USING MOBILE HEALTH APPLICATIONS TO PREVENT PREECLAMPSIA IN PREGNANT WOMEN: A SCOPING REVIEW

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ABSTRACT

Preeclampsia remains one of the leading causes of maternal morbidity and mortality worldwide. One of the interventions implemented is health education for pregnant women. However, in practice, this is often hindered by limited time and healthcare personnel. With the advancement of technology, the use of mobile applications in preeclampsia prevention can serve as an alternative educational medium that is easily accessible to pregnant women, as mobile health technology can improve the management of high blood pressure through patient education, facilitate communication between patients and healthcare providers, and support self-monitoring of blood pressure. This study aims to systematically map the use of information systems and digital technology in preventing preeclampsia in pregnant women through a scoping review approach. The scoping review was conducted following the PRISMA-ScR guidelines. A literature search was performed in international and national scientific databases for articles published from 2018 to 2026 via Google Scholar, Scopus, PubMed, and ScienceDirect. Studies meeting the inclusion criteria were mapped based on research design, type of mHealth intervention, focus, and reported outcomes. Findings from 9 articles indicate that mHealth apps are used for education, early detection, health monitoring, improved access to health services, and increased engagement of pregnant women in health services. The most frequently reported outcomes and objectives of mHealth interventions were early detection and blood pressure monitoring in pregnant women (n=4), while evidence regarding preventive behavioral changes and clinical impacts remains limited. Mobile health applications play a role in supporting preeclampsia prevention, particularly through increased knowledge and engagement among pregnant women. However, further research is needed to evaluate their impact on preventive behavioral changes and clinical outcomes.

Keywords: Mobile Health Application, Prevention, Preeclampsia, Pregnant Women.

INTRODUCTION

Preeclampsia is a specific hypertension disorder in pregnancy that significantly contributes to maternal and perinatal morbidity and mortality worldwide, especially in low- and middle-income countries (Ibrahim et al, 2024). Preeclampsia usually appears after the 20th week and is marked by high blood pressure and often the presence of protein in

the urine. The exact cause isn't fully understood, but it's thought to involve several factors, including issues with the placenta, genetic components, and the immune system (Karrar & Hong, 2024; Ives et al, 2020; Jung et al, 2022). Preeclampsia is linked to 2% - 8% of pregnancy complications globally. More than 50,000 maternal deaths and nearly 500,000 infant deaths occur worldwide. About 9% - 26% happen in low-income countries and around 16% in high-income countries (Karrar & Hong, 2022).

Preeclampsia affects premature birth, stunted fetal growth, and oligohydramnios, which increases morbidity and mortality. Preeclampsia can also be caused by health problems, like high body fat, poor nutrition, or inadequate blood flow to the uterus, as well as preeclampsia that occurs due to genetic factors (Karrar, Fogel, and Hong, 2023). According to the 2024 Indonesia Health Profile data, hypertension during pregnancy is the second biggest contributor to maternal death in Indonesia, after non-obstetric complications (Indonesia Health Profile, 2024).

Therefore, strengthening preventive interventions against complications in pregnant women, like preeclampsia, has very important public health implications. One effort that can be done is early detection and behavior changes in pregnant women, such as monitoring blood pressure, regular visits to antenatal care (ANC) services, and recognizing the signs and risks of preeclampsia, which can help reduce the incidence and complications (Indonesian Health Profile, 2024; Ibrahim et al., 2024).

Even though the urgency of early detection and behavior modification has been clinically proven to reduce complications, its effectiveness on the ground is often limited by lack of access to information and inconsistent monitoring. That's why efforts are needed to make accessing services easier, one of which is through information technology like mobile health (mHealth) or mobile apps that can provide educational content, appointment reminders, and self-monitoring. Studies in various contexts show good health behavior changes during pregnancy, such as increased compliance with ANC visits and risk behavior modification (Ameyaw et al, 2024).

In line with research conducted by Treasa et al. (2026), it was stated that the use of Mobile Health significantly improves knowledge, antenatal care compliance, and satisfaction with midwifery services. Furthermore, research by Puspitasari and Indrianingrum (2021) also stated that m-health applications influence pregnant mothers' knowledge about danger signs in the third trimester compared to the MCH book. Other research also stated that evaluation results showed that the prototype for prevention scored 81 on the SUS, indicating good usability and meeting user needs (Adelia, Pradini, Khudori, 2025).

The advantage of using m-Health is that it makes it easier for pregnant women to access pregnancy information, making it educational content that can be accessed anytime and anywhere. Through m-Health technology, pregnant women can increase their knowledge. Knowledge influences attitudes and eventually determines behavior towards their health, leading to efforts in preventing preeclampsia in pregnant women (Puspitasari and Indrianingrum, 2021).

The implementation of information systems and digital technology in preeclampsia risk

screening not only supports clinical decision-making but also strengthens the overall health system. With digital platforms, data can be collected, analyzed, and shared in real-time, allowing for faster and more targeted interventions (Ruru, Purnami, and Pradigdo, 2026). Some studies have developed Android-based preeclampsia prevention or screening app prototypes and shown potential in improving knowledge and user engagement, but there haven't been many studies assessing their direct impact on behavior change for prevention or mapping the role of mobile health apps in supporting preeclampsia prevention in pregnant women (Feroz et al, 2021). On the other hand, digital health has also been widely used to assess and monitor health issues, making it impossible to separate technology from disease management. Given the common challenges in communities such as uneven distribution of healthcare workers, unequal access to health facilities, and the limitations of diverse geographical patterns across regions, the use of technology has a significant impact on healthcare management, especially in cases of preeclampsia in pregnant women.

LITERATURE REVIEW

Preeclampsia is a complex pregnancy-related hypertension disorder, characterized by newly developed high blood pressure and proteinuria or organ dysfunction after 20 weeks of pregnancy (ACOG, 2020). Preeclampsia is high blood pressure that occurs after 20 weeks of pregnancy accompanied by proteinuria. Clinical symptoms of preeclampsia are divided into mild and severe preeclampsia. Severe preeclampsia is preeclampsia with a systolic blood pressure ≥ 160 mmHg and diastolic blood pressure ≥ 110 mmHg along with proteinuria > 5 g/24 hours. Preeclampsia and eclampsia can occur before, during, or after childbirth (Angsar, 2016).

Preeclampsia affects premature birth, stunted fetal growth, and oligohydramnios, which increases morbidity and mortality. Preeclampsia can also be caused by health problems, like high body fat, poor nutrition, or inadequate blood flow to the uterus, as well as preeclampsia that occurs due to genetic factors (Karrar, Fogel, and Hong, 2023). According to the 2024 Indonesia Health Profile data, hypertension during pregnancy is the second biggest contributor to maternal death in Indonesia, after non-obstetric complications (Indonesia Health Profile, 2024).

Obstetric complications in preeclampsia include Intrauterine Growth Restriction (IUGR), Intrauterine Fetal Death (IUFD), premature delivery, HELLP syndrome, and Eclampsia. Non-obstetric complications in preeclampsia include heart failure, peripartum cardiomyopathy, pulmonary edema, future cardiovascular disease risk, posterior reversible encephalopathy syndrome, stroke, kidney failure, acute kidney injury, risk of end-stage kidney disease in the future, liver failure, liver rupture, and coagulopathy (Pankiewicz et al, 2019).

Early and consistent prenatal care is really important to monitor and manage potential risk factors. Preventive measures focus on regular prenatal visits to check for early signs of pre-eclampsia. Recommendations include: 1) Regular blood pressure checks; 2) Urine tests for protein; 3) Monitoring symptoms like headaches and vision problems; 4) Consider lifestyle factors, like keeping a healthy weight and staying active (if

allowed); 5) Managing pre-existing conditions, especially pre-existing high blood pressure (WHO, 2025)

Additional preventive steps include: 1) Low-dose aspirin at 20 weeks or when antenatal care starts;2) Calcium supplementation during pregnancy in places with low dietary intake; 3) Treating pre-existing high blood pressure with antihypertensive medication. (WHO, 2025).

Blood pressure control. The choices for antihypertensive therapy during pregnancy are limited. The most commonly given drugs include labetalol, hydralazine, and nifedipine. Labetalol and hydralazine are given both intravenously and orally, with intravenous injections often used in severe cases or emergencies. Labetalol and nifedipine are better known as first-line antihypertensive drugs for gestational hypertension disorders.

Management that can be done like: 1) Seizure prevention. Magnesium is the drug of choice for preventing seizures in preeclampsia and eclampsia cases. It has been shown to be superior to other anticonvulsant drugs due to fewer side effects; 2) Delivery and termination of pregnancy. The only way to stop or block the process of preeclampsia is to deliver the baby. Therefore, delivery is indicated once the patient reaches full-term pregnancy; 3) Fluid management. Women with preeclampsia often experience fluid overload, which can lead to serious complications like pulmonary edema; 4) Diet management. Controlling the mother's weight, high fiber intake, using probiotics, calcium and vitamin D supplements, multivitamin and multimineral supplements, as well as avoiding high-salt diets and raw foods are considered beneficial. A diet rich in vegetables, fruits, and healthy fats has also been shown to reduce the risk of preeclampsia; 5) Exercise. Aerobic exercise is associated with a decrease in gestational hypertension problems because it improves placentation and generally healthier immune responses; 6) Long-term follow-up. Long-term follow-up for potential complications should be considered since residual symptoms in the cardiovascular system, liver, and kidneys can occur. Close monitoring over the years is recommended, which requires vigilance from a good medical team and the patient's medical compliance.

RESEARCH METHODOLOGY

This research was prepared based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using a scoping review approach. The methodology review follows the methodology as proposed in studies by Arksey et al. and Levac et al. This scoping review aims to analyze the sophistication and identify research gaps related to how mobile technology can prevent the occurrence of preeclampsia during pregnancy.

The main research question for this scoping review is: What is known in the literature about mobile health used to support pregnant women in the prevention of preeclampsia and high-risk preeclampsia in Indonesia? This study uses the population, concept, and context (PCC) framework recommended by the Joanna Briggs Institute for scoping reviews. The operationalization of the PCC framework for this scoping review includes: population (pregnant women with preeclampsia/high-risk preeclampsia), concept (mobile health), and context (Developed and Developing Countries).

This review covers studies involving pregnant women with preeclampsia and those at high risk of preeclampsia by applying digital solutions to support early detection and management of preeclampsia in pregnant women. mHealth includes wearable devices, predictive models implemented through clinical apps, health information technology, health management systems, and other mHealth-related innovations that can aid in diagnosis, monitoring, and treatment. The inclusion criteria for this study are shown in Table 2.

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
1. research reporting information on the use of mHealth for hypertension disorders during pregnancy 2. Studies in Indonesian and English 3. Articles published between January 1, 2019, and January 30, 2026 4. Includes primary research studies, including experimental studies (e.g., randomized controlled trials (RCT), quasi-experimental studies), observational studies (e.g., cohort, case-control) 5. Population of pregnant women with preeclampsia or high-risk pregnancies experiencing PE and/or health workers in maternal complication management programs	1. Only in abstract form 2. Using systematic review/meta-analysis/scoping review methods 3. Published before 2018 4. Article is not a full paper 5. Article published in two or more journals (duplicate) 6. Sample not taken from pregnant women with PE or at high risk for PE

Four main electronic databases were used, including Google Scholar, Scopus, PubMed, and ScienceDirect. References from relevant systematic reviews and the latest included articles were also manually searched to find relevant studies. This strategy covers three main concepts that are the focus: target population (pregnant women), health condition (PE), and intervention (mHealth). The search strategy used the keywords in Table 2 and Figure 1.

Table 2. Kata Kunci

Mobile Health Application		Prevention		Preeclampsia/High-Risk Preeclampsia		Pregnant Women
Mobile Health Application	AND	Prevention	AND	Eclampsia	AND	Pregnant women
OR		OR		OR		OR
mHealth	AND	Monitoring	AND	Preeclampsia	AND	Pregnancy
OR		OR		OR		OR

Digital Health Apps	AND	Self-monitoring	AND	Pre-eclampsia	AND	High risk pregnant
OR		OR		OR		OR
Mobile Application	AND	Self-monitoring	AND	Pre-eclampsia	AND	High risk pregnant

The data abstraction table is designed to determine the appropriate variables, such as author, year, research method, population, sample size, digital interventions used, theory, results, keywords, and the purpose of the digital intervention (Table 3**). An** inductive approach was used to thematically organize and summarize the results from the included articles to answer the research questions. The results extracted from each article were read repeatedly to identify recurring patterns, similarities, and differences in the use of mHealth to prevent pregnant women from preeclampsia. The identified data were analyzed into five groups, including study characteristics, mHealth objectives, mHealth users, and the types of outcomes evaluated by the included studies.

RESEARCH RESULTS

The data sources for this study came from Google Scholar, Scopus, PubMed, and ScienceDirect. From the search results, a total of 9 research publications were found to be relevant to the topic of mobile health applications and their impact on preeclampsia prevention behavior in pregnant women, and met the established inclusion and exclusion criteria. The articles that passed the selection were then manually extracted by recording important information, including the authors' names, year of publication, article titles, sample sizes, and the variables studied. A summary of these extracted results is presented systematically in Figure 1.

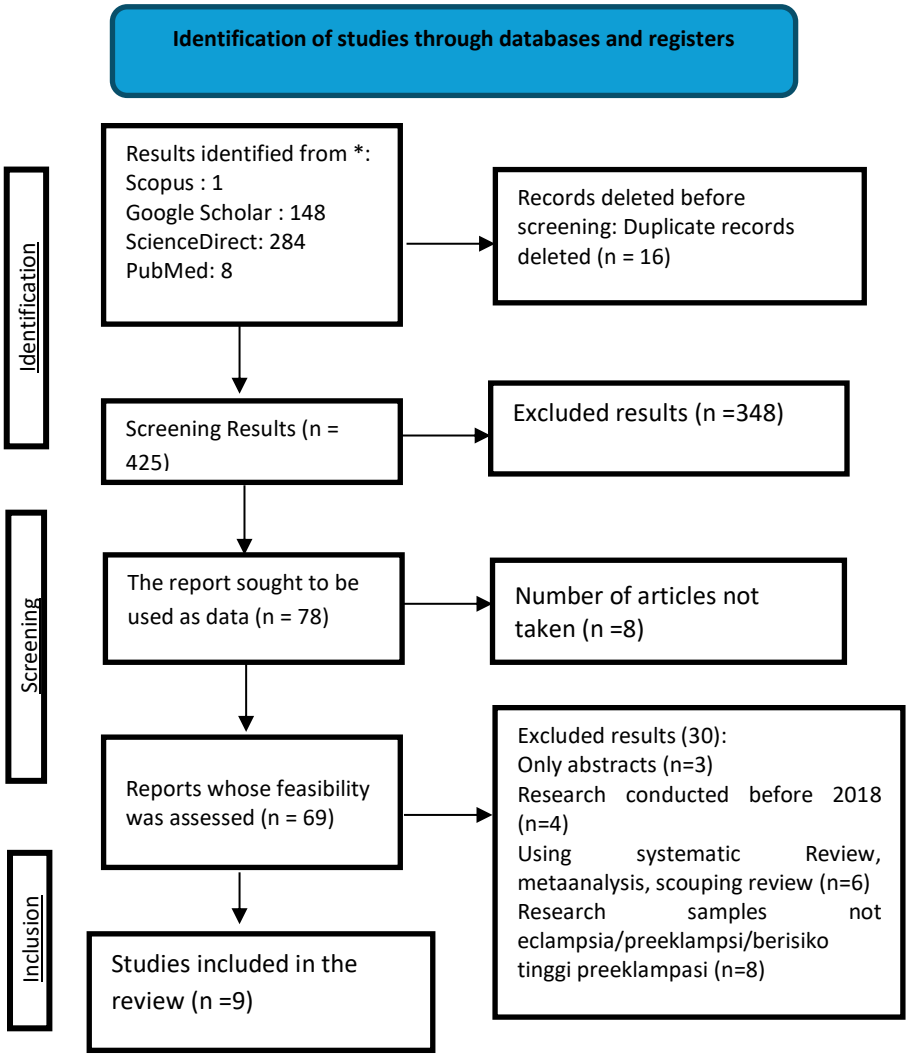

Figure 1. Journal Identification Chart
(https://www.prisma-statement.org/prisma-2020-flow-diagram)

Tabel 3. Ekstraksi Data

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
1	Wills et al. (2025)	USA (low-income setting)	Mixed methods	Pregnant woman	9 pregnant women with Hypertensiv	mHealth prototype for HDP management	TAM, person-centered design	Usability (SUS), acceptability	High ease of use (SUS=81), high acceptance level; customized feedback and real-	Monitoring blood pressure in pregnant and postpartum women

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
					e Disorders				time communication are needed	
2	Elbeltagy, Ahmed, Fadel. (2024)	Mesir	A quasi-experimental research design (pre and post test)	Pregnant woman	118 pregnant women at high risk of preeclampsia	Virtual App	PRECEDE Model	knowledge scores of predisposing,enabling, and reinforcing factors, perilaku pencegahan,	The application of the virtual PRECEDE model has proven to be an effective tool for improving pregnant mothers' knowledge and practices regarding preeclampsia prevention behaviors.	Conducting an evaluation of the effects of a virtual application based on the PRECEDE model
3	**Pangesti et al. (2024)**	Indonesia	Prototype	App prototype	-	mHealth	Flutter dan menerapkan pola BloC (Business Logic Component)	Early-onset preeclampsia risk screening and monitoring application	Application; Android; screening; monitoring; early preeclampsia	Increasing pregnant women's knowledge about preeclampsia
4	Mamat & Sansuwito. (2024)	Indonesia	Cross-sectional	Pregnant mom and partner	86 pregnant women with preeclampsia and	mHealth	-	Uses and development of applications	Eclampsia prevention, mobile application, mother, partner	Increasing knowledge and awareness in preventing preeclampsia

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
					their husbands					
5	Wang et al. (2025)	Mongolia	andomized controlled trial	pregnant women	58 ibu hamil berisiko tinggi	mHealth	Behavior Change Wheel theory and Family Health Theory	The main outcomes include prenatal diagnostic needs and pregnancy outcomes, while secondary outcomes include health knowledge, levels of anxiety and depression, decision conflicts, and other factors.	cellular health, behavior change wheel, family health theory, prenatal diagnosis, high-risk pregnancy, pregnancy outcomes	Increasing participation in prenatal diagnostic screenings and improving psychological health as well as pregnancy outcomes in high-risk pregnant women.
6	Moulaei et al. 2021	Iran	Development of a Pregnant Women Prototype	Pregnant women	20 pregnant women with preeclampsia and Covid 19	Mobile Apps	-	11 Apps were eligible for the study. All were present on the Android operating system; only one was available on both operating systems, Android and iOS. Of the 11,	Health promotion; Mobile applications; Preeclampsia; Pregnant mothers; Smartphones	Managing and controlling diseases

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
								six Apps addressed PE characteristics; only one addressed the clinical management of PE. The scores for evaluation of the Apps ranged from 14 to 29 points, on a scale that ranged from 6 to 30 points. Only two Apps had Portuguese versions.		
7	Aini, Widyawati, Santoso. 2019	Indonesia	Quasy-eksperimental	Pregnant woman	23 pregnant women and 5 women with preeclampsia	Web	-	Web-based information systems can also improve the speed of diagnosis by up to 7.21%. The statistical test using an Independ	Diagnosis, Preeclampsia, Information System, Web	Diagnosing the type of preeclampsia

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
								ent T-Test resulted in a P-value of 0.041<0.05 (α).		
8	Anderssonet al. 2026	Swedia	Prospective Longitudinal Feasibility Study	Ibu hamil	87 preeclampsia mothers, 40 high-risk PE mothers, and 32 healthy pregnant mothers	mHealth	-	The Anura app is well received by pregnant women and is useful for early detection and self-monitoring of blood pressure during pregnancy	blood pressure; experience; cell phone; preeclampsia; self blood pressure monitoring; pregnancy	Checking a pregnant woman's blood pressure on your own
9	Shahil-Feroz. 2023	Pakistan	A qualitative remote usability testing approach	Pregnant mother	14 mothers at high risk of PE	mHealth	-	articipants emphasized the importance of enhancing the clarity of instructions, messaging, and terminology within the Raabta app. In particular,	uji kegunaan; aplikasi Raabta; ibu hamil berisiko tinggi mengalami preeklampsia; Pakistan; teknik berpikir keras; teknik penyelesaian tugas	to take daily blood pressure readings at home with a provided Bluetooth-enabled home blood pressure monitor and to answer one yes/no symptom question

No	Author (Year)	Country	Research Method	Population	Sample Size	Digital Intervention	Intervention Design/ Theory	Measured Outcomes	Findings	Purpose of the Digital Intervention
								users recommended clearer instructions for blood pressure measurement tasks and suggested amending the symptom assessment question to ensure an accurate understanding.		

DISCUSSION

Review of the Studies Used

A total of 9 publications in this scoping review reported that all studies used mHealth and web technologies such as mobile apps, telemonitoring, and virtual education in the management of preeclampsia prevention in pregnant women both in Indonesia and in other countries like Pakistan, Sweden, Iran, Mongolia, Egypt, and the USA. This shows that the use of digital technology in maternal health is a global issue that is relevant in both developing and developed countries.

Most of the studies used quasi-experimental, randomized controlled trial (RCT), cross-sectional, prototype development, prospective longitudinal, feasibility study designs, with quasi-experimental and RCT designs showing that digital interventions are not only developed but also empirically tested for effectiveness. All studies also met the inclusion criteria, which were articles published from 2018-2026. Sample sizes varied (5-118 respondents), with the main population being pregnant women in their second and third trimesters. The variety in studies also shows that the research wasn't just aimed at testing the effectiveness of mHealth on preeclampsia, but there was also a study using a prototype development method to provide educational information to help prevent preeclampsia in pregnant women (Adelia, Pradini, Khudori, 2025; Pangesti et al, 2024).

Purpose of the mHealth App

This article reports that out of the 9 included, all were aimed at supporting pregnant women to avoid pregnancy complications, namely preeclampsia. The analysis results showed that the purposes of using mHealth include increasing pregnant women's knowledge about preeclampsia (n=2) (Mamat & Sansuwito, 2024; Pangesti et al., 2024).

The second goal is to increase participation in prenatal diagnostic check-ups as well as improve psychological health and pregnancy outcomes in high-risk pregnant women (n=1) (Wang et al, 2025). This aligns with Feroz's research (2022), which states that one effective program for managing pregnancies with preeclampsia is through mobile applications for screening and monitoring. The development of mobile app studies in other countries has targeted healthcare workers at community and secondary healthcare services. The next goal is the early detection of blood pressure in pregnant women, which is the most common objective in the use of mHealth (n=4) (Wills et al., 2025; Moulaei et al., 2021; Aini, Widyawati, Santoso, 2019; Andersson et al., 2026; Shahil-Feroz et al., 2023).Mobile health (mHealth) is an innovation of telemedicine that uses gadgets as a medium to access digital-based health information and services by utilizing electronic devices connected to the internet. mHealth services are distinguished based on the interaction between users and healthcare professionals, namely services that are interactive and services that are non-interactive (Hasanah et al, 2025).

mHealth Users

The overall users in this study are pregnant women with preeclampsia and pregnant women at high risk of developing preeclampsia. In addition, the sample used also includes the partners of pregnant women with preeclampsia

Tabel 4. Hasil Penelitian

Referensi	Judul	Hasil Penelitian
Wills et al (2025)	Usability and acceptability of a mobile application prototype for managing hypertensive disorders of pregnancy: A mixed methods evaluation	The capabilities of the digital health app designed for pregnant women with preeclampsia show that most of them experienced a good increase in digital health literacy, with high SUS scores in line with the qualitative themes about acceptability and ease of use, especially for monitoring blood pressure (BP), and the pregnant women acknowledged these features as essential for making informed decisions and taking timely actions.
Elbeltagy, Ahmed, Fadel. (2024)	Effect of Virtual PRECDE Model Application on Pregnant Women's Knowledge and Reported Practices Regarding Preventive Behaviors of Preeclampsia	There was a statistically significant increase in the total knowledge scores of predisposing, facilitating, and reinforcing factors both immediately and one month after. In addition, one month after the intervention, pregnant women showed adequate practices for preeclampsia prevention compared to before the intervention. Moreover, most high-risk pregnant women did not experience preeclampsia after using the PRECDE Model intervention.
Pangesti et al. (2024)	Pengembangan Aplikasi Skrining dan Pemantauan Risiko Preeklamsi AwitanDini Berbasis Android untuk Ibu Hamil di Layanan Primer	The development of an early onset preeclampsia screening and monitoring app aims to make it easier for pregnant women to carry out pregnancy screening and monitoring on their own. The features created include risk factor screening, health professional consultations, and early onset preeclampsia education. A Likert scale was used to assess the material in the app by 3 expert validators. The total validation result from the experts showed it is very feasible (92.22%) to be trialed with users, with a few improvements.

Mamat & Sansuwito. (2024)	Development of a user-friendly mobile app for eclampsia prevention targeting preeclampsia mother and spouse	The mobile app is easy to use, and they feel confident using it. All participants confirmed that the mobile app has the necessary content (appropriate). The results of the mobile app testing showed positive outcomes.
Wang et al. (2025)	The influence of mobile health intervention on the rate of prenatal diagnosis and pregnancy outcomes among pregnant women with highrisk prenatal screening results: protocol for a randomized controlled trial	This study suggests that mobile health interventions based on the Transtheoretical Model of Behavior Change and Family Health Theory can effectively boost participation in prenatal diagnostic check-ups and improve psychological health as well as pregnancy outcomes in high-risk pregnant women.
Moulaei et al. (2021)	The Design and Evaluation of a Mobile based Application to Facilitate Self-care for Pregnant Women with Preeclampsia during COVID-19 Prevalence	Out of 20 obstetricians and pregnant women, a needs assessment was carried out. In the second stage, based on the identified needs, an application prototype was designed and then evaluated. For the evaluation, 20 pregnant women were asked to use the app for 10 days. The QUIS version 5.5 questionnaire was used for the evaluation. Descriptive statistics and the Mann-Whitney test in SPSS version 23 were used for data analysis. Out of 66 information needs identified through the questionnaire, 58 were considered in the app design. The app features designed were grouped into 5 categories: user profile, lifestyle, disease prevention and control, app capabilities, and user satisfaction.
Aini, Widyawati, Santoso (2019)	Preeclampsia Care (A Web-Based Informastion System) Effective For detecting The Risk Of Preeclampsia In Pregnant Women	Pregnant women who previously couldn't do early detection of preeclampsia on their own can now, by using this web-based information system, check their risk of preeclampsia independently. Data from most pregnant women shows that they are not at risk of preeclampsia, which amounts to 51.5%.

Andersson et al. 2026	Evaluating a Smartphone App to Monitor Blood Pressure in Normotensive Pregnancies, High-Risk Pregnancies, and Women With Preeclampsia: Prospective Longitudinal Feasibility Study	Anura consistently shows higher diastolic values (around 5–7 mm Hg) and lower systolic values, with significant differences in the second and third trimesters. In high-risk pregnancies, both systolic and diastolic BP are generally lower with Anura, especially in the second and third trimesters, while women with preeclampsia show the biggest differences, with Anura showing lower systolic and diastolic values.
Shahil-Feroz et al. 2023	Remote Moderated Usability Testing of a Mobile Phone App for Remote Monitoring of Pregnant Women at High Risk of Preeclampsia in Karachi, Pakistan	This study produced findings related to four themes: improving the clarity of instructions, messages, and terminology; accessibility for Urdu-speaking users who are not tech-savvy and are illiterate; enhancing visuals and icons for user engagement; and simplifying navigation and functionality. Overall, user feedback emphasized the importance of improving the clarity of instructions, messages, and terminology in the Raabta app.

Critical Appraisal Within Sources of Evidence

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools according to the respective study designs. The detailed appraisal results are presented in Table 5.

Overall, the methodological quality of the included studies ranged from moderate to high. Of the 9 studies included in this review, 2 studies achieved high-quality ratings (23%), while 7 studies were categorized as moderate quality (77%). No studies were classified as low quality or excluded based on critical appraisal results.

Table 5. Summary of JBI Critical Appraisal Results

No	Study	Study Design	JBI Checklist Tool	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Score	Percentage	Overall Quality
1	Wills et al. (2025)	Mixed methods	JBI Cross Sectional Study	Y	Y	Y	Y	N	N	Y	Y						6/8	75%	Moderate
			JBI Qualitative Research	Unclear	Y	Y	Y	Y	N	N	Y	Y	Y				8/10	80%	High
2	Elbeltagy, Ahmed, Fadel. (2024)	A quasi-experimental research design (pre and post test)	JBI quasi-experimental research	Y	Y	Y	Y	N	N	Y	Y						6/8	75%	Moderate
3	Pangesti et al. (2024)	Prototype	-																
4	Mamat & Sansuwito. (2024)	Cross-sectional	JBI Cross Sectional	Y	Y	Y	Y	N	N	Y	Y						6/8	75%	Moderate
5	Wang et al. (2025)	andomized controlled trial	JBI RCT	Y	Y	Unclear	Unclear	Unclear	Unclear	Y	Unclear	Y	Y	Y	Y	Y	5/13	61%	Moderate

No	Study	Study Design	JBI Checklist Tool	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Score	Percentage	Overall Quality
6	Moulaei et al. 2021	Pengembangan Prototype	-																
7	Aini, Widyawati, Santoso. 2019	Quasi eksperimental	JBI Quasy-eksperimental Research	Y	Y	Y	N	Y	Unclear	Y	Y	Y					7/9	77%	Moderate
8	Andersson et al. 2026	Prospective Longitudinal Feasibility Study	JBI Quasi-eksperimental studies	Y	Y	Y	Y	Unclear	N	Y	Y						6/8	75%	Moderate
9	Shahil-Feroz. 2023	A qualitative remote usability testing approach	JBI Qualitative Research	Unclear	Y	Y	Y	Y	N	N	Y	Y	Y				8/10	80%	High

Results of Individual Sources of Evidence

A total of nine studies met the inclusion criteria. The studies were published between 2019 and 2026 and came from various countries, including Indonesia, Egypt, Iran, Pakistan, China, Australia, and Sweden. The research designs used varied, including quasi-experimental studies, mixed-methods evaluations, development studies, randomized controlled trial protocols, usability testing, and feasibility studies. The interventions developed consisted of mobile health (mHealth) apps and web-based information systems designed to improve early detection, monitoring, health education, and prevention of preeclampsia complications.Penelitian Aini et al. (2019) mengembangkan sistem informasi berbasis web *Preeclampsia Care* yang mampu meningkatkan deteksi risiko preeklampsia pada ibu hamil. Sistem ini menyediakan identifikasi faktor risiko dan mendukung pengambilan keputusan awal dalam pelayanan antenatal.

Moulaei et al. (2021) developed a self-care mobile app for pregnant women with preeclampsia during the COVID-19 pandemic. The app provides health information, monitors the mother's condition, gives care reminders, and offers self-education, which is considered capable of supporting sustainable disease management. Shahil-Feroz et al. (2023) evaluated the telemonitoring app "Raabta" using remote moderated usability testing. The study results showed that the app was well accepted by high-risk pregnant women with preeclampsia after some improvements were made to navigation, language, and visual design.

Elbeltagy et al. (2024) evaluated the effectiveness of a Virtual PRECEDE Model-based app on knowledge and prevention practices of preeclampsia in pregnant women. The study results showed a significant increase in both knowledge and preventive behaviors after using the app. Pangesti et al. (2024) developed an Android app for early-onset preeclampsia risk screening and monitoring in primary healthcare. The app is designed to help identify risk factors and facilitate continuous monitoring of pregnant women. Mamat and Sansuwito (2024) developed a user-friendly mobile app for preventing eclampsia in mothers with preeclampsia and their partners. The app focuses on family involvement by providing information, reminders, and education about the warning signs of preeclampsia and eclampsia.

Wills et al. (2025) conducted a mixed-methods evaluation of a prototype app for managing hypertensive disorders during pregnancy. The results showed high usability and acceptability, as well as the app's potential to support monitoring of mothers' conditions during pregnancy. Wang et al. (2025) published a randomized controlled trial protocol aiming to evaluate the effect of mHealth interventions on prenatal diagnosis rates and pregnancy outcomes in women with high-risk prenatal screening results. This study is still at the protocol stage and has not produced effectiveness data yet. Andersson et al. (2026) evaluated a smartphone app for monitoring blood pressure in pregnant women who are normotensive, high-risk, or have preeclampsia. The study showed a good level of acceptance and the potential of the app as an additional monitoring tool, although measurement accuracy still needs improvement in the preeclampsia group.

Synthesis of Results

Analysis of nine studies produced four main themes related to the use of mobile health in the prevention and management of preeclampsia.

Theme 1. Risk Screening and Early Detection of Preeclampsia

Five studies emphasized the use of apps as tools for screening and early detection of preeclampsia risk. The apps developed by Aini et al., Pangesti et al., and Wang et al. focused on identifying risk factors as well as supporting clinical decision-making. Digital systems allow health data to be collected more quickly and help healthcare workers identify pregnant women who need more intensive monitoring.

In addition, the app developed by Pangesti et al. specifically targets early-onset preeclampsia risk detection, which is one of the key factors in preventing maternal and neonatal complications.

Theme 2. Health Education and Behavioral Change

That mobile health apps play an important role in increasing knowledge and preventive behavior for preeclampsia. Elbeltagy et al. found a significant increase in knowledge and prevention practices after using an app based on the Virtual PRECEDE Model. Similar findings were also seen in apps developed by Mamat and Sansuwito as well as Moulaei et al., which provided educational materials on risk factors, warning signs, therapy compliance, and self-care. These results show that mHealth can be an effective educational tool to boost pregnant women's engagement in taking care of their health during pregnancy.

Theme 3. Remote Monitoring and Self-Management

Five studies integrated remote health monitoring features. Shahil-Feroz et al., Wills et al., Andersson et al., and Moulaei et al. developed apps that allow users to monitor blood pressure, clinical symptoms, and their health conditions independently.

The self-monitoring feature provides an opportunity to detect changes in condition earlier and facilitates faster communication between patients and healthcare providers. This approach is especially relevant for preeclampsia because the condition requires continuous monitoring and early detection of worsening signs.

Theme 4. Usability, Acceptability, and User-Centered Design

Most studies highlight the importance of usability and acceptability in the successful implementation of applications. Research by Wills et al., Shahil-Feroz et al., Mamat and Sansuwito, as well as Andersson et al. shows that apps with simple navigation, easy-to-understand language, attractive visual displays, and automatic reminder features tend to be more accepted by users. However, some challenges still exist, including limited digital literacy, the need for user training, uneven internet access, and the need to improve the accuracy of smartphone-based health monitoring technology.

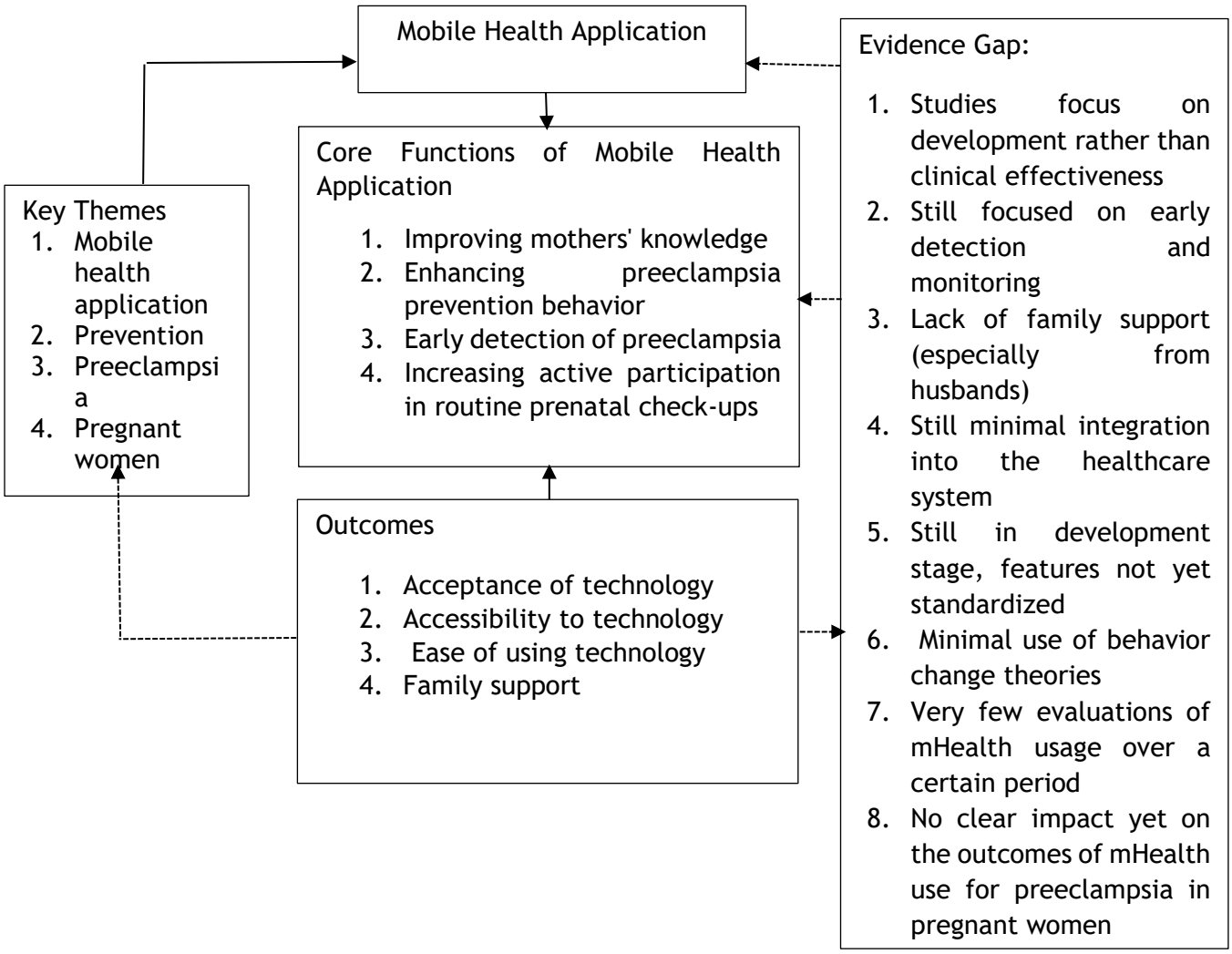

Figure 1. Conceptual Framework of Thematic Synthesis

Efektivitas Intervensi Digital

The results from all the studies showed positive outcomes from using mHealth for the prevention of preeclampsia, such as: 1) Pregnant women's knowledge about preeclampsia increased; 2) Early detection of risk factors and warning signs of preeclampsia; 3) Preventive behaviors against complications and adherence to antenatal care; 4) Monitoring blood pressure and clinical symptoms of antenatal care complications; 5) Self-efficacy and involvement of mothers in pregnancy care. The use of digital tools in health services has a significant impact on health, especially for pregnant women. This aligns with studies showing that digital interventions, particularly mobile health (mHealth) apps, increase the use of antenatal and postnatal services and are associated with improved maternal and neonatal outcomes (Sondaal et al., 2016; Feroz et al., 2017; Wagnew et al., 2018).Tekelab et al.,2019).

Sebagian besar hasil Penelitian limited to improving knowledge and behavior that is significant in the prevention of preeclampsia (Mamat & Sansuwito, 2024; Elbeltagy, Ahmed, Fadel, 2024; Pangesti et al, 2024) and limited to the usefulness of applications for early detection of

blood pressure in pregnant women with preeclampsia and high-risk PE (Andersson et al, 2026; Shahil-Feroz et al, 2023; Aini, Widyawati, Santoso, 2019). However, there are still no articles that examine the long-term impact of using mHealth on PE prevention.

Pendekatan Teoritis

Some studies use theoretical frameworks such as: 1) TAM (Technology Acceptance Model); 2) PRECEDE Model; 3) Flutter and applying the BloC (Business Logic Component) pattern; 4) Behavior Change Wheel theory and Family Health Theory. All the theories used prove an increase in knowledge and behavior changes carried out in the short term, such as interventions limited to only 14–30 days (Wills et al, 2025; Aini et al, 2024). In the use of the TAM theory, it is determined by five constructs: perceived ease of use, perceived usefulness, attitude toward using, behavioral intention to use, and actual system usage. All the constructs influence the effectiveness of providing digital interventions for pregnant women. However, in all the analyzed articles, the framework used is not explained (Wills et al, 2025).

In the research by Wills et al (2025), the TAM Model was used as a model to evaluate barriers and drivers in adoption, focusing on perceived usefulness (prototype feasibility and expected benefits) and perceived ease of use (how easy it is to use). In addition, we evaluated women's digital health literacy as a potential factor influencing acceptance and usability testing.

The second model is the use of the PRECEDE model, where PRECEDE is an acronym for predisposing factors, reinforcing factors, and enabling factors in education diagnosis and evaluation. Knowledge of predisposing factors includes pregnant women's knowledge about preeclampsia, such as the definition, risk factors, symptoms, and so on. symptoms, and so on. Knowledge about facilitating factors includes pregnant women's understanding of things that help them change their behavior, like participating in educational programs about preeclampsia, resources, access to medical services, and support in preventing preeclampsia. Knowledge about reinforcing factors is pregnant women's understanding of things that strengthen and motivate the desired behavior change, such as emotional support and getting help from family or healthcare workers (Elbeltagy, Ahmed, Fadeln, 2024).

Application Design Used

Figure 2. Example screenshot of a mobile app prototype designed for managing hypertension disorders during pregnancy in Newark, New Jersey, 2024.

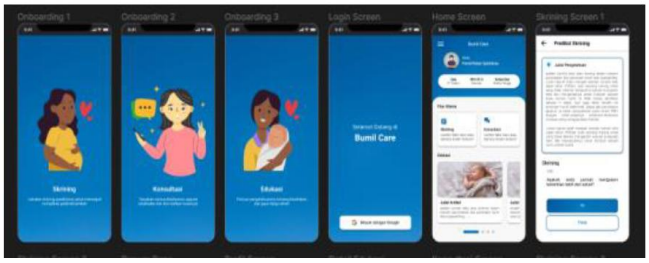

Figure 3. Application interface design (Pangesti et al. (2024)

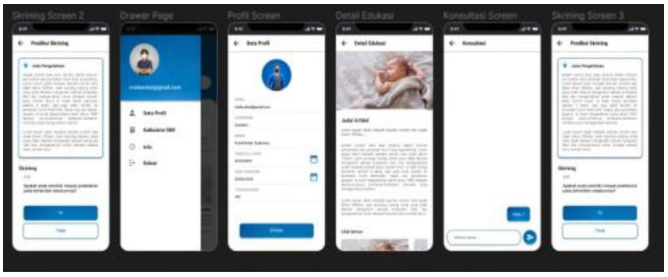

Figure 4. Application interface design (Pangesti et al, 2024)

The review in the first sprint received feedback in the form of an evaluation of interface color choices and the achievement of design implementation during the coding phase. The review results became the basis for improvements and planning for the next stage. The steps in the second sprint included improving the results of the first sprint's evaluation, implementing authentication, and creating application pages. The authentication service used is Firebase Authentication, and it uses Firebase Realtime Database for data storage. The database structure is shown in Figure 4.

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Figure 5. Education Modull, Monitoring, danIntroduction

Screening is done to predict the risk of early-onset preeclampsia. Figure 9 shows the question page and the user's screening risk factors (Figure 5).

Figure 6. Main page of the app

Screening is done to predict the risk of early-onset preeclampsia (Pangesti et al, 2024).

Article 4

Figure 6 shows the main menu display of the mobile app, including profile, information, communication, background, and log-out menus. This menu also facilitates communication and coordination between healthcare workers, mothers, and partners.

Figure 7. Main Menu of the App

Data was collected in two stages through this app. The first stage gathered material needs within the app related to the prevention of pregnancy disorders (eclampsia) in pregnant women. The questionnaire consisted of 20 statements, with answer categories 5 = Very Needed (VN), 4 = Needed (N), 3 = Not Very Needed (NVN), 2 = Not Needed (NN), 1 = Absolutely Not Needed (ANN). The second stage of mobile app development referred to the content results that had been identified, then collaborated with technology experts. After the mobile app was developed, its usability was measured. The measurement variables consisted of 10 statements about the usability of the mobile app and positive comments (numbers 1, 3, 5, 7, and 9) as well as negative statements (numbers 2, 4, 6, and 10).

Each statement consists of 5 categories on a Likert scale; for positive statements, a score of 5 = Strongly agree, 4 = Agree, 3 = Neutral, 2 = Disagree, 1 = Strongly disagree, while for negative

statements, a score of 5 = Strongly disagree, 4 = Disagree, 3 = Neutral, 2 = Agree, 1 = Strongly agree. Responses on the application's responsiveness and ease of use are categorized as 4 and 5 (Agree and Strongly agree) (Mamat & Sansuwito, 2024).

Figure 8. Main page of the self-care app for pregnant women with pre-eclampsia in dealing with COVID-19.

In the user profile category, users record their demographic and clinical information. The lifestyle category provides self-care recommendations for users. In 'Disease Prevention and Control,' besides introducing and explaining COVID-19 to pregnant women with preeclampsia, various prevention and control methods are provided for users based on specialist recommendations and reliable scientific information. This is aimed at helping them learn how to avoid and/or manage COVID-19 and preeclampsia through proper self-care and self-management.

Figure 7 shows that users can record the medications they take, the dosage, and the time they take them. In addition, users can also set reminders, view the list of past reminders and medications, and access educational videos about taking medicine regularly. Here, users can note their medical allergies and list all medications that have caused allergic reactions. This will also make it easier for them to provide this information to their doctor if needed.

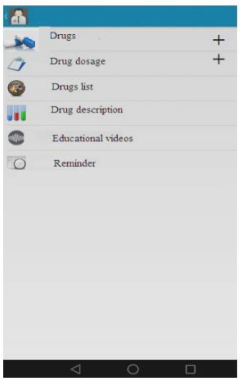

Figure 9. Medication Intake Management

Figure 9. Nutrition management

Figure 8 shows that users can record accurate information about their physical condition in the "nutrition and diet management" section, which includes areas like the user's daily eating habits, main meals, snacks consumed, calories consumed, and exact meal times. This will help users track and manage their weight better. After logging the relevant information, users will receive reminders and messages for timely eating and weight loss. Article 7 Figure 10 shows the login menu where midwives can access the information system after being registered by the admin. Midwives can only edit data for patients they have entered themselves and do not have access to change data on other midwives' accounts. However, midwives can access overall data on pregnant women to see the history of previous check-ups. Figure 11 shows the home menu, which includes several features such as statistics, patients, midwives, staff, and log out. In the statistics menu, midwives can see the number of patients entered along with the number of cases and a graph showing the distribution of examination results. To add patient data, midwives can click the add patient feature in the patients menu. Figure 12 shows the input of pregnant women data and check-ups. The data entered includes the mother's biodata, health history, obstetric history, Body Mass Index (BMI), and examination results. After the input is done, the system will process it and give out a diagnosis.

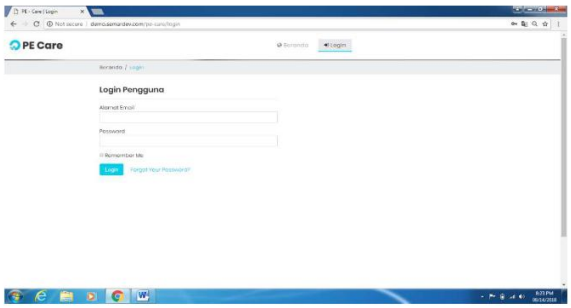

Figure 10. Menu Login

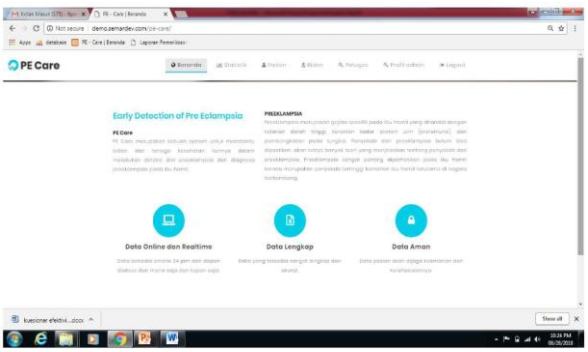

Figure 11. Home Menu Display

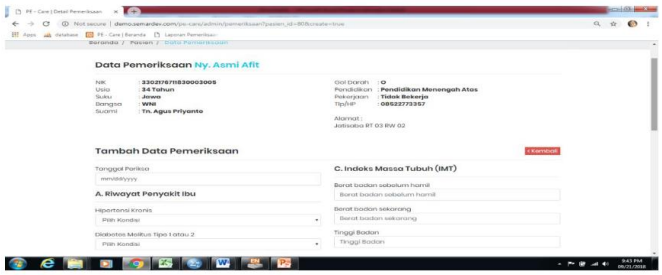

Figure 12. Pregnant Mother Check-Up Data Input Menu

Figure 13. User interface of the Anura application

Smartphone-based apps can be a user-friendly solution for monitoring blood pressure (BP). Anura is a smartphone app based on an innovative imaging method called transdermal optical imaging (TOI) and it takes advantage of the fact that light can pass through the skin and reflect due to the skin's transparency (Dawson et al, 2022). The reflected light can be captured by optical sensors (Stamataz et al, 2004). TOI uses images recorded through video and machine learning algorithms to extract blood flow information from the facial epidermis. The Anura app can perform this measurement in 30 seconds by simply asking the patient to record a 30-second selfie video (Figure 13). Thus, this app can remove the need for cuffs or other technical equipment (Liu et al, 2018). Based on a large video dataset of normotensive and hypertensive patients, along with their physiological measurements from gold-standard medical devices, TOI uses machine learning algorithms to build computational models to predict various vital signs.

Figure 14. Screenshot of the Raabta app

Figure 14 shows that this app is used for early detection of blood pressure. If a participant has hypertension with a systolic blood pressure between 140 and 154 mm Hg and a diastolic pressure between 90 and 104 mm Hg, without preeclampsia symptoms, the app will ask the participant to take a second blood pressure measurement within 4–6 hours. If a participant has severe hypertension (systolic ≥155 mm Hg and diastolic ≥105 mm Hg) and/or preeclampsia symptoms, the app will ask them to go to the emergency room immediately (Shahil-Feroz et al. 2023).

Implications for Preventing Preeclampsia

This review suggests that digital interventions have great potential in: 1) Improving pregnant women's health literacy; 2) Supporting early detection of preeclampsia; 3) Increasing adherence to antenatal visits; 4) Facilitating self-monitoring of blood pressure; 5) Reducing delays in decision-making when seeking help. With the growing smartphone penetration, especially in Indonesia, app-based interventions are becoming a feasible and scalable solution for the maternal health system.

This scoping review recommends 7 points for future research: (1) enabling the use of mHealth by pregnant women as the main users so it can be used for personal health screening; (2) considering a multidisciplinary team approach and interprofessional collaboration when designing mHealth for preeclamptic and high-risk pregnant women; (3) exploring the potential use of telemedicine in developing countries and remote areas to allow remote consultations between pregnant women and healthcare providers; (4) conducting further studies including cohort and prospective experimental studies to assess the effectiveness of mHealth implementation in preventing preeclampsia in pregnant women; (5) exploratory study to identify barriers and drivers related to the development, implementation, and evaluation of mHealth; (6) Integrating the use of AI to develop mHealth designs and features; (7) mHealth features that can be integrated with Health worker data include daily and monthly reports from patients.

CONCLUSION

This scoping review shows that mobile health apps play a role in supporting efforts to prevent preeclampsia in pregnant women, mainly through increasing knowledge, providing health information, risk screening, and enhancing user engagement in pregnancy care. However, most studies still focus on cognitive outcomes and technology acceptance, self-monitoring of blood pressure in pregnant women, and ease of access to maternal health services if early signs of preeclampsia are detected. Meanwhile, evidence on behavior changes for preeclampsia prevention and the clinical impact of using these apps is still limited. These findings emphasize the need for further research that evaluates the role of mobile health applications more comprehensively, the risk factor features that can cause preeclampsia in pregnant women, the results of evaluations or reports on the risk of preeclampsia in pregnant women, including their impact on preeclampsia prevention behaviors and their integration into maternal health care systems.

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