

The Effectiveness of Mobile Health (mHealth)-Based Educational Interventions in Improving Knowledge and Health Behaviors Among Pregnant Women

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Article Information

Received: September 14, 2026

Revised: September 29, 2026

Online: October 10, 2026

Keywords

mHealth, Pregnancy, Antenatal Care, Digital Health Intervention, Health Education, Health Behavior, Structured Literature Review

ABSTRACT

Background: Mobile health (mHealth) can extend antenatal education beyond clinic visits, but its effects differ across educational, behavioral, and clinical outcomes. This structured literature review synthesized quantitative evidence on mHealth-based educational interventions for pregnant women. Methods: A targeted search of PubMed and publisher journal pages, supplemented by reference chaining, emphasized peer-reviewed studies published from 2016 through September 2026. Eligible studies involved pregnant women, used a mobile or web-enabled channel for education or behavior support, and reported a comparator, pre-post assessment, or controlled design. Thirteen controlled studies with verifiable quantitative findings formed the primary synthesis; systematic reviews and WHO guidance were used for contextual interpretation. No individual-level data were analyzed and no pooled effect was calculated. Results: The most consistent benefits were observed for pregnancy knowledge, health literacy, self-care knowledge-attitude-practice, patient activation, and selected preventive behaviors. Examples included improved danger-sign knowledge and birth preparedness in Tanzania, higher iron-folic acid consumption following daily WhatsApp education in Indonesia, improved health-promoting lifestyle scores in Indonesia and Iran, and substantial nutrition-literacy gains with Taiwan's i-PregMom application. Effects on physical activity, gestational weight gain, supplement adherence, and maternal-perinatal outcomes were heterogeneous, with several trials reporting null findings for specific outcomes. Conclusion: mHealth-based education is best positioned as an adjunct to antenatal care. Interventions appear more promising when content is tailored to gestational stage and local context, repeated, interactive, theory-informed, and linked to feedback or professional support. Longer follow-up and standardized maternal-perinatal outcomes are needed.



Keywords: *mHealth, Pregnancy, Antenatal Care, Digital Health Intervention, Health Education, Health Behavior, Structured Literature Review*

INTRODUCTION

Pregnancy is a period in which women make frequent decisions about nutrition, physical activity, medication and supplement use, recognition of danger signs, preparation for childbirth, and when to seek professional care. Antenatal education therefore has a direct role in supporting informed self-care and timely use of health services. The World Health Organization (WHO) recommends antenatal care that provides relevant information, effective communication, and support for a positive pregnancy experience (WHO, 2016). Digital health guidance has also emphasized that digital interventions should strengthen, rather than replace, health-system functions and person-centered care (WHO, 2019).

Mobile health (mHealth) expands the reach of prenatal education through smartphone applications, short message service (SMS), WhatsApp, automated voice messages, web platforms, and wearable-linked applications. These approaches can deliver gestational-age-specific content repeatedly, allow self-monitoring, provide reminders, and create opportunities for two-way communication. A meta-analysis by Chan and Chen (2019) reported moderate-to-large effects of social media and mHealth interventions on maternal physical health ($d = 0.72$), mental health ($d = 0.84$), and knowledge about pregnancy ($d = 0.80$). Earlier systematic reviews, however, cautioned that intervention types and outcome measures were highly heterogeneous, limiting firm conclusions about clinical effectiveness (Daly et al., 2018; Hussain et al., 2020).

Evidence from low- and middle-income countries (LMICs) is particularly important because mHealth may reduce barriers related to distance, time, and limited opportunities for face-to-face education. Reviews have found that mHealth can increase antenatal care use, facility-based delivery, and skilled birth attendance in some settings, although effects depend on baseline service utilization and whether communication is one-way or interactive (Sondaal et al., 2016; Feroz et al., 2017; Rahman et al., 2022). More recent reviews indicate that behavior-change techniques such as goal setting, self-monitoring, instruction, feedback, and social support are frequently embedded in successful maternal mHealth interventions (Er et al., 2026).

Despite this expanding literature, the meaning of 'effectiveness' remains difficult to interpret when knowledge gains, behavioral changes, and clinical outcomes are treated as equivalent endpoints. Improvements in knowledge or self-efficacy may occur without measurable changes in supplement adherence, physical activity, gestational weight gain, or maternal-perinatal outcomes. Existing reviews also combine diverse digital interventions, populations, delivery channels, and outcome measures, making it difficult to determine which benefits are most reproducible for educational interventions specifically. The present review addresses this gap by focusing on quantitative evidence from educational mHealth interventions among pregnant women and by explicitly separating proximal outcomes (knowledge, health literacy, self-care, and patient

activation) from behavioral and distal maternal-perinatal outcomes. This approach is intended to clarify where the evidence is relatively consistent, where it remains heterogeneous, and which intervention characteristics may explain differences in observed effects.

METHODS

This article was designed as a structured literature review rather than a new clinical trial or formal meta-analysis. A targeted search was conducted using PubMed and publisher journal pages, supplemented by reference chaining from systematic reviews. Searches emphasized peer-reviewed studies published from 2016 through September 2026, while a small number of earlier foundational mHealth studies were retained when they directly informed pregnancy education interventions. The review question was: among pregnant women, what quantitative effects have mobile or web-enabled educational interventions demonstrated for knowledge, health literacy, self-care, health behaviors, and selected maternal health outcomes?

Search concepts combined terms for pregnancy or pregnant women with mobile health, mHealth, mobile application, smartphone, WhatsApp, text message, voice message, prenatal education, antenatal education, knowledge, health literacy, self-care, health behavior, nutrition, physical activity, birth preparedness, and supplement adherence. Priority was given to randomized controlled trials, controlled before-after studies, quasi-experimental studies, and systematic reviews reporting verifiable quantitative results. The search and synthesis were conducted to identify studies with directly interpretable numerical findings rather than to estimate a pooled treatment effect.

Studies were eligible for the main synthesis when: (1) participants were pregnant women; (2) the intervention used a mobile or web-enabled device as a major channel for health education or behavior support; (3) a comparator, pre-post assessment, or other controlled design was available; and (4) at least one outcome reflected knowledge, health literacy, self-care, preventive behavior, diet, physical activity, supplement use, birth preparedness, or health-service use. Studies limited to diagnosis, remote physiologic monitoring without an educational component, or postpartum-only interventions were not emphasized. Studies were excluded from the primary synthesis when the educational component could not be distinguished from other intervention components or when quantitative outcome information could not be verified from the available publication or indexed abstract.

For each study, the design, sample size, intervention modality, target outcome, and quantitative findings were transcribed from the published article or indexed abstract. Reported effect estimates, means, standard deviations, confidence intervals, and p values were retained as published. No individual-level data were generated, no missing values were imputed, and no new effect sizes were calculated. Because interventions and outcome measures were heterogeneous, results were synthesized narratively rather than statistically pooled. Thirteen controlled studies with verifiable quantitative findings were included in the primary evidence synthesis presented in Figure 1. Systematic reviews and WHO documents were retained as contextual sources rather than counted as primary intervention studies. The original manuscript did not preserve a complete record-level search log; therefore, exact database-level counts of records identified and excluded



cannot be reconstructed retrospectively without introducing unsupported figures. To improve transparency without fabricating counts, a PRISMA-informed selection schematic is provided as Figure 1, together with explicit reporting of the 13 studies included in the primary synthesis. As this review used only publicly available published data and collected no new data from human participants, independent ethical approval was not required.

Identification Targeted searches: PubMed + publisher journal pages + reference chaining Record-level totals were not retained in the original search log
Screening / Eligibility Pregnant women + mobile/web educational intervention + comparator/pre-post or controlled design + relevant quantitative outcome
Included in primary synthesis 13 controlled studies with verifiable quantitative findings
Contextual evidence Systematic reviews and WHO guidance used to interpret heterogeneity, implementation factors, and health-system implications

Figure 1. PRISMA-informed study-selection schematic for the structured literature review

RESULTS

The primary evidence synthesis comprised 13 controlled studies with verifiable quantitative findings, representing stand-alone smartphone applications, interactive mobile messaging, daily WhatsApp education, stage-based voice messages, and apps combined with wearables or professional counseling. Sample sizes ranged from small pilot trials with several dozen participants to implementation evaluations involving more than 2,000 women. To address the reviewer's request for clearer organization, findings are presented by five major outcome categories: (1) knowledge and health literacy; (2) health behaviors and self-care; (3) supplement adherence and nutrition; (4) physical activity, lifestyle, and gestational weight; and (5) birth preparedness, care-seeking, and maternal-perinatal outcomes. Table 1 summarizes the representative controlled studies for which numerical results could be verified.

The identified literature included stand-alone smartphone applications, interactive mobile messaging, daily WhatsApp education, stage-based voice messages, smartphone websites, and apps combined with wearables or professional counseling. Sample sizes ranged from small pilot trials with several dozen participants to large implementation evaluations involving more than 2,000 women. Outcomes also varied substantially, from pregnancy knowledge and health literacy to lifestyle scores, supplement adherence, physical activity, birth preparedness, service utilization, and gestational weight gain. Table 1 summarizes representative controlled studies in which the published numerical results could be verified.

Table 1. Representative Published Studies of mHealth-based Educational Interventions Among Pregnant Women

Study / Setting	Design / Sample	mHealth Intervention	Primary Educational/Behavioral Outcome	Published Finding
Ledford et al., 2016 United States	Randomized pilot; n=173 randomized, n=127 completed	Prenatal education/engagement mobile app vs spiral notebook	Engagement; patient activation	App users recorded pregnancy information more frequently (p=.04) and had greater patient activation (p=.02); no difference in interpersonal clinical communication.
Parsa et al., 2019 Iran	Controlled before-after; n=110 recruited, n=108 analyzed	Pre-eclampsia educational mobile app	Pre-eclampsia knowledge	No baseline group difference (p=.94); post-intervention knowledge differed significantly between groups (p<.001).
Masoi & Kibusi, 2019 Tanzania	Controlled quasi-experimental; n=450 (150 intervention, 300 control)	Interactive two-way mobile messaging on danger signs and birth preparedness	Knowledge; birth preparedness	Knowledge score 9.531±2.666 vs 6.518±4.304 (p<.001); preparedness score 4.165±1.365 vs 2.631±1.775 (p<.001). High knowledge: 77.3% vs 48.0%; prepared for birth: 70.7% vs 29.7%.
Murthy et al., 2020 India	Pseudo-randomized trial; n=2,016 (1,516 intervention, 500 control)	mMitra gestational-age/stage-based voice messages	Maternal practices; knowledge	Higher odds of tetanus toxoid injection (OR 1.60, 95% CI 1.05-2.40), seeking doctor for bleeding (OR 1.72, 1.07-2.75), saving money for delivery (OR 1.79, 1.38-2.33), and hospital delivery (OR 2.50, 1.49-4.35). Knowledge advantage was limited to one indicator.



Study / Setting	Design / Sample	mHealth Intervention	Primary Educational/Behavioral Outcome	Published Finding
Farzi Karamolahi et al., 2021 Iran	Randomized controlled trial; n=140	Mobile app training, weekly learning for 8 weeks	Maternal health literacy	Mean change in health literacy was significantly greater in intervention vs control ($p<.001$); control pre-post change was not significant ($p=.609$).
Kiani & Pirzadeh, 2021 Iran	Quasi-experimental; n=93	Educational mobile app supporting pregnancy physical activity	Physical activity; perceived benefits/barriers	Post-intervention activity $1,872.44\pm653.86$ vs $1,413.29\pm758.74$ METs (between-group $p=.002$); intervention increased from $1,570.00\pm754.11$ ($p=.014$).
Ariyani et al., 2022 Indonesia	Randomized controlled trial; n=145 (71 intervention, 74 control)	Application-based antenatal education using Social Cognitive Theory	Healthy lifestyle; iron tablets; birth readiness	HPLP-II rose 2.62 ± 0.331 to 2.94 ± 0.273 (change $+0.32$), vs $+0.13$ in control ($p=.001$). No significant between-group difference for iron-tablet consumption ($p=.333$) or birth/complication readiness ($p=.557$).
Persis et al., 2023 India	Three-arm pragmatic RCT; n=150 (50 app, 50 WhatsApp, 50 control)	Pregnancy self-care education by app or WhatsApp	Knowledge-attitude-practice (KAP)	Both mHealth groups showed significantly greater KAP improvement than standard care ($p<.001$); app vs WhatsApp difference was not significant ($p>.05$).
Arifah et al., 2023 Indonesia	Pilot RCT; n=44	Daily WhatsApp educational messages for 7 weeks	Anemia knowledge; IFA use; diet	IFA tablet consumption over 42 days: 39.54 ± 3.94 vs 34.86 ± 8.13 ($p=.003$); knowledge improved ($p=.007$); anemia-prevention diet did not differ significantly.

Study / Setting	Design / Sample	mHealth Intervention	Primary Educational/Behavioral Outcome	Published Finding
Asadollahi et al., 2026 Iran	Parallel RCT; n=80	Comprehensive multimedia mHealth app for 4 weeks	Health-promoting lifestyle	Intervention produced higher HPLP-II scores than standard care (mean difference 29.5, $p=.004$), with improvement across all reported subscales.
Chen et al., 2026 Taiwan	Multisite RCT; n=160 randomized; 149 completed 12-week follow-up	Scenario-based i-PregMom nutrition-literacy app	Nutrition literacy; healthy eating	Nutrition literacy 20.5 ± 1.6 vs 18.2 ± 2.1 ; MD 2.3 (95% CI 1.67-2.88), $p<.001$, $d=1.22$. Healthy eating 45.6 ± 7.0 vs 42.2 ± 7.0 ; MD 3.4 (95% CI 1.22-5.73), $p=.003$, $d=.50$.
Karakoç & Cesur, 2026 Türkiye	Randomized controlled trial; n=54 (27 per group)	Mobile app education and counseling for gestational diabetes	Healthy lifestyle behaviors	Post-intervention HLBS total score favored the app group (MD 15.7, 95% CI 9.2-22.1, $p<.001$); effect persisted at follow-up (MD 13.8, 95% CI 8.4-19.3, $p<.001$).
Sandborg et al., 2021 Sweden	Randomized controlled trial; n=305	HealthyMoms app with information, push notifications, self-monitoring, feedback	Diet; gestational weight; activity	No overall effect on gestational weight gain ($p=.62$), but healthy-eating index was higher in intervention group (difference 0.27, 95% CI 0.05-0.50, $p=.017$). No significant MVPA difference.

1. Effects on Knowledge and Health Literacy

Knowledge and health literacy were the outcomes with the most consistent direction of benefit. Parsa et al. (2019) reported that a pre-eclampsia application produced a highly significant post-intervention knowledge difference ($p<.001$) despite equivalent baseline scores. In Tanzania, the interactive messaging intervention of Masoi and Kibusi (2019) increased mean danger-sign knowledge to 9.531 ± 2.666 compared with 6.518 ± 4.304 in the control group, while the proportion



classified as knowledgeable reached 77.3% versus 48.0%. The same intervention also improved birth preparedness, suggesting that information gains translated into a concrete planning behavior.

Health literacy findings support the value of repeated, accessible digital learning. Farzi Karamollahi et al. (2021) found significantly greater improvement in maternal health literacy after eight weeks of app-based education ($p < .001$). The three-arm pragmatic trial by Persis et al. (2023) similarly showed that both a dedicated application and WhatsApp education improved pregnancy self-care knowledge, attitudes, and practices compared with standard care ($p < .001$), with no significant difference between the two digital channels. These results suggest that the quality and continuity of educational content may be more important than whether the content is delivered through a custom app or an established messaging platform.

The recent i-PregMom trial provides one of the clearest effect estimates for competency-oriented education. At 12 weeks, nutrition literacy was 20.5 ± 1.6 in the intervention group versus 18.2 ± 2.1 in controls, corresponding to a mean difference of 2.3 points (95% CI 1.67–2.88; $p < .001$) and a large effect size ($d = 1.22$) (Chen et al., 2026). The intervention also improved healthy-eating behavior with a moderate effect ($d = .50$), indicating that scenario-based learning may help bridge the gap between knowing and applying nutrition information.

2. Effects on Health Behaviors

Behavioral effects were positive but less uniform than knowledge outcomes. The mMitra evaluation in India showed statistically significant improvements in several maternal practices, including tetanus toxoid vaccination, consulting a physician for bleeding, saving money for delivery, and hospital delivery. Importantly, not every measured practice improved, and two indicators favored the control group (Murthy et al., 2020). This pattern illustrates why broad claims that mHealth improves all maternal behaviors are not justified.

Supplement adherence provides another example of selective effectiveness. Daily WhatsApp messages in Surakarta increased iron-folic acid tablet consumption over the previous 42 days to 39.54 ± 3.94 tablets compared with 34.86 ± 8.13 in controls ($p = .003$), while knowledge also improved ($p = .007$) (Arifah et al., 2023). In contrast, the Bali trial using a theory-based antenatal education application significantly improved the overall HPLP-II lifestyle score but did not produce a significant between-group difference in iron-tablet consumption ($p = .333$) or readiness for delivery and complications ($p = .557$) (Ariyani et al., 2022). Thus, a change in a global lifestyle score should not be assumed to imply improvement in every component behavior.

Physical activity outcomes varied according to intervention intensity and context. Kiani and Pirzadeh (2021) observed significantly higher post-intervention physical activity in the app group, whereas other digital trials have reported limited or no effects when messaging alone was used. The HealthyMoms randomized trial found no overall effect on gestational weight gain or moderate-to-vigorous physical activity, but did identify a modest improvement in healthy eating and a possible weight-gain benefit among women with overweight or obesity (Sandborg et al., 2021). The Pas and Pes trial combining a smartband, app, and midwife counseling also increased physical activity at

late gestation but did not consistently alter maternal or perinatal outcomes (Gonzalez-Plaza et al., 2022).

3. Lifestyle Modification and Behavioral Changes

Recent trials provide stronger evidence that multicomponent and professionally developed mobile health interventions can produce meaningful improvements in healthy lifestyle behaviors during pregnancy. In the category of lifestyle modification, Asadollahi et al. (2026) reported a significant improvement in overall health-promoting behaviors following a four-week comprehensive application-based intervention, with an adjusted mean difference of 29.5 points in the total Health-Promoting Lifestyle Profile II (HPLP-II) score compared with the control group ($p = .004$). This finding suggests that applications integrating multiple health-promotion components may be effective in supporting broader behavioral changes rather than merely increasing health-related knowledge.

Similarly, among women with gestational diabetes, Karakoç and Cesur (2026) demonstrated a significant improvement in healthy lifestyle behavior scores, with a post-intervention mean difference of 15.7 points between the intervention and control groups (95% CI: 9.2–22.1; $p < .001$). Importantly, the beneficial effect was maintained during follow-up, indicating that structured digital interventions may contribute to sustained lifestyle modification.

Taken together, these studies indicate that interventions combining health education, structured guidance, counseling, and ongoing behavioral support appear to have greater potential for modifying lifestyle behaviors than applications that primarily provide passive information. The findings therefore support the importance of incorporating interactive and professionally guided components into maternal mobile health interventions when behavioral change is the intended outcome.

4. Supplement Adherence and Nutrition Outcomes

Table 2. Summary of Evidence Across Maternal and Perinatal Outcome Domains

Outcome domain	Overall pattern in published evidence	Interpretation
Pregnancy knowledge / danger signs	Consistently positive in controlled studies such as Parsa et al. and Masoi & Kibusi.	Strongest and most reproducible effect of educational mHealth.
Health literacy / self-care KAP	Positive in Farzi Karamolahi et al., Persis et al., and i-PregMom.	Repeated, accessible, scenario-based education appears effective.
Supplement adherence	Positive in the WhatsApp anemia pilot; non-significant in the Bali app trial.	Behavior depends on reminders, access, beliefs, and treatment burden, not knowledge alone.



Outcome domain	Overall pattern in published evidence	Interpretation
Birth preparedness / care seeking	Improved in interactive messaging and voice-message programs, but not universally.	Two-way communication and context-specific action messages may support behavior change.
Diet / healthy lifestyle	Generally favorable but heterogeneous.	Stronger effects when apps include self-monitoring, feedback, or theory-based content.
Physical activity / gestational weight	Mixed; some trials show activity or subgroup benefits, others null overall effects.	Education alone may be insufficient; wearable feedback and counseling may add value.
Clinical maternal/perinatal outcomes	Inconsistent and less frequently improved.	Current evidence supports mHealth as an adjunct, not a substitute for clinical antenatal care.

Table 2 summarizes the overall pattern of evidence across the major outcome domains and shows that the effects of mHealth-based education are not uniform. The clearest and most consistent benefits are seen in pregnancy knowledge, health literacy, and self-care, whereas supplement adherence, physical activity, gestational weight, and maternal-perinatal outcomes remain more variable. These findings suggest that educational mHealth interventions are most effective when the intervention strategy is closely matched to the specific behavior or outcome being targeted.

5. Physical Activity, Lifestyle, and Gestational Weight Outcomes

Behavioral effects were positive but less uniform than knowledge outcomes. The mMitra evaluation in India showed statistically significant improvements in several maternal practices, including tetanus toxoid vaccination, consulting a physician for bleeding, saving money for delivery, and hospital delivery. Importantly, not every measured practice improved, and two indicators favored the control group (Murthy et al., 2020). This pattern illustrates why broad claims that mHealth improves all maternal behaviors are not justified.

6. Birth Preparedness, Care-Seeking, and Maternal Outcomes

Evidence for birth preparedness and care-seeking was generally favorable but not uniform. Interactive messaging in Tanzania improved birth preparedness, while the mMitra voice-message intervention increased several care-related practices, including seeking a doctor for bleeding and hospital delivery. In contrast, the Bali application trial did not significantly improve readiness for delivery and complications. Across the reviewed studies, direct maternal or perinatal clinical outcomes were less consistently affected than knowledge or self-care measures, supporting a cautious interpretation of mHealth as an adjunct to antenatal care rather than a substitute for clinical assessment.

Supplement adherence provides another example of selective effectiveness. Daily WhatsApp messages in Surakarta increased iron-folic acid tablet consumption over the previous 42 days to 39.54 ± 3.94 tablets compared with 34.86 ± 8.13 in controls ($p=.003$), while knowledge also improved ($p=.007$) (Arifah et al., 2023). In contrast, the Bali trial using a theory-based antenatal education application significantly improved the overall HPLP-II lifestyle score but did not produce a significant between-group difference in iron-tablet consumption ($p=.333$) or readiness for delivery and complications ($p=.557$) (Ariyani et al., 2022). Thus, a change in a global lifestyle score should not be assumed to imply improvement in every component behavior.

Physical activity outcomes varied according to intervention intensity and context. Kiani and Pirzadeh (2021) observed significantly higher post-intervention physical activity in the app group, whereas other digital trials have reported limited or no effects when messaging alone was used. The HealthyMoms randomized trial found no overall effect on gestational weight gain or moderate-to-vigorous physical activity, but did identify a modest improvement in healthy eating and a possible weight-gain benefit among women with overweight or obesity (Sandborg et al., 2021). The Pas and Pes trial combining a smartband, app, and midwife counseling also increased physical activity at late gestation but did not consistently alter maternal or perinatal outcomes (Gonzalez-Plaza et al., 2022).

This review indicates that mHealth-based education is most consistently associated with outcomes that are directly linked to the educational content—knowledge, health literacy, patient activation, self-care KAP, and selected preventive behaviors. The pattern is compatible with the meta-analysis by Chan and Chen (2019), which reported a large pooled effect for pregnancy knowledge ($d=0.80$), while systematic reviews have emphasized heterogeneity in behavioral and clinical outcomes (Daly et al., 2018; Hussain et al., 2020). The distinction between proximal and distal outcomes is therefore important: an intervention may improve what women know or intend to do without necessarily changing gestational weight gain, anemia status, obstetric complications, or neonatal outcomes. The current synthesis contributes by making that distinction explicit across intervention types rather than treating all outcomes as evidence of equivalent effectiveness.

Several interacting factors may explain differences in intervention effectiveness. First, digital literacy affects whether users can navigate applications, interpret health information, and act on reminders or self-monitoring functions. Second, accessibility is shaped by smartphone ownership, internet stability, data affordability, language, disability access, and the cognitive burden of frequent digital messages. Third, socioeconomic circumstances may influence whether women can convert knowledge into action—for example, saving money for delivery, purchasing nutritious food, or obtaining supplements. Fourth, healthcare-provider involvement may strengthen interventions by allowing clarification, personalization, referral, and reinforcement. Finally, intervention design matters: stage-tailored content, repeated exposure, two-way messaging, scenario-based decision making, self-monitoring, feedback, reminders, and theory-based behavior-change techniques provide different mechanisms for translating information into behavior. The 2026 systematic review by Er et al. identified goal setting, self-monitoring, instruction, feedback, and social support among commonly used behavior-change techniques in maternal mHealth interventions.



Findings from low- and middle-income countries also show that technological sophistication is not synonymous with effectiveness. WhatsApp and automated voice messages produced meaningful effects in Indonesia and India, while interactive messaging improved danger-sign knowledge and birth preparedness in Tanzania. These channels may be valuable where data costs, device capability, health literacy, or application installation are barriers. However, accessibility alone does not guarantee uniform effectiveness: the mMitra evaluation showed that some practices improved while other indicators did not, and the intervention's knowledge advantage was limited. This suggests that digital delivery should be selected according to the target population, the behavior to be changed, and the level of support required.

The Indonesian evidence illustrates the importance of matching intervention intensity to the behavioral target. Ariyani et al. (2022) reported improvement in a general health-promoting lifestyle score using an application grounded in Social Cognitive Theory, but specific adherence and birth-readiness outcomes remained non-significant. Arifah et al. (2023), by contrast, found that a simpler daily WhatsApp intervention improved anemia knowledge and iron-folic acid tablet consumption. A plausible interpretation is that repeated, actionable reminders may be sufficient for a discrete behavior, whereas broader lifestyle change may require self-monitoring, feedback, counseling, and sustained motivational support. These findings should be interpreted as patterns across studies rather than as evidence that one technology is universally superior to another.

Table 3. Summary of Outcome-Specific Evidence on the Effectiveness of mHealth-Based Educational Interventions Among Pregnant Women

Outcome domain	Overall pattern in published evidence	Interpretation
Pregnancy knowledge / danger signs	Consistently positive in controlled studies such as Parsa et al. and Masoi & Kibusi.	Strongest and most reproducible effect of educational mHealth.
Health literacy / self-care KAP	Positive in Farzi Karamolahi et al., Persis et al., and i-PregMom.	Repeated, accessible, scenario-based education appears effective.
Supplement adherence	Positive in the WhatsApp anemia pilot; non-significant in the Bali app trial.	Behavior depends on reminders, access, beliefs, and treatment burden, not knowledge alone.
Birth preparedness / care seeking	Improved in interactive messaging and voice-message programs, but not universally.	Two-way communication and context-specific action messages may support behavior change.
Diet / healthy lifestyle	Generally favorable but heterogeneous.	Stronger effects when apps include self-monitoring, feedback, or theory-based content.

Outcome domain	Overall pattern in published evidence	Interpretation
Physical activity / gestational weight	Mixed; some trials show activity or subgroup benefits, others null overall effects.	Education alone may be insufficient; wearable feedback and counseling may add value.
Clinical maternal/perinatal outcomes	Inconsistent and less frequently improved.	Current evidence supports mHealth as an adjunct, not a substitute for clinical antenatal care.

Digital education also has important implementation and equity limitations. Smartphone ownership, internet stability, data affordability, language, disability access, privacy, and digital literacy can influence uptake and sustained engagement. Socioeconomic differences may further affect the feasibility of acting on recommendations delivered digitally. Provider involvement can mitigate some barriers by offering clarification, personalization, referral, and clinical follow-up, but it also increases implementation requirements. Apps may contain accurate information at launch but become outdated when clinical guidance changes. Health systems therefore need processes for content governance, professional review, data protection, and referral when women report symptoms or danger signs. mHealth should complement face-to-face antenatal care rather than create a false sense that educational content can replace examination, diagnostic testing, or emergency assessment.

The evidence base remains heterogeneous. Some trials are small pilots, follow-up is often short, and outcomes are frequently self-reported. Intervention descriptions differ in intensity and theoretical basis, while control conditions range from routine care to active written or face-to-face education. Differences in baseline service access, socioeconomic context, digital literacy, provider involvement, and outcome measurement make direct comparisons difficult. The structured design of this review also has limitations: because a complete record-level search log was not preserved in the source manuscript, the exact number of records identified and excluded cannot be reconstructed retrospectively. The review therefore avoids presenting unsupported PRISMA counts and instead transparently reports the 13 controlled studies whose quantitative findings were verifiable for the primary synthesis. Recent reviews continue to call for theory-based, culturally adapted interventions with longer follow-up and standardized outcomes (Er et al., 2026; Jafari et al., 2026).

Future research should report engagement metrics alongside behavioral and clinical outcomes; examine whether effects persist into late pregnancy and the postpartum period; and assess cost-effectiveness, accessibility, and equity. Trials should pre-specify a small number of clinically meaningful primary outcomes, distinguish educational exposure from technology novelty, and use standardized measures for maternal and perinatal outcomes. Future studies should also report digital literacy, socioeconomic characteristics, intervention dose, provider involvement, adherence to the digital intervention, and reasons for disengagement. Pragmatic comparisons of low-cost messaging platforms, dedicated applications, and blended digital-plus-midwife models



would help determine which delivery approaches are feasible and effective in routine antenatal services.

Findings from LMICs demonstrate that sophisticated applications are not the only viable approach. WhatsApp and automated voice messages produced meaningful effects in Indonesia and India, while interactive messaging improved danger-sign knowledge and birth preparedness in Tanzania. These channels may be particularly valuable where data costs, device capability, health literacy, or app installation are barriers. The mMitra results also suggest that voice messages can reach women in lower-literacy contexts, although the limited effect on knowledge and the presence of outcomes favoring controls show that accessibility does not guarantee uniform effectiveness.

The Indonesian evidence is especially relevant for practical implementation. Ariyani et al. (2022) demonstrated that an application grounded in Social Cognitive Theory improved a general health-promoting lifestyle score among pregnant women in Denpasar, but specific adherence outcomes remained non-significant. Arifah et al. (2023) showed that a much simpler daily WhatsApp intervention improved anemia knowledge and iron-folic acid tablet consumption. Together, these findings imply that intervention design should be matched to the target behavior. For a single, measurable behavior such as daily supplement use, short repeated reminders and actionable messages may be sufficient; for broader lifestyle change, theory-based content, self-monitoring, and counseling may be needed.

Published evidence supports mHealth-based educational interventions as useful tools for improving pregnancy knowledge, health literacy, self-care KAP, patient activation, and selected health behaviors. The most consistent effects occur for outcomes closely connected to the educational content, whereas supplement adherence, physical activity, gestational weight gain, and maternal or perinatal clinical outcomes show greater variability. Differences in digital literacy, accessibility, socioeconomic circumstances, healthcare-provider involvement, intervention intensity, and behavior-change techniques may contribute to this heterogeneity. Accordingly, mHealth should be implemented as an adjunct to high-quality antenatal care rather than as a replacement for direct clinical assessment. Future research should use standardized maternal and perinatal outcome measures, longer follow-up into late pregnancy and postpartum, transparent reporting of engagement and adherence, explicit assessment of equity and digital access, and appropriate economic evaluation. These improvements will help determine when and how digital education can translate gains in knowledge into sustained maternal health behavior and measurable clinical benefit.

The evidence base itself remains heterogeneous. Some trials are small pilots, follow-up is often short, and outcomes are frequently self-reported. Intervention descriptions differ in intensity and theoretical basis, while control conditions range from routine care to active written or face-to-face education. These differences make direct comparisons difficult. Recent reviews continue to call for theory-based, culturally adapted interventions with longer follow-up and standardized outcomes (Er et al., 2026; Jafari et al., 2026).

Future research should report engagement metrics alongside clinical and behavioral outcomes, examine whether effects persist into late pregnancy and postpartum, and assess cost-

effectiveness and equity. Trials should distinguish educational exposure from technology novelty and should pre-specify a small number of clinically meaningful primary outcomes. For implementation in routine antenatal services, pragmatic comparisons of low-cost messaging platforms, dedicated apps, and blended digital-plus-midwife models would be especially useful. The authors acknowledge the investigators whose published findings were synthesized in this review. No primary participant data were collected for this manuscript.

CONCLUSIONS

Published evidence supports mHealth-based educational interventions as effective tools for improving pregnancy knowledge, health literacy, self-care KAP, patient activation, and several specific health behaviors. The strongest and most consistent effects occur for outcomes that are closely connected to the educational content, whereas physical activity, gestational weight gain, supplement adherence, and maternal or perinatal clinical outcomes show greater variability. Interventions are more likely to influence behavior when they are tailored to gestational stage and local context, repeated over time, interactive, theory-informed, and linked to self-monitoring, feedback, or professional support. Accordingly, mHealth should be implemented as an adjunct to high-quality antenatal care rather than as a replacement for direct clinical assessment. Future trials should use standardized outcome measures, longer follow-up, transparent reporting of engagement, and equity-focused implementation strategies so that improvements in knowledge can be more reliably translated into sustained maternal health behavior and clinical benefit.

ACKNOWLEDGMENT

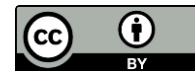
The authors acknowledge the investigators whose published findings were synthesized in this review. No primary participant data were collected for this manuscript. Thank you to all the participants.

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