

ORIGINAL ARTICLE

Digital Approaches to Antenatal Education: A Scoping Review of Innovations and Health Benefits

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ABSTRACT

Introduction: Antenatal education prepares expectant mothers for childbirth and parenthood, traditionally through face-to-face sessions. Modern digital tools like mobile apps, SMS reminders, and mHealth platforms address barriers such as distance and scheduling conflicts. **Purpose:** This scoping review aims to evaluate the health benefits, accessibility, and effectiveness of digital antenatal education in comparison to traditional face-to-face methods. The review examines its impact on maternal confidence, anxiety, parenting skills, and healthcare utilization. **Method:** A systematic search was conducted across PubMed, Web of Science, and Scopus to identify randomized controlled and quasi-experimental trials focused on digital antenatal education. Thirteen relevant studies were included, assessing various outcomes such as antenatal care uptake, maternal knowledge, and neonatal outcomes. **Results:** The review found that digital antenatal education methods, including mobile apps, SMS reminders, and mHealth platforms, significantly improve maternal knowledge, increase antenatal care uptake, and positively impact neonatal outcomes. However, the studies also identified challenges such as digital literacy, technological barriers, and disparities in access to digital tools. **Conclusion:** Digital antenatal education demonstrates promising potential in enhancing maternal and neonatal health outcomes. Addressing challenges related to digital access and literacy is crucial to ensure equitable and widespread implementation of these methods for optimal maternal and child health.

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INTRODUCTION

Antenatal education plays a crucial role in preparing expectant mothers and their families for childbirth and early parenthood. Traditional antenatal programs, often comprising face-to-face sessions focusing on childbirth preparation and postnatal care, have demonstrated positive impacts on maternal and neonatal outcomes. These programs help reduce maternal anxiety, improve childbirth confidence, and enhance parenting skills. However, with advancements in technology and a growing emphasis on personalized healthcare, there has been a paradigm shift toward modern approaches in antenatal education that leverage innovative methods and digital platforms (1).

Recent global trends highlight a surge in the adoption of digital health technologies in maternal care. Over

70% of countries have implemented some form of digital health strategy, with maternal health identified as a key priority area (2). Delivery of antenatal education has expanded through the use of various digital innovations. Referred to collectively as digital antenatal education, these methods include mobile apps, tele-education systems, and immersive technologies, all designed to provide accessible and engaging learning experiences during pregnancy (2). The term mHealth (mobile health) describes a broader category of health services and information made available through portable electronic devices such as smartphones and tablets. Mobile apps, which fall under the umbrella of mHealth, frequently incorporate interactive learning modules, progress tracking tools, reminder features, and evidence-based information customized for pregnant users (3). Meanwhile, tele-education facilitates remote participation in prenatal classes through video conferencing and web-based platforms, expanding access to antenatal care for those facing logistical or geographical barriers (3). Other emerging technologies, such as virtual reality (VR), simulate labor and delivery

experiences, providing immersive learning environments to build confidence and preparedness among pregnant women (4,5).

The health benefits of these modern approaches extend beyond convenience. Study suggest that innovative antenatal education methods contribute to improved maternal mental health, reduced fear of childbirth, and better adherence to prenatal care recommendations (6). Moreover, digital and interactive platforms have been associated with increased pregnancy-related knowledge, greater confidence in childbirth preparation, and enhanced partner involvement during the antenatal period (7). Research indicates that these methods are effective in promoting positive behavior changes by incorporating motivational interviewing and behavior change theories (8). Furthermore, personalized education strategies tailored to cultural contexts and individual risk factors optimize maternal and neonatal outcomes (9). For example, culturally adapted antenatal programs have demonstrated success in improving breastfeeding initiation and immunization uptake in underserved populations (10). The integration of remote monitoring technologies into antenatal education has also improved early detection of complications, empowering women to seek timely medical attention (11).

These advancements underscore the need for a holistic approach to antenatal education that leverages modern technologies and evidence-based strategies to address the diverse needs of pregnant women. Despite these advances, gaps remain in understanding the effectiveness, accessibility, and implementation of modern antenatal education methods. Evidence comparing traditional and innovative approaches across diverse populations is limited. Moreover, challenges such as digital literacy, privacy concerns, and cultural adaptability require further exploration. Addressing these gaps is critical to developing comprehensive strategies that integrate modern approaches while ensuring inclusivity and equity in antenatal care (12). This scoping review aims to systematically map the current landscape of modern antenatal education methods, with a focus on digital innovations and their associated maternal and neonatal health outcomes. Through a synthesis of the available evidence, this review aims to offer concrete guidance for adapting digital education strategies to the needs of different populations and contribute to future research, policy, and practice in maternal health.

METHOD

Design

The methodology followed the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) guidelines, which provide a structured framework for reporting scoping reviews with clarity and transparency. The scoping approach was selected to examine the breadth

and characteristics of existing research, particularly in areas where the evidence base is diverse, fragmented, or emerging.

Searching strategies

To ensure a comprehensive review, databases such as Google Scholar, PubMed, Web of Science, Scopus, Scientific Information Database (SID), and Cochrane Library were utilized for the literature search. The search keywords were tailored to suit the specific indexing and search mechanisms of each database, incorporating terms relevant to the topic. Boolean operators, truncation, and filters were applied to optimize the search. The search was limited to clinical trials published in Bahasa Indonesia and English. References from prior systematic reviews and related studies were also examined for additional relevant papers. Restrictions were applied regarding the publication date from January 1st, 2016 to October 30th, 2024, ensuring inclusivity of historical and contemporary research. Boolean operators (AND, OR), truncation (e.g., "educat*"), and filters (e.g., language, date range, study type) were employed to refine the search and improve relevance. The search terms used included combinations of the following keywords: "mHealth" AND "maternal health", "mobile messaging" OR "SMS reminders", "antenatal care" AND "education", "mobile applications" AND "pregnancy", "interactive health interventions" AND "maternal outcomes".

The search was conducted twice during the study timeline: First, initial stage was conducted at the start of the research to establish a baseline and identify potentially relevant studies. Then, follow-up search was conducted just before the research concluded to capture any new studies published during the research period. Notably, no differences in the included studies were observed between the two searches.

Grey literature, including conference abstracts, theses, and unpublished reports, was excluded to maintain methodological rigor, ensure peer-review quality, and enhance the replicability of findings. Reference lists from previous systematic reviews and relevant studies were also screened to identify additional eligible articles.

Eligibility criteria

This scoping review included randomized controlled and quasi-experimental research. The intervention group in these studies received both standard prenatal care and an antenatal education class, whereas the control group either received just normal prenatal care or no class at all. Pregnant women are mandated to engage in structured prenatal education between the 20th and 37th weeks of pregnancy. This education entails attending training classes instructed by certified midwives, nurses, or obstetricians. The classes cover various topics including fundamental pregnancy information, prenatal care, labor and delivery, postpartum care, and infant care. Each session has a duration of one hour. During a normal

prenatal appointment, the patient has a comprehensive assessment of their medical history, a thorough physical examination, an ultrasound procedure, and receives educational information. The allowed time of fifteen to twenty minutes is insufficient to provide comprehensive coverage of prenatal education. The research included women who had no previous medical issues during pregnancy and desired to have a vaginal delivery, either with assistance or induction, instead of a cesarean surgery. This study examined many outcomes, such as primary outcomes (concerns about labor and delivery), secondary outcomes (utilization of pain medicine), maternal self-confidence, symptoms of post-traumatic stress disorder (PTSD), parenting partnership, and emotional connection between parents. Valid and reliable methodologies were used to assess all outcomes in all included studies.

Selection of studies

To ensure the integrity and accuracy of the selection process for the systematic review, a two-step procedure was implemented. In the first step, three reviewers (M.O., D.S., and B.I.U.) independently screened the titles and abstracts of all identified studies. This initial screening was performed to quickly exclude studies that were clearly irrelevant to the systematic review based on predefined eligibility criteria. During this stage, studies that lacked sufficient information in the title or abstract but appeared potentially relevant were retained for the next stage to avoid premature exclusion. The second step involved a more thorough evaluation of the full text of the remaining articles. The content of each study was assessed systematically against the previously established inclusion criteria, which included factors such as population, intervention, comparison, outcomes, and study design (PICOS framework). This comprehensive review ensured that only studies meeting all criteria were included in the final analysis. In cases where discrepancies arose during either stage, the reviewers engaged in collaborative discussions to reach a consensus. If disagreements persisted despite discussions, the decision was deferred to a senior reviewer (M.O. and F.) for final arbitration. This approach minimized bias and ensured that the selection process remained consistent and transparent throughout. Additionally, the use of multiple reviewers at each step enhanced the reliability of the review process, reducing the risk of errors or subjective interpretations.

Data extraction

To ensure accuracy and minimize bias during the data collection process, all articles were systematically reviewed, and their details were meticulously entered into a standardized data extraction form developed based on guidelines from the Cochrane Handbook for Systematic Reviews of Interventions. This form included key components necessary for a comprehensive analysis of the included studies. For each article, specific data points were extracted, including the authors' names,

publication year, study location, type of intervention, comparison group details, final sample size, measuring instruments utilized, primary and secondary outcomes, and overall findings.

The data extraction process was carried out independently by three researchers (M.O., D.S., and B.I.U.), each working separately to reduce individual bias and ensure thoroughness. Discrepancies in the extracted data were resolved through consensus discussions, ensuring reliability and consistency. This multi-researcher approach adhered to best practices for systematic reviews, providing robust and reliable data for subsequent analysis. The standardized form facilitated uniform data collection and streamlined comparisons across studies, thereby enhancing the credibility and reproducibility of the review findings.

Quality assessment

In this review, the included randomized controlled trials were evaluated for potential sources of bias using the Risk of Bias (ROB-1) tool. This assessment considered several methodological elements, including how random sequences were generated, whether allocation concealment was properly conducted, and the extent to which blinding was applied to participants, personnel, and outcome assessors. It also reviewed the completeness of outcome data and the possibility of selective reporting. For quasi-experimental designs, the ROBINS-I tool was employed to examine potential weaknesses in study conduct and design. While scoping reviews typically do not require a formal appraisal of study quality, we incorporated the GRADE approach to assess five critical areas, namely risk of bias, inconsistency, indirectness, imprecision, and publication bias. This process was not intended to influence inclusion or to rate evidence certainty in the traditional sense, but rather to highlight methodological shortcomings and guide recommendations for improving future research quality. By examining these aspects, the review offers a more nuanced understanding of the current evidence landscape. Two independent reviewers (M.O. and D.S.) performed the evaluations, and any disagreements were resolved through discussion with a third contributor (M.O.).

Synthesis of results

Structured summaries of the included trials are presented in the "Characteristics of Included Trials" (Table 1). These summaries include key details such as study design, participant demographics, sample sizes, intervention types, duration, and outcome measures. Intervention effects derived from the included trials are systematically calculated and presented as risk ratios (for dichotomous outcomes) or mean differences (for continuous outcomes), along with corresponding 95% confidence intervals and two-sided P values for each reported outcome. These values are detailed in the results tables to provide a transparent view of the

effectiveness of the interventions. Despite rigorous data extraction and calculation of effect sizes, performing a meta-analysis was not feasible due to the significant heterogeneity observed among the included trials. This heterogeneity arose from variations in the content and delivery methods of experimental interventions, control conditions, follow-up periods, and measurement tools. Additionally, differences in study populations

and contexts further limited the ability to pool data meaningfully. As a result, the findings were presented descriptively, focusing on individual study outcomes rather than attempting to synthesize an overarching effect size through meta-analytic methods. This approach ensures that the distinct characteristics and nuances of each study are preserved and accurately interpreted.

Table 1: Summary of included studies

Study	Author & Year	Study Design	Sample	Approach/methods of education	Findings
Utilization of Mobile Phone SMS to Enhance Antenatal Care	(MAKUNYI, 2018)	Quasi-experimental	Pregnant women in Tharaka Nithi, Kenya	SMS alerts	Increased uptake of focused antenatal care.
Enhanced reminders on postnatal clinic attendance	(Kebede et al., 2019)	Cluster RCT	Postnatal mothers in Addis Ababa, Ethiopia	SMS reminders	Improved postnatal clinic attendance.
Effectiveness of mHEALTH Application in Ethiopia	(Kassa & Matlakala, 2022)	Comparative study	Pregnant women in rural Ethiopia	mHealth application	Significant improvement in maternal and newborn health services.
mHealth "ImTeCHO" intervention in Gujarat	(Dhiren Modi et al., 2019)	Cluster RCT	Tribal areas of Gujarat, India	mHealth platform	Improved delivery of maternal, neonatal, and child care services.
Female Community Health Volunteer and SMS in Nepal	(Singh et al., 2020)	Cluster RCT	Pregnant women in southern Nepal	Capacity building, SMS	Reduced inappropriate gestational weight gain and improved hemoglobin levels.
Mobile phone SMS on maternal health in Nigeria	(Omole et al., 2018)	RCT	Pregnant women in South-West Nigeria	SMS alerts	Improved maternal health outcomes.
Connecting mothers to care in Timor-Leste	(Thompson et al., 2019)	Mixed-methods evaluation	Pregnant women in Timor-Leste	mHealth intervention	Increased access to maternal and child health services.
Interactive mHealth in Dodoma, Tanzania	(Masoi et al., 2023)	Quasi-experimental	Pregnant women in Dodoma	Interactive mHealth app	Improved antenatal care service utilization.
Mobile messaging for danger signs in Tanzania	(Masoi & Kibusi, 2019)	Controlled quasi-experimental study	Pregnant women in Dodoma	Interactive mobile messaging	Increased knowledge of danger signs and improved birth preparedness.
mMitra voice messaging service in India	(Murthy et al., 2020)	Pseudo-randomized controlled trial	Low-income women in India	Voice message service	Improved maternal health knowledge and practices.
MomConnect in South Africa	(Barron et al., 2016)	Implementation study	Pregnant women and health workers in South Africa	mHealth platform	Improved maternal and child health service delivery on the supply side.
Mobile phones for maternal health in Guinea	(Flueckiger et al., 2019)	Randomized control trial	Pregnant women in Guinea	SMS alerts	Increased antenatal care attendance and malaria prevention practices.
Tablet-based self-monitoring in pregnancy	(Kobayashi et al., 2017)	Feasibility study	Pregnant women in various settings	Tablet-based app	Feasible for self-monitoring and managing health during pregnancy.

RESULTS

A total of 3,278 papers have been identified via the searches, and an additional four articles were uncovered by examining the reference lists. After reviewing the titles and abstracts, a total of 373 articles were selected for

further examination of the complete text. Out of them, 266 publications were eliminated at this stage mostly because they did not meet the inclusion criteria. Only 13 studies were included for review. The procedure is outlined in the PRISMA flow chart seen in Figure 1.

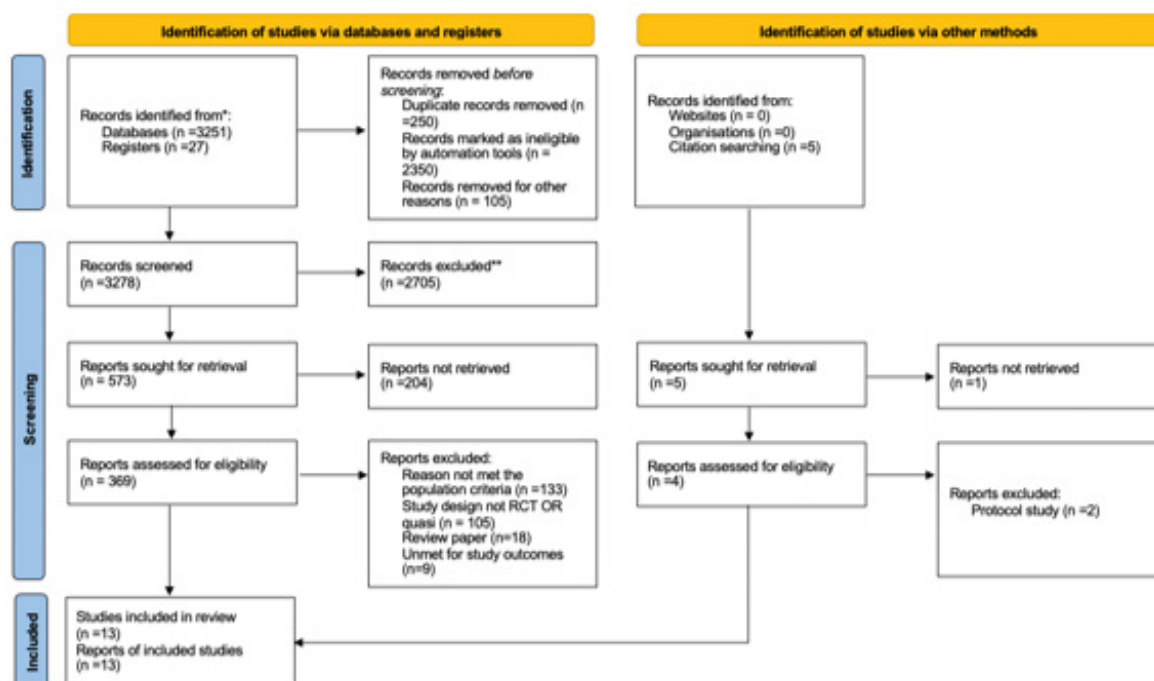


Figure 1: PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources

The study by (13) in Kenya utilized a quasi-experimental design to evaluate the effect of SMS reminders on focused antenatal care (FANC) attendance among 500 pregnant women. The findings showed a significant increase in FANC uptake due to SMS reminders. Similarly, (14) conducted a cluster randomized controlled trial in Ethiopia, finding that enhanced reminders led to a 15% improvement in postnatal clinic attendance among 1,200 mothers. In rural Ethiopia, (15) employed a comparative study design involving 450 pregnant women. The mHealth application was effective in improving maternal and newborn service utilization. In Gujarat, India, (16) demonstrated through a cluster RCT involving 2,000 participants that the "ImTeCHO" app significantly enhanced neonatal care practices. A cluster RCT in Nepal by (17) assessed the impact of SMS reminders and community health volunteer training on gestational weight gain and hemoglobin changes in 800 pregnant women. The intervention group experienced significant improvements in these outcomes. In South-west Nigeria, reported increased maternal health service utilization among 600 pregnant women receiving SMS-based maternal health information. Similarly, (18) in Timor-Leste showed scalable improvements in maternal care through a comprehensive mHealth program.

Two studies in Dodoma, Tanzania, (19), evaluated the

use of interactive mHealth tools and SMS messaging systems among 700 and 600 pregnant women, respectively. Both studies reported increased antenatal service utilization and improved knowledge of birth preparedness. A pseudo-randomized controlled trial by (20) in India evaluated the mMitra voice messaging service for 900 low-income women. The service improved maternal health knowledge and practices. In South Africa, (21) reported that the MomConnect initiative improved maternal and child health services on the supply side. Lastly, (22) explored mobile technology for maternal health in Guinea and tablet-based self-monitoring systems among pregnant women. Both studies demonstrated the effectiveness and feasibility of digital interventions in enhancing maternal care.

Quality of appraisal

The randomized controlled trials reviewed in this study were generally rigorous, characterized by well-defined interventions, consistent outcome measures, and limited risk of bias (18,22–25). Although these trials suggest beneficial effects, the overall certainty was rated as moderate due to some concerns, particularly regarding the clarity of reporting and lack of blinding in certain instances. In contrast, the quasi-experimental and comparative studies presented moderately reliable findings, yet the absence of random allocation and

potential for selection bias limited the strength of their conclusions (16,26,27). Evidence drawn from mixed-methods and feasibility studies was considered to be of low certainty due to unclear causal pathways,

reduced precision in measurement, and inherent design weaknesses.

Table II: Summary of appraisal

Author & Year	Risk of Bias (ROBINS-I)	GRADE	Reasoning
(MAKUNYI, 2018)	Moderate	Moderate	Non-randomized; SMS alerts likely beneficial but confounding factors (e.g., socioeconomic status) not controlled.
(Kebede et al., 2019)	Low	High	Cluster RCT; strong methodology, but potential for contamination between clusters. Consistent and precise findings.
(Kassa & Matlakala, 2022)	Moderate	Moderate	Comparative study without randomization; significant results, but selection bias is possible.
(Dhiren Modi et al., 2019)	Low	High	Cluster RCT with robust design, improved maternal and neonatal outcomes; results are consistent and generalizable.
(Singh et al., 2020)	Low	High	Cluster RCT with a strong design; clear evidence of reduced weight gain and improved hemoglobin levels.
(Omole et al., 2018)	Low	High	RCT; improved maternal health outcomes. High consistency and precision in results.
(Thompson et al., 2019)	Moderate	Low to Moderate	Mixed-methods evaluation limits direct evidence. Bias due to confounding cannot be ruled out.
(Masoi et al., 2023)	Moderate	Moderate	Quasi-experimental design introduces potential confounding. Outcomes show benefit, but results are less precise.
(Masoi & Kibusi, 2019)	Moderate	Moderate	Controlled quasi-experimental study with risks of bias in confounding and classification of intervention.
(Murthy et al., 2020)	Moderate	Moderate	Pseudo-randomized design; potential selection and confounding bias. Results demonstrate improvement, but precision is limited.
(Barron et al., 2016)	Low	High	Implementation study; well-structured mHealth platform led to clear service delivery improvements.
(Flueckiger et al., 2019)	Low	High	RCT design with consistent and precise results for antenatal care attendance.
(Kobayashi et al., 2017)	Moderate	Moderate	Feasibility study; high potential for selection bias, and evidence lacks precision for generalization.

DISCUSSION

Digital interventions have emerged as a transformative tool in addressing maternal and neonatal health challenges globally, with numerous studies highlighting their effectiveness across diverse contexts. These interventions, ranging from SMS reminders to sophisticated mobile health (mHealth) applications, have demonstrated significant improvements in health outcomes and service utilization. Multiple studies have consistently demonstrated the positive impact of digital interventions on maternal and neonatal health. For instance, a study by (28) highlighted that SMS reminders significantly increased antenatal care (ANC) visits and adherence to immunization schedules, particularly in low-resource settings. Similarly, mHealth applications, such as the one studied by (29), were associated with improved monitoring of pregnancy complications, enhancing maternal health outcomes. Unlike digital formats, conventional antenatal education is usually provided through face-to-face sessions, either in group settings or as individual consultations with healthcare professionals. These programs have consistently been linked to enhanced maternal understanding, reduced levels of anxiety, improved readiness for childbirth, and more favorable outcomes for newborns (11). Core topics often covered include prenatal nutrition, labor and delivery preparation, infant feeding practices, and early parenting skills. Despite their benefits, such sessions

may not be easily accessible for all, particularly in areas with limited healthcare infrastructure due to factors like distance to facilities, time constraints, and shortages of trained staff (10). These findings align with the outcomes of our review, underscoring the potential of digital tools in optimizing healthcare delivery.

The effectiveness of digital antenatal education is not uniform across all populations; it often depends on various demographic and regional influences. Factors such as literacy levels, comfort with digital tools, cultural values, and economic conditions play a critical role in shaping how these interventions are received and utilized. For example, research by (30) highlighted that in certain rural areas of South Asia, limited digital literacy significantly impacted women’s ability to use health-related apps independently, with many depending on relatives for assistance. On the other hand, urban communities, where smartphone access is more widespread, exhibited higher levels of engagement and consistent participation. Cultural influences further affect how digital health tools are perceived and adopted. In some societies, deep-rooted trust in traditional birth attendants or reliance on family guidance may lead to skepticism toward digital information. As noted in [30], mismatches between app content such as language, visuals, or tone and users’ cultural expectations resulted in lower engagement among Indigenous groups. This emphasizes the need for digital solutions that are not

only functional but also culturally attuned. Incorporating native languages, intuitive voice navigation, and community-informed content design can enhance usability and acceptance. Several real-world initiatives support these insights. The Safe Delivery App in Ethiopia (15), for instance, offers video-based training tailored for birth attendants, using familiar language and culturally relevant practices, and has contributed to improved maternal care. Likewise, India's mMitra program uses voice messages in local dialects to overcome literacy barriers, effectively reaching and educating women in underserved communities (20).

Improving access to digital antenatal education requires inclusive, context-sensitive strategies. These may include distributing affordable or subsidized mobile devices, implementing grassroots digital literacy programs, and collaborating with local organizations to build community trust and encourage engagement. For regions with limited internet connectivity, mobile platforms that support offline access or hybrid delivery models offer practical alternatives. By tailoring interventions to reflect the unique needs of diverse populations, their reach and effectiveness can be maximized. Digital technologies have significantly reshaped maternal and neonatal care by enhancing access to reliable health information and promoting active involvement among pregnant and postpartum women. These tools empower mothers with self-management capabilities, fostering greater autonomy in health decision-making (25). In remote or underserved areas, they help bridge service gaps by enabling timely communication and access to essential resources (24). On a systems level, digital interventions streamline data collection, improve care coordination, and support more informed clinical decision-making (32). To fully realize these benefits, it is essential to invest in foundational infrastructure and human resources. This includes expanding internet coverage, training healthcare workers such as nurses, midwives, and community health agents in the use of digital tools, and establishing policies that ensure safe, ethical, and equitable deployment. Cross-sector collaboration between governments, healthcare institutions, and technology developers is equally crucial to produce culturally relevant, user-centered solutions that are scalable across different settings (33). Embedding digital antenatal education into national health strategies can improve maternal and newborn outcomes and accelerate progress toward universal health coverage.

Despite their potential, digital interventions are not without limitations. Technological barriers, including inconsistent internet connectivity and lack of access to smartphones, remain significant challenges, particularly in low-income regions. While digital tools hold great promise in maternal healthcare, their implementation presents notable ethical and practical concerns. In many underserved and rural settings, unreliable internet service, frequent power outages, and limited smartphone

ownership continue to hinder equitable access. A lack of digital literacy among both healthcare users and providers further complicates the adoption of such technologies, emphasizing the need for user-friendly designs and targeted training. Moreover, unresolved issues surrounding the confidentiality of maternal health data may discourage participation unless robust privacy safeguards are transparently established and maintained (34). Additionally, the use of algorithms in digital tools risks reinforcing bias unless developed with inclusive datasets and stakeholder input (35). Finally, the variability in study designs and contexts makes it difficult to generalize existing evidence, highlighting the need for standardized evaluation and long-term follow-up research. Additionally, the heterogeneity of study designs and outcomes in existing research poses challenges for generalizability. More robust, standardized methodologies are needed to provide conclusive evidence on the long-term impact of digital interventions on maternal and neonatal health.

CONCLUSION

Digital approaches to antenatal education offer a promising pathway to strengthen maternal and newborn health, especially when thoughtfully adapted to cultural contexts and integrated with existing face-to-face services. In settings with limited resources, implementing such interventions requires concrete, context-sensitive actions. These include expanding access to affordable digital infrastructure, designing multilingual and offline-compatible platforms, equipping community health workers with digital skills, and fostering grassroots initiatives that build trust and promote participation. Collaborative efforts between public institutions and private sectors can further support sustainable implementation and equitable distribution of digital health solutions. Looking ahead, health systems and policymakers are encouraged to explore blended models that merge in-person care with digital engagement, ensuring flexibility while preserving the interpersonal support central to maternal care. Such models are well-positioned to meet the diverse needs of pregnant women and overcome local challenges. Future investigations should focus on assessing the long-term impact of these combined strategies, both in terms of behavioral change and health outcomes. Additionally, the development of universal, adaptable frameworks will be vital for guiding effective integration across varied populations. Embedding these innovations within national maternal health agendas can serve as a strategic lever to address disparities in care and advance progress toward inclusive, high-quality health coverage.

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