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AI-POWERED PREGNANCY: ADVANCEMENTS IN FETAL MONITORING AND SUPPORT

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ABSTRACT

Artificial intelligence has been extensively used in most fields of study, including medicine and health. Pregnancy-related issues or illnesses have the potential to harm the lives of both the mother and the foetus. The concept that emotional factors—like worry, stress, or depression, for example—can be a significant risk factor during pregnancy is sufficiently supported by scientific research. The purpose of this study is to identify the approaches, strategies, algorithms, and frameworks utilized in Artificial Intelligence and Affective Computing for pregnant health and well-being. For the past 12 years (2008-2020), a scoping review of the scientific literature has been conducted. This review was created using the PRISMA-ScR framework and the technique suggested by Arksey and O'Malley. One of the primary conclusions of this study is that, despite the potential importance of emotional status as a risk factor during pregnancy, there is currently a dearth of substantial literature on automatic emotion analysis. Future research on this area is highly recommended since artificial intelligence and affective computing-based gadgets can improve the health and well-being of pregnant women.

KEYWORDS: Artificial intelligence, pregnancy health, pregnancy well-being, machine learning.

INTRODUCTION

All pregnancies have some risk, even though the majority of pregnancies and deliveries go smoothly. According to the WHO (2019), 15% of all pregnant women will have a life-threatening problem that has to be treated by a specialist. Some of these women may even need substantial obstetric intervention to live. According to the World Health Organization (WHO), about 800 women die every day throughout the world from avoidable causes connected to the inherent hazards of pregnancy. In 2017, an estimated 295,000 women lost their lives both during and after pregnancy and delivery. 94% of these deaths took place in environments with limited resources, and the majority of them were avoidable (WHO, 2019).

Anxiety is a common emotion for mothers both before and after their pregnancies.[1] For the protection of both the mother and the fetus, the mother's health has to be controlled and closely watched throughout this difficult period.

Expectant mothers ought to pursue well-planned prenatal care that takes into account a thorough assessment of the clinical data, routine blood testing, ultrasound pictures, and any further relevant information that can assist healthcare professionals in making the best clinical decisions for a safe birth.[1] Analyzing the data from various disparate sources—such as ultrasound pictures, lab results, and electronic health records—provides complicated, modern hurdles when it comes to clinical readings throughout a woman's pregnancy.[2] Technologies based on artificial intelligence have been hailed as a potential help for assessing diverse data sources. It can support medical diagnostics and help doctors make well-informed decisions about the best course of care for expectant patients. Pregnancy and the employment of AI technology are poorly understood. To the best of our knowledge, there isn't a review of AI methods and their uses in pregnancy in the current literature. The purpose of this scoping study is to investigate the characteristics of AI-powered pregnancy aids.

A woman's pregnancy may have an influence on both her physical and mental health, making it a difficult and important time in her life. On the one hand, adjusting to the significant physiological changes brought on by pregnancy could be challenging. On the other side, a fundamental component of her psychological health, including emotional conduct, is her need to protect both her fetus and herself. The pursuit of well-being may require learning new skills, modifying one's lifestyle (diet, exercise, sleep patterns, employment, etc.), receiving appropriate medical attention, and scheduling follow-up appointments on time. Pregnancy-related health issues are another important aspect that can have a detrimental effect on a woman's psychological well-being, particularly if there is a significant likelihood of difficulties. Furthermore, in this instance, physiological issues may arise as a result of preexisting medical conditions or they may serve as risk factors for the development of illnesses during pregnancy.[3]

In order to ascertain if worry during pregnancy is associated with an increased risk of pre-eclampsia, Kordi et al.[4] examined the records of 300 expectant mothers, of whom 150 experienced pre-eclampsia and the other half did not. 10.7% of women in the second group and 26.7% of women in the first group reported having anxiousness. The authors arrived at the conclusion that anxiety during pregnancy may be regarded as a pre-eclampsia risk factor. Concern during pregnancy and its effects on women's health were examined by Krishnamurti et al.[5], however not in a way that was directly tied to anxiety or depression particularly, but to other emotional elements.

In light of the aforementioned data, it would appear that emotional state affects not just the likelihood of developing pre-eclampsia but also a multitude of additional issues. The side effects of pregnancy might possibly last even after giving delivery. Therefore, there is reason to think that the use of technology that can recognize and process emotions may be appropriate for both assisting patients who have already received a diagnosis as well as for the prevention of pregnancy diseases like preeclampsia. Artificial intelligence, or "AI," has been used more and more in many different fields over the past few decades, including the field of health. The purpose of this study is to discuss AI applications that are concerned with pregnant women's health and well-being in addition to the use of affective computing (AC). In the interdisciplinary area of AC, computer science interacts with electrical, mechanical, robotics, and psychological sciences in addition to other technical specialties. In this situation, the computer can identify, decipher, analyze, or mimic human emotion; moreover, it may modify its own behavior based on the emotion that the user of the machine expresses.[6]

BACKGROUND

Artificial Intelligence (AI) is a computational subject that has demonstrated significant promise in recent decades and increased relevance and importance across other fields, including medicine (Jiang et al., 2017).[7] In a 2017 survey on the topic, Jiang et al.[7] reported on the use of AI in health. They identified a number of applications, including providing healthcare professionals with up-to-date, reliable scientific information, developing new medical procedures or improving current ones that can enhance patient care, lowering the error rate in diagnosis, and locating pertinent information in large data sets to lower health risks and provide real-time diagnosis predictions. The exponential rise in the body of research in this field between 2002 and 2003 is demonstrated by a 2009 analysis on the evolution of the scientific literature on AI applied to medicine and health, published by Tran et al.[8] The necessity for thorough assessments that enable the assessment of the state of the art emerges in tandem with the scientific literature in this field of study expanding at a rapid pace. As stated in this section, the authors of this study were unable to locate a review on the use of AI and AC in relation to the health and welfare of expectant mothers and their fetuses as of yet.

METHODS

We followed the PRISMA-ScR standards[9] for conducting this scoping review. We examined every primary study on AI usage during pregnancy. Articles about postpartum and childbirth AI were not included. All papers published in languages other than English were omitted. Regarding the publishing year, nation, and locations, no limitations were imposed. The studies were retrieved using PubMed and Google Scholar. We looked over the first sixty publications on Google Scholar. To find other pertinent studies, a backward-reference list check was also carried out. The goal intervention (such as artificial intelligence) and target health condition (such as pregnancy) were the search phrases used to access the databases. Three primary stages constituted the basis of the research selection process: the identification phase included eliminating duplicates, the screening phase involved vetting titles and abstracts, and the eligibility step involved reviewing entire texts. The features of the AI approach (branch, model, and model validation type), the properties of the dataset utilized in the model (data source, data type, and dataset size), and the characteristics of the study (author, year, nation, and publishing type) were all included in the extracted data. Authors AH and IA carried out the research selection and data extraction separately. Any differences of opinion between the two reviewers were settled through conversation. A narrative technique was then used to synthesize the retrieved data.

To find pertinent research, a systematic literature search has been created using information from many bibliographic databases, including Scopus, Pubmed, Web of Science (WoS), IEEE Xplore, and Association for Computing Machinery (ACM). A variety of information sources have been used in an effort to provide the most thorough search method feasible. Pregnancy, health and well-being, as well as AI, ML, and AC, were the key topics that guided the search phrases that were taken into consideration for this evaluation.

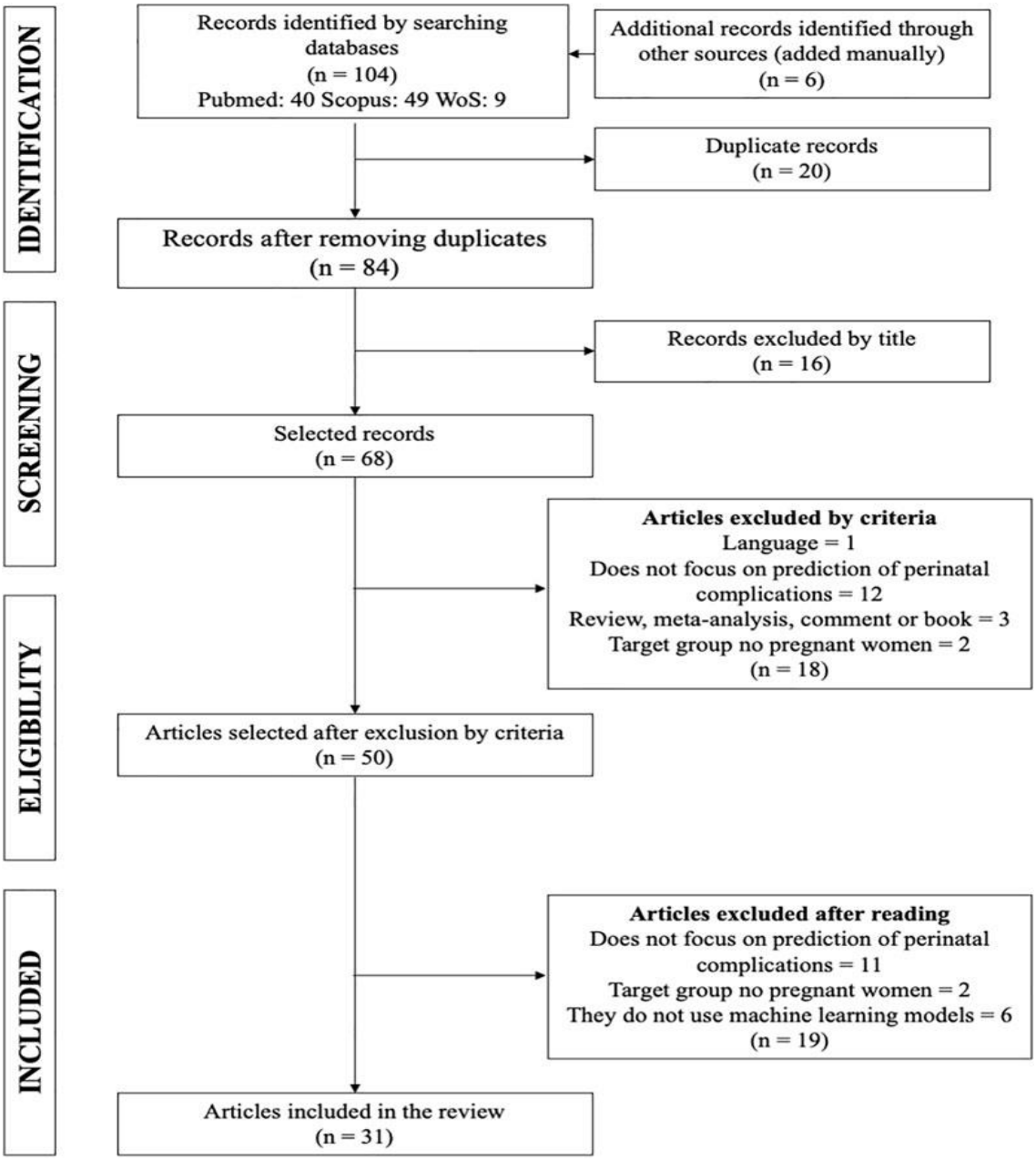
Three scientific databases, PubMed, Scopus, and Web of Science, yielded a total of 98 articles that were related to perinatal complications, also known as "complications in pregnancy" or "pregnancy complications," when searching with the terms "machine learning," "deep learning," and "artificial intelligence." We used the PRISMA approach for classification and the Mendeley platform for management.

RESULTS

The two databases yielded a total of 1,753 articles. 38 of these were found to be duplicates, which we eliminated. After looking over the titles and abstracts of 1,595 papers, they were not included in the screening process. After their entire

texts were reviewed, 96 of the 120 surviving publications were eliminated because they discussed unrelated treatments (e.g., employing statistical tests instead of AI). There were twenty-four studies included in all. Appendix A displays the flowchart for the research selection procedure.

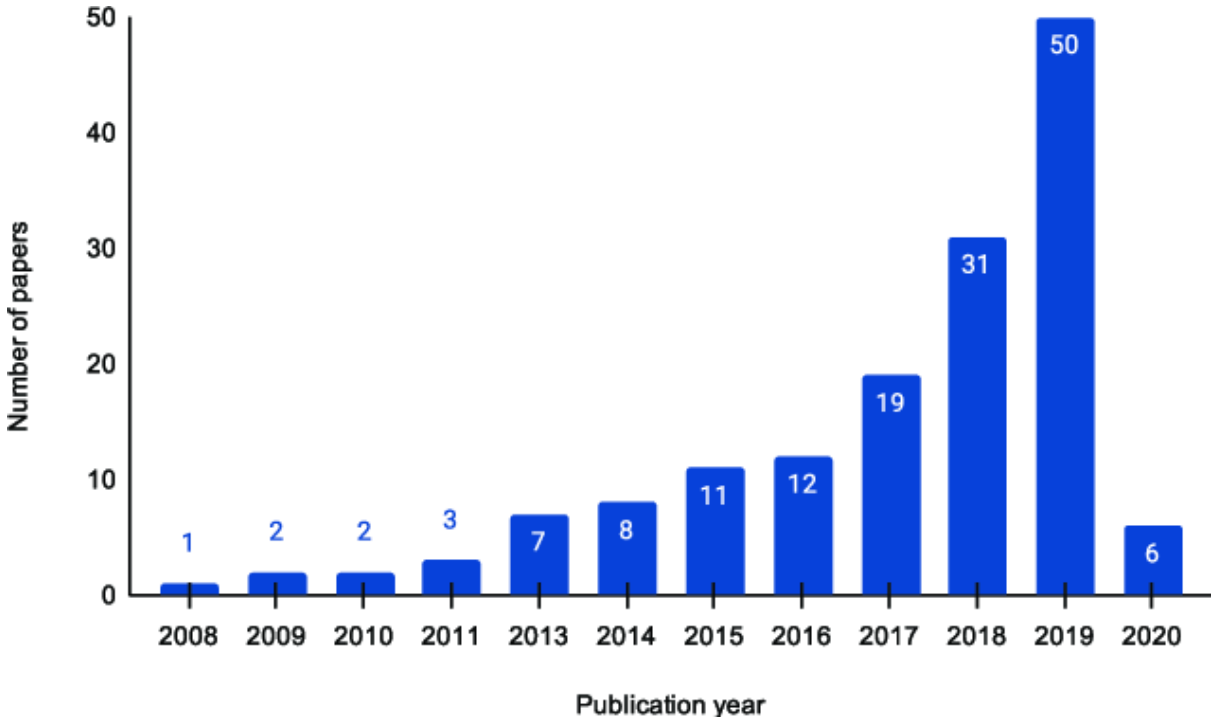
Following the elimination of duplicates and preliminary screening, the reviewing team began with a total of 207 publications, of which six studies lacked complete text. A 74.1% agreement rate (149 out of 201 studies) was attained following the team's first screening procedure. The team's disagreements were identified through the reviewers' comments on the choices. The primary difference pertained to the inclusion or removal of research that were limited to fetuses, rather than pregnant women. The fetal state has been deemed acceptable for this study because to its dual role as a cause and a result of the maternal state. Following this explanation, the remaining not included studies underwent another screening procedure.[10]



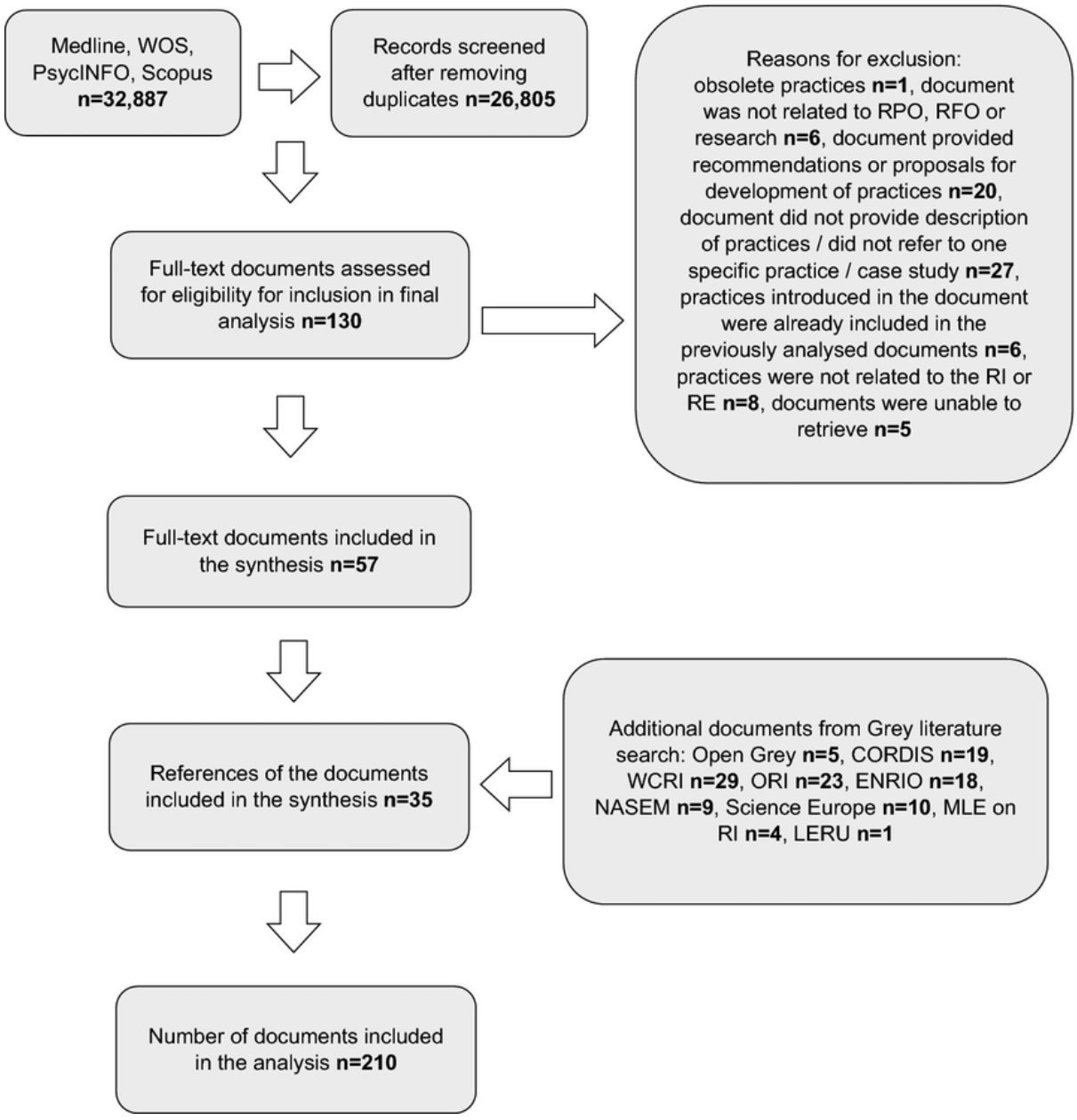
SYNTHESIS OF RESULTS - GENERAL INFORMATION

AUTHOR KEYWORDS

A preliminary understanding of the findings authors are emphasizing from their study has been obtained by analyzing the most often used author keywords in the included studies. Based on their frequency, the most popular terms are shown in Fig 6. Observations may be made in three areas according on the topic: words connected to health, AI, and pregnancy-related medicine. Pregnancy, gestational diabetes, fetal heart rate, gestational age, low birth weight, hypertensive disorders, fetal macrosomia, chromosomal abnormalities, pregnancy outcomes, preterm birth, congenital heart diseases, severe maternal moridity, and others are among the most frequently searched terms in the first category. The utilization of healthcare, risk assessment, prenatal care, and medical problems might be emphasized under the second group. Lastly, a list of terms related to artificial intelligence includes machine learning, decision support systems, data mining, artificial neural networks, mobile health, and decision trees.



Most frequent author keywords in the included studies.



PRISMA-ScR flow diagram for the scoping review process. CORDIS...

DISCUSSION

The role of AI in pregnancy is summed up in this review. About 75% of the included studies employed AI approaches to predict pregnancy-related illnesses or problems. There is a vacuum in the literature as we found a few difficulties that the examined research did not address. Initially, research on the efficacy of models for treating conditions such gestational diabetes or preeclampsia was not found. Second, not much was known about the public data sources used to train the AI models. Therefore, in future research, it is imperative to give top priority to monitoring hypertension and suggesting novel AI applications for the detection and treatment of preeclampsia. To describe the validation strategy and algorithms used by AI technology during pregnancy, more evaluations are also required.

This research has certain restrictions. The ability of AI algorithms to forecast and diagnose pregnancies was not evaluated. Consequently, we urge more researchers to carry out systematic studies of AI models' efficacy for similar

purposes. Furthermore, we did not take into account the postpartum period or births; instead, we restricted our attention to research pertaining to pregnant women and pregnancy. Consequently, it's possible that we missed some other sub-domains related to the topic of pregnancy and delivery. The literature was retrieved from just two databases, even though a larger number of databases may have yielded more thorough results. Lastly, only English-language studies were included in the search approach. Thus, it's possible that we overlooked research on AI and pregnancy that were written in a language other than English.

CONCLUSIONS

We draw the conclusion that, among the research in this review, ML and LR were found to be the most often used AI techniques and models. Pregnant patients may receive better treatment thanks to AI-driven solutions. Future research should evaluate how effectively the models employed for the pregnant woman's well-being work.

Following processing and assessment of all the papers, the following concepts are included in the study's conclusions:
Artificial intelligence (AI) applications during pregnancy can lessen the challenges provided by socioeconomic circumstances, location of residence, or the pregnant woman's capacity to travel, therefore improving universal healthcare and reducing healthcare variability.

Pregnancy-related health may be closely monitored with AI apps. This might lessen the patient's emotions of fear or anxiety and help her feel more comfortable and connected to her healthcare provider.

There are two ways in which AI applications might lessen maternal-fetal morbidity:

1) Monitoring apps on smartphones and wearable technology allow for quick identification of risk variables.
2) Doctors can create more effective decision trees with the use of data automated analysis.

AI would make it possible to identify changes in the pathology of pregnant people early on.
AI applications may enhance any health program's assessment process and increase both its efficiency with reference to human and material resources.

There are still significant gaps in the area despite a rise in recent years in both awareness and research effort addressing the intelligent solutions in health treatments (as discussed in the Background section). To be more precise, a research gap has been found in which the potential of AC to enhance the psychological and physical health of expectant mothers has not yet been investigated. Particular assessment methods might be used at every stage of the process, from system design and development to testing and patient acceptance and recommendation. In addition, this sector is very innovative and has ethical ramifications that need to be thoroughly researched and thought through.

Furthermore, only 7% of the studies addressed data security, and only 23% addressed privacy problems, despite the topic's importance. This represents a gap in the existing research and a need for further investigation. It is also evident that a collaborative endeavor by the community to validate and replicate results will contribute to the development of stronger and more useful research standards. In conclusion, this study offers valuable perspectives for scholars and professionals seeking to expand their understanding of artificial intelligence and affective computing as they relate to the domains of obstetrics and gynecology. We contribute to the creation of next solutions in this rapidly evolving field challenge by offering these insights.

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