



MHEALTH FOR HIGH-RISK PREGNANCIES IN DEVELOPING COUNTRIES: A SCOPING REVIEW

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ABSTRACT

This study explores the application of mHealth technologies in antenatal care for high-risk pregnancies in developing countries, emphasizing their potential to enhance maternal health service quality. By leveraging the PRISMA-ScR checklist and PCC framework, a scoping review of 858 articles from PubMed, ScienceDirect, EBSCO, and Google Scholar identified 13 relevant studies. Key themes include the types of mHealth utilized (mobile apps, SMS, phone calls, and web-based platforms), their benefits (screening, monitoring, health education, and complication reduction), improvements in antenatal care (innovative care models, increased visit frequency, reduced risks, and better pregnancy outcomes), and their role in supporting high-risk pregnancies (emotional support, risk education, and clinical decision-making). The findings highlight mHealth's potential to address healthcare disparities and provide cost-effective solutions in resource-constrained settings. Moreover, mHealth offers promising contributions to achieving maternal health-related Sustainable Development Goals (SDGs) by 2030, notably by improving access to quality care, reducing maternal and neonatal risks, and mitigating healthcare inequities. However, further research is required to evaluate the long-term effects, scalability, and sustainability of mHealth initiatives in the developing countries.

Keywords: Mobile Health; Telemedicine; Maternal Health; High-Risk Pregnancy; Developing Countries

ABSTRAK

Penelitian ini mengeksplorasi penerapan teknologi *mHealth* dalam perawatan antenatal untuk kehamilan berisiko tinggi di negara-negara berkembang, dengan menekankan potensinya dalam meningkatkan kualitas layanan kesehatan maternal. *Scoping review* ini menggunakan PRISMA-ScR *checklist* dan kerangka kerja PCC. Sebanyak 858 artikel yang diperoleh dari PubMed, ScienceDirect, EBSCO, dan Google Scholar dianalisis, dan 13 studi yang relevan berhasil diidentifikasi. Tema utama yang ditemukan mencakup jenis teknologi *mHealth* yang digunakan (aplikasi seluler, SMS, panggilan telepon, dan platform berbasis web), manfaat (skrining, pemantauan, edukasi kesehatan, dan upaya mengurangi komplikasi), peningkatan kualitas asuhan antenatal (model asuhan inovatif, peningkatan frekuensi kunjungan, upaya penurunan risiko, dan hasil kehamilan yang lebih baik), serta peran *mHealth* dalam mendukung kehamilan berisiko tinggi (dukungan emosional, edukasi risiko tinggi, dan pengambilan keputusan klinis). Temuan ini menyoroti potensi *mHealth* dalam mengatasi kesenjangan layanan kesehatan dan menyediakan solusi yang hemat biaya di daerah dengan sumber daya terbatas. Selain itu, *mHealth* menawarkan kontribusi yang menjanjikan dalam mencapai *Sustainable Development Goals* (SDGs) terkait kesehatan maternal pada tahun 2030, terutama dengan meningkatkan akses ke layanan berkualitas, mengurangi risiko maternal dan neonatal, serta mengatasi kesenjangan layanan kesehatan. Namun, penelitian lebih lanjut diperlukan untuk mengevaluasi dampak jangka panjang, skalabilitas, dan keberlanjutan inisiatif *mHealth* di negara berkembang.

Kata kunci: *mHealth*; Telemedicine; Kesehatan Ibu; Kehamilan Berisiko Tinggi; Negara Berkembang

INTRODUCTION

Risk is defined as "the possibility of harm, loss, injury, or other adverse consequences". Generally, it refers to the potential or likelihood of experiencing loss. Thus, when healthcare providers refer to a "high-risk pregnancy," they describe a scenario where the pregnant woman, fetus, or both face a higher probability of complications, adverse events, or negative outcomes during or after pregnancy and birth compared to a low-risk or uncomplicated pregnancy (Scrimshaw S & Backes, 2020).

High-risk pregnancies are linked to a heightened risk of maternal mortality. In 2020, approximately 287,000 women died during pregnancy and childbirth. Nearly 95% of these maternal deaths occurred in low- and lower-middle-income countries, and the majority were preventable (WHO et al., 2023). In Nepal, women with high-risk pregnancies were 4.2 times more likely to experience severe maternal morbidity during childbirth (Rajbanshi et al., 2020). Nearly half of all pregnancies in India have one or more high-risk factors, which is a matter of concern (Kuppusamy et al., 2023). Factors such as low family income and maternal illiteracy (Win et al., 2024; Mehboob et al., 2021), limited access to healthcare facilities, particularly in rural areas, contribute to delays in receiving essential care (Mehboob et al., 2021; Okonofua, 2021), and the shortage of trained healthcare providers as well as the quality of maternal healthcare services (Mehboob et al., 2021) exacerbate the situation. In this context, *mHealth* technology can serve as a crucial solution to support early detection, monitoring, and pregnancy education for high-risk populations. In Indonesia, maternal mortality declined from 390 to 189 per 100,000 live births between 1991 and 2020. This figure is close to the RPJMN 2024 target of 183 per 100,000 live births. Despite the downward trend, further efforts are necessary to accelerate the reduction of the maternal mortality rate to meet the SDG target of 70 per 100,000 live births by 2030 (Kemenkes RI, 2023).

Antenatal Care (ANC) is any activity and/or a series of activities carried out from the conception period to before the start of the labor process that is comprehensive and quality and is provided to all pregnant women (Kemenkes RI, 2020). Antenatal care is vital for preventing and detecting health issues in high-risk pregnancies. Early detection, regular health

monitoring, education, and prompt medical intervention can significantly lower the risk of complications, thereby enhancing maternal and infant health outcomes.

In low-resource environments, identifying high-risk pregnancies is often difficult due to insufficient national resources and weak health system infrastructure. However, mobile health (mHealth) technology has shown promise in enhancing antenatal care in these areas (Mishra et al., 2023). Mobile and wireless technologies have the potential to revolutionize healthcare delivery globally. With over 7 billion mobile phone subscribers worldwide, more than 70% of whom are in low-or middle-income countries, mobile phones are more accessible than clean water in many regions (WHO, 2023). In recent years, the global healthcare landscape has shifted significantly toward digitalization, with telemedicine playing a central role. This change has been especially impactful in developing countries (Rerey et al., 2023). mHealth interventions have shown promise in enhancing antenatal care for high-risk pregnancies. By making prenatal care more accessible and offering necessary support to pregnant women, mHealth can significantly improve the health and well-being of both individuals and communities (Kusyanti et al., 2022).

Several previous reviews on the use of mHealth in developing countries have explored mHealth interventions for monitoring the physiological aspects of antenatal care among pregnant women (Mishra et al., 2023), mHealth interventions specifically for high-risk pregnant women with pre-eclampsia and eclampsia (Feroz, Afzal, et al., 2022), effect of mHealth intervention on increasing antenatal care visits and skilled birth attendance (Rahman et al., 2022), and mHealth's role in perinatal depression (Dosani et al., 2020). Based on existing reviews, this study takes a different objective by mapping research findings on the role of mHealth (mobile health)-based technologies in antenatal care for high-risk pregnancies in developing countries. Through a deeper understanding of the potential of this technology, it is hoped that more effective solutions can be found to improve the quality of maternal health services, particularly for high-risk pregnant women in these regions. The knowledge gap regarding the effectiveness and efficiency of mHealth in such settings includes the lack of empirical evidence on its impact on maternal and neonatal health outcomes, limited integration into national healthcare systems, and insufficient attention to the sustainability and costs of long-term implementation. By providing more targeted evidence, this study aims to support the development of evidence-based policies, drive innovation in antenatal care services, and strengthen clinical practices to reduce maternal mortality rates in developing countries.

METHOD

This research employs the Scoping Review method, a type of knowledge synthesis that systematically and iteratively identifies and synthesizes existing or emerging literature on a specific topic (Thomas et al., 2017). *Scoping reviews are considered "exploratory projects" that systematically map the existing literature on a topic. They identify key concepts, theories, sources of evidence, and research gaps* (Peters et al., 2020).

The steps followed in this research are adapted from Arksey and O'Malley, Daniel Levac, and Susanne Mak. They include identifying the research question, finding relevant studies, selecting studies, charting the data, and then collating, summarizing, and reporting the results (Levac et al., 2010; Mak & Thomas, 2022; Malley, 2005).

Step 1: Identifying the review question or focus of the review

This study utilized a PCC framework (Population, Concept, Context). This framework was used to define the research focus, encompassing: Population (pregnant women with high-risk pregnancies), Concept (utilization of mHealth technologies in antenatal care), and Context (developing countries). This framework enables researchers to systematically explore how mHealth technologies can

contribute to improving antenatal care services for high-risk populations in developing countries. The combination of PRISMA-ScR and PCC provides a robust methodological foundation to ensure the quality and reproducibility of this study. Articles were searched across multiple databases, including PubMed, ScienceDirect, EBSCO, and the search engine Google Scholar. The keywords used were “m-health” OR mhealth OR ehealth OR “mobile health” OR telemedicine AND “antenatal care” OR “prenatal care” OR “high-risk pregnancanc*” OR “high risk pregnanc*”.

Step 2: Identifying relevant studies

The article selection process was carried out systematically to ensure the quality and relevance of the data used. The inclusion criteria consisted of original articles published between 2019 and 2023, articles focused on the role of mHealth technologies in high-risk pregnancies, full-text articles, articles written in English or Indonesian. Exclusion criteria included review, protocol, report, and opinion articles. Thirteen articles met these criteria and were critically appraised using the Joanna Briggs Institute (JBI) methodology.

Step 3: Article selection

The search across three databases and one search engine yielded 858 articles: 379 from PubMed, 7 from EBSCO, 271 from Science Direct, and 201 from Google Scholar. Initial screening was performed using Zotero and Rayyan, filtering the articles by title, resulting in 796 irrelevant articles and 6 duplicates. Subsequently, 57 articles were screened according to the inclusion criteria, leading to 13 relevant articles for this scoping review. These articles were then analyzed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools. The search process is documented in the following PRISMA-ScR flow chart:

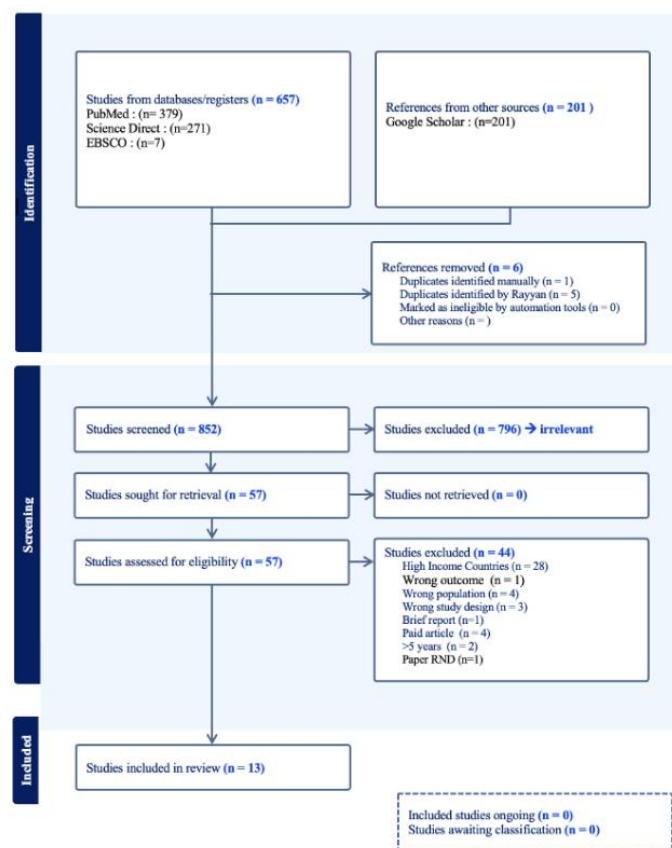


Figure 1. PRISMA-ScR Flowchart

The PRISMA-ScR framework was selected as it aligns with the objectives of this study, which are to map existing literature, identify knowledge gaps, and present evidence in a structured manner. This framework provides comprehensive guidelines for conducting scoping reviews, ensuring transparency and accountability throughout the research process.

Step 4 : Identifying relevant studies

The data was combined using data charting which includes author, year, country, aim of research, method of data collection, and research findings. Data mapping was conducted in consultation with the second author, and the results are presented in Table 1.

Table 1. Data Charting

Author, country	Aim of Research	Method of Data Collection	Research Findings
(Bola et al., 2022) Nigeria	Assess and compare the rates of maternal mortality and morbidity in Benue State, Nigeria.	Cohort study/ included data collection of all Community Maternal Danger Score (CMDs) variables. The respondents were women who received antenatal care in Gboko between 2015-2017 and 2020-2021, with no exclusion criteria.	The CMDs is more efficient in data acquisition and assessment, allowing for real-time risk identification.
(Bogale et al., 2020) West Bank and Gaza	Describe the planning, creation, and assessment of Targeted Client Communication (TCC) interventions, which are guided by theory and automatically generated from maternal and child health records.	Qualitative method/ data collection through interviews / Respondents of this study consisted of 18 pregnant women, 4 doctors, and 4 nurses.	To increase ANC utilization and address pregnant women's knowledge gaps, researchers developed text messages that can be followed up with users using the recommended message framing model.
(Tian et al., 2021) China	To assess the effectiveness of using WeChat group chats for Blood Glucose (BG) management in comparison to standard clinical prenatal care for women with Gestational Diabetes Mellitus (GDM).	Randomized Control Trial method/data collection via WeChat chat and control group/Research respondents totaled 125 women.	Instant messaging platforms such as WeChat, used for health education and lifestyle interventions in China are likely to be more effective for controlling blood sugar levels compared to standard prenatal clinical care alone.
(Mohamadian et al., 2023) Iran	Examining the effects of health coaching in preventing gestational diabetes mellitus (GDM) among overweight pregnant women.	Quasi Experiment Method/ Data collection through survey / Research respondents totaled 64 women.	The incidence rate of Gestational Diabetes Mellitus (GDM) was 24.1% in both the control and intervention groups. Post-survey results indicated a greater reduction in Gestational Weight Gain (GWG) in the coaching group compared to the control group from pre-trial (T0) to post-trial (T1).
(Guo et al., 2021) China	To assess the effectiveness of combined online and offline medical care management for	Randomized Controlled Trial Method/ Data collection through control group / Study respondents amounted to 140 patients with gestational diabetes.	Overall, integrated online-offline medical care management effectively enhanced blood glucose levels, mental state, self-management behaviors, quality of

	individuals with gestational diabetes.		life, and pregnancy outcomes in patients with gestational diabetes.
(Feng et al., 2023) China	Evaluate the effect of a smartphone application aimed at controlling pregnancy weight gain on caesarean section rates among overweight and obese women.	Randomized Controlled Trial Method/ Data collection through control group / Study respondents amounted to 260 overweight pregnant women.	Smartphone-assisted weight control may help lower caesarean section rates by effectively managing pregnancy weight gain.
(Venkat eswaran et al., 2022) West Bank Palestine	Compare the quality of antenatal care in clinics utilizing e-Registry with those relying on paper-based records.	Cluster Randomized Controlled Trial Method / Data collection using e-Registry / The study was conducted in 133 primary health care clinics in the West Bank, Palestine.	Clinical decision support for antenatal care within the e-Registry outperformed in most process outcomes but did not impact adverse health outcomes. Digital health interventions targeting attendance gaps could enhance effective antenatal care coverage.
(Valencia et al., 2023) Colombia	To assess the usability and patient satisfaction of the application designed to assist in managing high-risk obstetric patients.	Prospective Observational Method/ Data collection through survey / Research respondents totaled 62 patients.	The Information Systems Usability Questionnaire (CSUQ) results indicated patient acceptance of the application across global scores and various domains, including System Utility (SYSUSE), Information Quality (INFOQUAL), and Interface Quality (INTERQUAL). The satisfaction survey also showed positive results overall and by domain.
(Mohamed et al., 2023) Egypt	To assess the impact of Tele-nursing guidelines on the knowledge of women with gestational diabetes during the COVID-19 pandemic.	Quasy-experiment method / data collection through questionnaires and interviews / Research respondents totaled 50 pregnant women with gestational diabetes.	Tele-nursing guidelines significantly enhanced women's knowledge of gestational diabetes mellitus and their self-care management skills.
(Ayatollahi et al., 2019) Iran	To compare the feasibility of using web-based and mobile-based technologies for managing high-risk pregnancies.	Cross sectional method/ Data were collected through questionnaires/ Respondents of this study were 60 midwives and 43 obstetricians.	Results indicated that midwives (p=0.001) and gynecologists (p=0.003) generally found mobile-based technology more feasible than web-based technology for managing high-risk pregnancies.
(Feroz, De Vera, et al., 2022) Pakistan	To investigate the telemedicine needs of pregnant women at high risk of pre-eclampsia in Karachi, Pakistan..	Descriptive and interpretative Qualitative Method/Data collected through interviews/resources totaling 15 pregnant women and 21 key informants.	Both pregnant women and healthcare providers recognize the benefits of the telemedicine program, such as early detection of pregnancy complications, prompt treatment, convenience, cost-effectiveness, increased empowerment in accessing health services, continuity of care, and reduced pregnancy risks.
(Zhu et al., 2019) China	To examine the role of combining usual care with telemedicine in managing high-risk pregnancies.	Retrospective study method/ Data were collected from Hangzhou Maternity Hospital between October 2012 and September 2016/ 93,465 respondents in the usual care group and 134,884 in the telemedicine group..	The group that received telemedicine services had significantly more prenatal visits than the usual care group. Despite having a higher proportion of high-risk women, the telemedicine group saw a reduction in maternal mortality rates.

(Özkan Şat & Yaman Sözbir, 2021) Turkey	To examine how pregnant women used mobile apps to access health information and services during the COVID-19 pandemic.	Cross sectional method (descriptive)/ Data collection through questionnaires / Respondents amounted to 376 pregnant women.	The pandemic has impacted pregnancy stress and pregnant women's use of health mobile apps. Mobile apps can be a commonly used prenatal follow-up tool during the COVID-19 pandemic.
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RESULTS AND DISCUSSION

Table 2. Theme and Sub Theme

Theme	Subtheme	Studies	Practical Implications
Types of mHealth	Mobile applications, SMS, phone calls, and web-based systems.	(Bola et al., 2022; Bogale et al., 2020; Tian et al., 2021; Mohammadian et al., 2023; Guo et al., 2021; Feng et al., 2023; Venkateswaran et al., 2022; Valencia et al., 2023; Mohamed et al., 2023; Ayatollahi et al., 2019; Feroz, De Vera, et al., 2022; Zhu et al., 2019; Özkan Şat & Yaman Sözbir, 2021)	Improves access and sustainability of antenatal care services in developing countries
Benefits of mHealth	Screening, monitoring maternal conditions, health education, and reducing complications.	(Bola et al., 2022; Bogale et al., 2020; Tian et al., 2021; Mohammadian et al., 2023; Guo et al., 2021; Venkateswaran et al., 2022)	Reduces complications and increases maternal engagement in healthcare.
Improvement in ANC Quality	Innovative care models, increased ANC visits, reducing risk, improving pregnancy outcome and the completeness of antenatal records	(Bogale et al., 2020; Guo et al., 2021; Feng et al., 2023; Venkateswaran et al., 2022; Valencia et al., 2023; Feroz, De Vera, et al., 2022; Zhu et al., 2019; Özkan Şat & Yaman Sözbir, 2021)	Enhances healthcare efficiency and compliance with ANC among pregnant women.
Support for High-Risk Pregnancies	Emotional support, education on risk signs, and clinical decision-making assistance.	(Venkateswaran et al., 2022; Özkan Şat & Yaman Sözbir, 2021)	Addresses psychological barriers and enhances maternal self-management.

Types of mHealth

The mHealth apps used in antenatal care in developing countries found in this review include the use of apps to identify high-risk (Bola et al., 2022), maintenance monitoring and management (Ayatollahi et al., 2019; Feng et al., 2023; Guo et al., 2021; Tian et al., 2021), periodic text messages/short message service (SMS) (Bogale et al., 2020), periodic phone calls (Mohamed et al., 2023; Mohammadian et al., 2023), and web-based systems (Ayatollahi et al., 2019). This is in line with previous research which states that some of the mHealth applications that have been used include SMS messaging, smartphone/PDA applications, and telemonitoring approaches involving fetal heart rate monitoring combined with uterine contractions in pregnancies with complications, thus enabling remote monitoring in high-risk pregnancies. These applications have also been used in

both developed and developing countries, with a large number of studies conducted in developing countries (Abaza & Marschollek, 2017).

Of all the types of mHealth mentioned, the use of *mobile apps* is the most widely used, which is related to the growing popularity of mobile phones and mobile-based technologies that are accessible to many people. In addition, many mobile-based applications have been developed in the health field and many people are familiar with this type of technology. However, despite the development of technology, adequate attention must be paid to various aspects to prevent undesirable outcomes. Future research is needed to design and implement mobile-based applications and test the effectiveness of using this technology to monitor high-risk pregnancies compared to using traditional face-to-face visits (Ayatollahi et al., 2019).

These technologies have proven to be effective in improving health services and overcoming financial constraints, which are major barriers to delivering health services in developing countries (Nguyen et al., 2022). Although this technology holds promise for improving health services in developing countries, it is recommended to conduct more large-scale clinical trials with comprehensive objectives for future research to draw stronger conclusions about the effectiveness of mHealth interventions in improving antenatal care in developing countries (Hoque et al., 2020; Nguyen et al., 2022). The use of mobile applications and other communication technologies, such as SMS or phone calls, facilitates access to antenatal services in areas with limited healthcare infrastructure. Future research should focus on cost-effectiveness and system interoperability to ensure the sustainability of this technology in developing regions.

Benefits of mHealth for high-risk pregnancies

Mobile health developed as a high-risk screening function (Bola et al., 2022; Venkateswaran et al., 2022), monitoring of gestational diabetes (Bogale et al., 2020; Guo et al., 2021; Mohammadian et al., 2023; Tian et al., 2021), and provide education on high-risk pregnancy care management (Guo et al., 2021). This aligns with other studies that indicate the benefits of mHealth in pregnancy, including enhancing pregnant women's knowledge and education regarding high-risk pregnancy care management. The mHealth app can help women understand how to manage their condition and reduce the risk of complications, helping pregnant women make informed decisions about their health and well being (Kusyanti et al., 2022).

A study in rural India assessed the SMART-Health Pregnancy platform, a clinical decision support system for high-risk pregnant women. This platform was used for screening, referral, and counseling for high-risk pregnancy conditions, aiming to enhance the health of rural women who are especially vulnerable due to limited health literacy and access to healthcare services (Nagraj et al., 2023). Another benefit of mHealth services is that it helps to track pregnancies and encourage more antenatal visits, which are crucial for monitoring maternal and fetal health (Bawadi et al., 2023). In general, mobile health (mHealth) applications have been widely used in developing countries to improve greater healthcare access where traditional healthcare infrastructure is limited and help lower the cost of healthcare delivery, making it more affordable (Davey et al., 2014). This is consistent with current research which suggests that mHealth interventions have the potential to improve access to obstetric services through apps that help pregnant women and healthcare providers communicate and monitor their health during pregnancy. mHealth technologies are increasingly being used to increase accessibility of services and improve maternal and fetal health (Mishra et al., 2023).

mHealth can be used to change behaviors towards preventive healthcare actions, ultimately improving health outcomes in vulnerable/at-risk populations. Another benefit is that it enhances the availability of decision support information for healthcare providers, leading to more informed care and treatment decisions. mHealth (mobile app-based) can also be used as a research tool for household surveys, clinical trials, surveillance, and spatial or geographic data collection, thereby supporting public health

research and interventions (Davey et al., 2014). Other studies have demonstrated that mHealth technologies enhance health outcomes in developing countries, including improved maternal and infant medication adherence, higher immunization rates, and better infectious disease prevention (Kruse et al., 2019).

The potential of mHealth to enhance healthcare delivery and health outcomes in developing countries is widely acknowledged. mHealth services can save time and provide better coverage, and improve interactions between patients and healthcare providers, especially in low-resource settings (Nguyen et al., 2022). One type of mHealth currently in use is Homebased Telemonitoring of maternal and fetal well-being parameters, such as blood pressure and fetal heart rate, can be performed using a wireless portable device, allowing pregnant women to remain in a private and comfortable environment. mHealth can reduce clinic costs by facilitating remote monitoring and self-management, leading to better access to healthcare services and improved patient satisfaction (Van Den Heuvel et al., 2020).

While mHealth applications offer significant benefits, there are also challenges to their successful implementation and expansion in developing countries, including barriers related to technology infrastructure, interoperability, and evaluation standards (Hoque et al., 2020). Policymakers should prioritize integrating mHealth interventions into maternal health services in developing countries. They must ensure these interventions are cost-effective, accessible, and sustainable, and that healthcare workers receive proper training for effective implementation (Mishra et al., 2023). This technology has been proven to enhance early detection and management of pregnancy complications, contributing to a reduction in maternal mortality rates. However, longitudinal evaluations are needed to assess the long-term impact of mHealth on pregnancy outcomes.

Antenatal Care Quality Improvement

The integration of mHealth into antenatal care in high-risk pregnancies is creating innovative models of antenatal care in developing countries (Ayatollahi et al., 2019; Bogale et al., 2020; Feng et al., 2023; Guo et al., 2021; Özkan Şat & Yaman Sözbir, 2021; Venkateswaran et al., 2022; Zhu et al., 2019), improving pregnancy outcomes (Feng et al., 2023), reduce risk, and increase ANC visit rates (Ayatollahi et al., 2019; Feroz, De Vera, et al., 2022; Zhu et al., 2019).

The Pregnancy and Newborn Diagnostic Assessment (PANDA), an mHealth-based system in Madagascar, demonstrates potential to improve the standard of antenatal care (ANC), standardize ANC visits, change provider behavior, boost the chances of women returning for follow-up visits, and promote early ANC attendance during pregnancy (Benski et al., 2020). The mHealth intervention for pregnant women led to increased use of maternal and infant services, as evidenced by higher antenatal care attendance, greater utilization of facility services, improved delivery attendance, and increased vaccination rates (Sondaal et al., 2016)

A five-year cross-sectional study in Madagascar used mHealth to provide antenatal care to pregnant women in rural areas, demonstrating that the mHealth intervention significantly improved the quality of care. Additionally, a qualitative study investigated the experiences of women receiving mHealth-supported antenatal care in a village, uncovering that the intervention enhanced access to care and offered valuable information (Arnaert et al., 2019).

mHealth used to monitor antenatal care in pregnant women in low- and middle-income countries has proven effective in improving the completeness of antenatal care and increasing the number of antenatal care visits (Mishra et al., 2023). Additionally, mHealth is linked to a significant improvement in the completion of antenatal records (Feroz et al., 2017). The mHealth intervention

was associated with significant enhancements in the completeness of antenatal records and an increase in the number of antenatal care visits (Kusyanti et al., 2022). Overall, these studies demonstrate that the integration of mHealth into antenatal care for high-risk pregnancies has significantly improved care quality, pregnancy outcomes, and antenatal visit rates in developing countries. By creating innovative care models, mHealth addresses challenges in low-resource settings, enhancing access to services, promoting early ANC attendance, and improving the completeness of antenatal records. These interventions not only facilitate the utilization of maternal and infant services but also provide valuable emotional support and education for pregnant women, empowering them to actively participate in their care. Further studies should focus on scaling mHealth solutions, ensuring sustainability, and optimizing their impact through cost-effective and culturally adapted approaches.

Support for High-Risk Pregnancies

Besides serving as a tool for screening, monitoring, and even care management in high-risk pregnancies, mHealth also provides support to high-risk pregnant women in the form of mental health support (Özkan Şat & Yaman Sözbir, 2021), clinical decision support (Venkateswaran et al., 2022). Several studies have shown that mHealth can support high-risk pregnant women in developing countries by providing mental health support, clinical decision support, and education on high-risk signs and symptoms, as well as self-care management. Additionally, mHealth apps can deliver valuable information on pregnancy care, including pre- and postnatal care, and offer support to pregnant women (Kusyanti et al., 2022). mHealth interventions have the potential to enhance self-management, acceptance of pregnancy and motherhood, and social support (Arnaert et al., 2019). Upcoming studies should prioritize assessing the sustained effectiveness of mHealth in delivering psychosocial support, alleviating stress, and tailoring interventions to suit various cultural settings in developing nations. Furthermore, the creation of interactive functionalities, such as live chats with mental health professionals, could enhance its overall effectiveness.

CONCLUSIONS AND SUGGESTIONS

This study highlights the potential of mHealth technologies to revolutionize antenatal care for high-risk pregnancies in developing countries. Policymakers should prioritize the integration of mHealth into national maternal health strategies, ensuring accessibility, affordability, and sustainability. Healthcare providers must be equipped with adequate training to effectively implement mHealth interventions, which can improve antenatal care access, enhance maternal health literacy, and reduce complications. Future research should focus on evaluating the cost-effectiveness, scalability, and long-term impact of mHealth technologies to inform policy and practice more comprehensively.

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REFERENCES

- Abaza, H., & Marschollek, M. (2017). mHealth application areas and technology combinations: A comparison of literature from high and low/middle income countries. In *Methods of Information in Medicine* (Vol. 56, Issue MethodsOpen, pp. e105–e122). Schattauer GmbH. <https://doi.org/10.3414/ME17-05-0003>
- Arnaert, A., Ponzoni, N., Debe, Z., Meda, M. M., Nana, N. G., & Arnaert, S. (2019). Experiences of women receiving mhealth-supported antenatal care in the village from community health

- workers in rural Burkina Faso, Africa. *Digital Health*, 5. <https://doi.org/10.1177/2055207619892756>
- Ayatollahi, H., Ghalandar Abadi, M., & Hemmat, M. (2019). Web and mobile-based technologies for monitoring high-risk pregnancies? *BMJ Health and Care Informatics*, 26(1). <https://doi.org/10.1136/bmjhci-2019-000025>
- Bawadi, H. A., Abu Abed, A. S., Al-Hamdan, Z. M., & Alzubi, S. M. (2023). Receiving antenatal care via mobile clinic: Lived experiences of Jordanian mothers. *International Journal of Nursing Sciences*, 10(2), 230–237. <https://doi.org/10.1016/j.ijnss.2023.03.005>
- Benski, A. C., Schmidt, N. C., Viviano, M., Stancanelli, G., Soaroby, A., & Reich, M. R. (2020). Improving the Quality of Antenatal Care Using Mobile Health in Madagascar: Five-Year Cross-Sectional Study. *JMIR MHealth and UHealth*, 8(7), e18543. <https://doi.org/10.2196/18543>
- Bogale, B., Mørkrid, K., O'Donnell, B., Ghanem, B., Abu Ward, I., Abu Khader, K., Isbeih, M., Frost, M., Baniode, M., Hijaz, T., Awwad, T., Rabah, Y., & Frøen, J. F. (2020). Development of a targeted client communication intervention to women using an electronic maternal and child health registry: A qualitative study. *BMC Medical Informatics and Decision Making*, 20(1). <https://doi.org/10.1186/s12911-019-1002-x>
- Bola, R., Ujoh, F., & Lett, R. (2022). Identification and mitigation of high-risk pregnancy with the Community Maternal Danger Score Mobile Application in Gboko, Nigeria. *PLoS ONE*, 17(9 September). <https://doi.org/10.1371/journal.pone.0275442>
- Davey, S., Davey, A., & Singh, J. V. (2014). Mobile-health approach: A critical look on its capacity to augment health system of developing countries. *Indian Journal of Community Medicine*, 39(3), 178–182. <https://doi.org/10.4103/0970-0218.137160>
- Dosani, A., Arora, H., & Mazmudar, S. (2020). mHealth and Perinatal Depression in Low-and Middle-Income Countries: A Scoping Review of the Literature. *International Journal of Environmental Research and Public Health*, 17(20), 7679. <https://doi.org/10.3390/ijerph17207679>
- Feng, Y., Shi, C., Zhang, C., Yin, C., & Zhou, L. (2023). Effect of the smartphone application on caesarean section in women with overweight and obesity: a randomized controlled trial in China. *BMC Pregnancy and Childbirth*, 23(1). <https://doi.org/10.1186/s12884-023-06004-7>
- Feroz, A. S., Perveen, S., & Aftab, W. (2017). Role of mHealth applications for improving antenatal and postnatal care in low and middle income countries: A systematic review. *BMC Health Services Research*, 17(1). <https://doi.org/10.1186/s12913-017-2664-7>
- Feroz, A. S., Afzal, N., & Seto, E. (2022). Exploring digital health interventions for pregnant women at high risk for pre-eclampsia and eclampsia in low-income and-middle-income countries: A scoping review. *BMJ Open*, 12(2). <https://doi.org/10.1136/bmjopen-2021-056130>
- Feroz, A. S., De Vera, K., Bragagnolo, N. D., Saleem, S., Bhutta, Z., & Seto, E. (2022). Understanding the Needs of a Mobile Phone-Based Telemonitoring Program for Pregnant Women at High Risk for Pre-Eclampsia: Interpretive Qualitative Description Study. *JMIR Formative Research*, 6(2). <https://doi.org/10.2196/32428>
- Guo, Y., Zhou, L., Sun, B., Wang, C., & Zhang, J. (2021). Application Of Online-Offline Integrated Medical Care Management In Patients With Gestational Diabetes. *Ginekologia Polska*, 92(10), 720–725. <https://doi.org/10.5603/GP.a2021.0054>
- Hoque, M. R., Rahman, M. S., Nipa, N. J., & Hasan, M. R. (2020). Mobile health interventions in developing countries: A systematic review. *Health Informatics Journal*, 26(4), 2792–2810. <https://doi.org/10.1177/1460458220937102>

- Kemenkes RI. (2020). *Pedoman Pelayanan Antenatal Terpadu*. <https://repository.kemkes.go.id/book/147>
- Kemenkes RI. (2023). *Profil Kesehatan Indonesia 2022*. <https://kemkes.go.id/id/profil-kesehatan-indonesia-2022>
- Kruse, C., Betancourt, J., Ortiz, S., Luna, S. M. V., Bamrah, I. K., & Segovia, N. (2019). Barriers to the use of mobile health in improving health outcomes in developing countries: Systematic review. In *Journal of Medical Internet Research* (Vol. 21, Issue 10). JMIR Publications Inc. <https://doi.org/10.2196/13263>
- Kuppusamy, P., Prusty, R. K., & Kale, D. P. (2023). High-risk pregnancy in India: Prevalence and contributing risk factors – a national survey-based analysis. *Journal of Global Health*, 13, 04116. <https://doi.org/10.7189/jogh.13.04116>
- Kusyanti, T., Wirakusumah, F. F., Rinawan, F. R., Muhith, A., Purbasari, A., Mawardi, F., Puspitasari, I. W., Faza, A., & Stellata, A. G. (2022). Technology-Based (Mhealth) and Standard/Traditional Maternal Care for Pregnant Woman: A Systematic Literature Review. In *Healthcare (Switzerland)* (Vol. 10, Issue 7). MDPI. <https://doi.org/10.3390/healthcare10071287>
- Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science*, 5(1). <https://doi.org/10.1186/1748-5908-5-69>
- Mak, S., & Thomas, A. (2022). Steps for Conducting a Scoping Review. In *Journal of graduate medical education* (Vol. 14, Issue 5, pp. 565–567). NLM (Medline). <https://doi.org/10.4300/JGME-D-22-00621.1>
- Malley, H. (2005). Theory & Practice This is an electronic version of an article published in Arksey. In *The International Journal of Social Research Methodology* (Vol. 8). <http://journalsonline.tandf.co.uk/OpenURLlinktothearticle:http://www.journalsonline.tandf.co.uk/openurl.asp?genre=article&eissn=1464-5300&volume=8&issue=1&spage=19>
- Mehboob, R., Amir Gilani, S., Khalid, S., Hassan, A., & Alwazzan, A. (2021). Maternal Mortality Ratio in Low Income Developing Countries. In *Global Women's Health*. IntechOpen. <https://doi.org/10.5772/intechopen.95258>
- Mishra, M., Parida, D., Murmu, J., Singh, D., Rehman, T., Kshatri, J. S., & Pati, S. (2023). Effectiveness of mHealth Interventions for Monitoring Antenatal Care among Pregnant Women in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Healthcare*, 11(19), 2635. <https://doi.org/10.3390/healthcare11192635>
- Mohamed, A., Mohamed, A.-M., Salah, H., Mohamed, E.-D., Mohamed, N., Ahmed, E., Ahmed, E., & Ahmed, G. (2023). 9-during COVID on Knowledge among Women with GDM nursing Guidelines-Tele Asmaa Mohamed Effect of Tele-nursing Guidelines on Knowledge among Women with Gestational Diabetes during COVID-19 Pandemic. In *Zagazig Nursing Journal* (Vol. 19, Issue 1).
- Mohammadian, F., Delavar, M. A., Behmanesh, F., Azizi, A., & Esmaeilzadeh, S. (2023). The impact of health coaching on the prevention of gestational diabetes in overweight/obese pregnant women: a quasi-experimental study. *BMC Women's Health*, 23(1). <https://doi.org/10.1186/s12905-023-02750-0>
- Nagraj, S., Kennedy, S., Jha, V., Norton, R., Hinton, L., Billot, L., Rajan, E., Mohammed Abdul, A., Phalswal, A., Arora, V., Praveen, D., & Hirst, J. (2023). A Mobile Clinical Decision Support System for High-Risk Pregnant Women in Rural India (SMARThealth Pregnancy): Pilot Cluster Randomized Controlled Trial. *JMIR Formative Research*, 7, e44362. <https://doi.org/10.2196/44362>

- Nguyen, H. L., Tran, K., Doan, P. L. N., & Nguyen, T. (2022). Demand for Mobile Health in Developing Countries During COVID-19: Vietnamese's Perspectives from Different Age Groups and Health Conditions. *Patient Preference and Adherence*, 16, 265–284. <https://doi.org/10.2147/PPA.S348790>
- Okonofua, F. (2021). Maternal Mortality in Developing Countries. In *Contemporary Obstetrics and Gynecology for Developing Countries* (pp. 13–22). Springer International Publishing. https://doi.org/10.1007/978-3-030-75385-6_3
- Özkan Şat, S., & Yaman Sözbir, Ş. (2021). Use of Mobile Applications by Pregnant Women and Levels of Pregnancy Distress During the COVID-19 (Coronavirus) Pandemic. *Maternal and Child Health Journal*, 25(7), 1057–1068. <https://doi.org/10.1007/s10995-021-03162-y>
- Peters, M. D. J., Marnie, C., Tricco, A. C., Pollock, D., Munn, Z., Alexander, L., McInerney, P., Godfrey, C. M., & Khalil, H. (2020). Updated methodological guidance for the conduct of scoping reviews. *JBI Evidence Synthesis*, 18(10), 2119–2126. <https://doi.org/10.11124/JBIES-20-00167>
- Rahman, M. O., Yamaji, N., Nagamatsu, Y., & Ota, E. (2022). Effects of mHealth Interventions on Improving Antenatal Care Visits and Skilled Delivery Care in Low- and Middle-Income Countries: Systematic Review and Meta-analysis. *Journal of Medical Internet Research*, 24(4), e34061. <https://doi.org/10.2196/34061>
- Rajbanshi, S., Norhayati, M. N., & Nik Hazlina, N. H. (2020). High-risk pregnancies and their association with severe maternal morbidity in Nepal: A prospective cohort study. *PLOS ONE*, 15(12), e0244072. <https://doi.org/10.1371/journal.pone.0244072>
- Rerey, H. V., Syauki, A. Y., Waqqosh, A., Limijadi, E. K. S., & Ruhana, F. (2023). Economic and management strategies for optimizing healthcare services: A case study on telemedicine in Indonesia. *Jurnal Aisyah : Jurnal Ilmu Kesehatan*, 8(3). <https://doi.org/10.30604/jika.v8i3.2139>
- Scrimshaw S, & Backes, E. P. (2020). *Birth Settings in America* (S. C. Scrimshaw & E. P. Backes, Eds.). National Academies Press. <https://doi.org/10.17226/25636>
- Sondaal, S. F. V., Browne, J. L., Amoakoh-Coleman, M., Borgstein, A., Miltenburg, A. S., Verwijs, M., & Klipstein-Grobusch, K. (2016). Assessing the Effect of mHealth Interventions in Improving Maternal and Neonatal Care in Low- and Middle-Income Countries: A Systematic Review. *PLOS ONE*, 11(5), e0154664. <https://doi.org/10.1371/journal.pone.0154664>
- Thomas, A., Lubarsky, S., Durning, S. J., & Young, M. E. (2017). Knowledge Syntheses in Medical Education: Demystifying Scoping Reviews. *Academic Medicine*, 92(2), 161–166. <https://doi.org/10.1097/ACM.0000000000001452>
- Tian, Y., Zhang, S., Huang, F., & Ma, L. (2021). Comparing the efficacies of telemedicine and standard prenatal care on blood glucose control in women with gestational diabetes mellitus: Randomized controlled trial. *JMIR MHealth and UHealth*, 9(5). <https://doi.org/10.2196/22881>
- Valencia, S. A., Barrientos Gómez, J. G., Gómez Ramirez, M. C., Luna, I. F., Caicedo, H. A., Torres-Silva, E. A., & Díaz, E. S. (2023). Evaluation of a telehealth program for high-risk pregnancy in a health service provider institution. *International Journal of Medical Informatics*, 179. <https://doi.org/10.1016/j.ijmedinf.2023.105234>
- Van Den Heuvel, J. F. M., Teunis, C. J., Franx, A., Crombag, N. M. T. H., & Bekker, M. N. (2020). Home-based telemonitoring versus hospital admission in high risk pregnancies: A qualitative study on women's experiences. *BMC Pregnancy and Childbirth*, 20(1). <https://doi.org/10.1186/s12884-020-2779-4>

- Venkateswaran, M., Ghanem, B., Abbas, E., Khader, K. A., Ward, I. A., Awwad, T., Baniode, M., Frost, M. J., Hijaz, T., Isbeih, M., Mørkrid, K., Rose, C. J., & Frøen, J. F. (2022). A digital health registry with clinical decision support for improving quality of antenatal care in Palestine (eRegQual): a pragmatic, cluster-randomised, controlled, superiority trial. *The Lancet Digital Health*, 4(2), e126–e136. [https://doi.org/10.1016/S2589-7500\(21\)00269-7](https://doi.org/10.1016/S2589-7500(21)00269-7)
- WHO. (2023). *Providing guidance and support for national mHealth programming since 2012*. <https://www.who.int/initiatives/behealthy/digital-health>.
- WHO, UNICEF, UNFPA, World Bank Group, & UNDESA. (2023). *Trends in maternal mortality 2000 to 2020*.
- Win, P. P., Hlaing, T., & Win, H. H. (2024). Factors influencing maternal death in Cambodia, Laos, Myanmar, and Vietnam countries: A systematic review. *PLOS ONE*, 19(5), e0293197. <https://doi.org/10.1371/journal.pone.0293197>
- Zhu, X. H., Tao, J., Jiang, L. Y., & Zhang, Z. F. (2019). Role of Usual Healthcare Combined with Telemedicine in the Management of High-Risk Pregnancy in Hangzhou, China. *Journal of Healthcare Engineering*, 2019. <https://doi.org/10.1155/2019/3815857>