data sources [2]. AI-based technologies have been touted as a possible aid in analyzing heterogeneous data sources. It can help in medical diagnostics and assist physicians in making informeds decision on treatment options for pregnant patients. Little is known about the state and use of AI technologies during pregnancy. To the best of our knowledge, there is no review in the current literature on AI techniques and their applications in pregnancy. This scoping review aims to explore features of AI-driven technologies used for pregnant women.

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2. Methods

We conducted this scoping review following the PRISMA-ScR guidelines [3]. All primary studies on the use of AI in pregnancy were reviewed. Articles that addressed the use of AI in childbirth and postpartum were excluded. We excluded all studies published in a language other than English. No restrictions were applied regarding the year or country of publication, and settings. Google Scholar and PubMed were used to retrieve the studies. The first 60 articles in Google Scholar were reviewed. Backward-reference list checking was also performed to retrieve additional relevant studies. The terms used to search the databases were related to the target intervention (e.g., artificial intelligence) and target health condition (e.g., pregnancy). The study selection process was based on three main phases: identification phase (i.e., removing duplicates), screening phase (i.e., screening titles and abstracts), and eligibility phase (i.e., reading full texts). The extracted data included the characteristics of the study (e.g., author, year, country, and publication type), features of the AI technique (e.g., branch, model, and model validation type), and features of the dataset used in the model (e.g., data source, data type, and dataset size). The study selection and data extraction were independently performed by authors AH and IA. Any disagreements between the two reviewers were resolved by discussion. The extracted data was then synthesized using a narrative approach.

3. Results

A total of 1,753 articles were retrieved from the two databases. Of these, we identified and removed 38 duplicates. In the screening phase, 1,595 articles were excluded after scanning their titles and abstracts. Of the remaining 120 articles, 96 were excluded after reviewing their full texts, as they reported on irrelevant interventions (e.g., using statistical tests rather than AI). A total number of 24 studies were included. The flowchart of the study selection process is shown in Appendix A.

More than one-third of the included studies were published in the USA (n=9, 37.5%). 22 studies were journal articles and 2 were conference proceedings. The majority of the studies (n=22) were published between 2016 and 2020. AI techniques were used for predicting pregnancy disorders/complications in about 75% (n=18) of the included studies [4-21]. Specifically, the techniques discussed were utilized for predicting preeclampsia [5, 7, 9, 15], preterm birth [6, 13, 19], gestational diabetes [8, 14, 21], gestational age [4, 18], patient's metabolomics profile [12, 20], suicidal behavior [11], uterine contractions [16], labor due date [17], and hypertensive disorder [10]. Additionally, of the 24 studies, four (n=4, 17%) employed AI techniques for treatment and management of ectopic pregnancies [22], gestational diabetes [23], late-onset preeclampsia [5], and hypertensive disorder [10]. Further, five studies (n= 5, 21%) used AI to assist with patients' safety outcome [13, 19, 24-26]. Specifically, AI was used to assess risk factors [13, 19, 26] and safety surveillance for pregnant women in online social media networks [24, 25].

Further, machine Learning (ML) techniques were used in most of the included studies (n=18, 75%). Linear Regression model, which outperformed than other ML models, was employed in six ML studies (n = 6, 33 %) [27 14, 15, 17, 18]]. 12 out of 18 studies (67%) used the ML models for prediction purposes [4, 5, 7-10, 14, 15, 18, 21, 23, 25]. In the second AI technique, deep learning (DL) -based techniques were implemented in eight studies (n=8, 33%) [6, 8, 9, 16, 19, 22, 24, 27]. Similar to the ML studies, DL

was used mainly for prediction purposes (n=7, 87%) [6, 8, 13, 16, 19, 22, 27]. Natural language processing techniques were implemented in one study [25] to understand how women seek information from a social network community. Clinical databases (i.e., database of health centers and hospitals) were the most commonly incorporated data source for model implementation and validation (n=13) [4-7, 10-12, 16, 17, 19, 22, 23, 26]. About 87.5% (n = 21) of the included studies reported the used model validation techniques. K-fold cross validation was the most commonly used technique (n=17) [4-8, 10, 12, 14-17, 19, 21, 22, 24, 26, 28].

4. Discussion

This review summarizes the contribution of AI in pregnancy. AI techniques were used in about 75% of the included studies for predicting pregnancy disorders/complications. We discovered a few issues that have not been addressed in the reviewed studies, which indicates a gap in the literature. First, did not find studies discussing the effectiveness of models used in treating disorders such as preeclampsia or gestational diabetes. Second, little information was available regarding public data sources for the AI models' training. As such, it is essential to prioritize monitoring hypertension and recommending new AI applications in the diagnosis/management of preeclampsia in future investigations. Further assessments are also needed to outline the validation approach and algorithms utilized by AI technology during pregnancy.

This study has a few limitations. We did not assess the effectiveness of AI models in predicting and diagnosing pregnancies. Therefore, we encourage future researchers to conduct systematic reviews that assess the effectiveness of AI models for the same. Moreover, we only focused on studies concerning the pregnant woman and pregnancy; we did not consider the childbirth or postpartum period. Therefore, we may have overlooked some other sub-domains within the field of pregnancy and childbirth. Only two databases were used to retrieve the literature whereas more databases may have been more comprehensive. Lastly, the search strategy was limited to studies written in English. Therefore, we may have missed AI and pregnancy-related studies published in a non-English language.

5. Conclusions

We conclude that ML and LR were identified as the most commonly utilized AI technique and models in the studies included in this review. AI-driven technologies may improve healthcare services provided to pregnant patients. It is recommended for future studies to assess the effectiveness of models used for the well-being of the pregnant woman. Appendix Files are available at GitHub: (https://github.com/AHassan2/AI-in-Pregnancy-Scoping-Review).

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