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Effect of short message service reminders

in improving optimal antenatal care, skilled

birth attendance and postnatal care in low-

and middle-income countries: a systematic

Abstract

Background Digital health has emerged as a promising solution for enhancing health system in the recent years, showing significant potential in improving service outcomes, particularly in low and middle-income countries where accessing essential health service is challenging. This review aimed to determine the effectiveness of short message services on focused antenatal care, skilled birth attendance, and postnatal care improvement in low and middle-income countries.

Method Electronic databases such as PubMed, EMBASE, Scopus, Cochrane, and Google and Google Scholar were searched. We extracted data of antenatal care visits, skilled birth attendance, and postnatal care visits from RCTs and quasi-experimental studies. The quality of included studies was examined using JBI risk of bias assessment tools. A measure of the random-effects model was used to estimate the pooled effect size expressed as Relative Risk (RR) with a 95%CI. The certainty of the evidence was assessed using Grade pro software.

Results Twenty-six studies were included in this review. The risk of bias assessment was greater than 50% in included studies. In aggregate, mobile short message service reminders had a significant effect on optimal antenatal care (RR = 1.34, 95% CI: 1.12–1.60), skilled birth attendance (RR = 1.18, 95% CI: 1.05–1.33), and postnatal care (RR = 1.51; 95% CI: 1.34–1.71). There was high heterogeneity for ANC with $I^2 = 96\%$; (p < 0.001), skilled birth attendance (IZ = 92.6%) (p = 0.000), and postnatal care $I^2 = 78.4\%$ (p < = 0.001).

Conclusions Short message service yielded a positive effect in improving antenatal care visit, skilled birth attendance, and postnatal care attendance in low-and middle-income countries. Short message service reminder intervention should be promoted as a tool to improve maternal health service utilization in low and middle-income countries.

Keywords SMS, ANC4+, SBA, PNC, LMICs, Optimal antenatal care, Systematic review and Meta-analysis

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review and meta-analysis





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Background

Digital health offered unprecedented opportunities to improve health and health service outcomes [1]. In the realm of health system outcomes, it shows immense potential addressing critical gaps in healthcare industry [2-4]. Moreover, it helps bridge the digital divide in lowand middle income countries, where accessing essential health service is challenging [5].

Digital health offers substantial benefits in healthcare industry such as improving maternal health service and health outcomes [2–4, 6–10], enhance quality health service delivery and adherence [11], behavioral health change [12], generation of health data quality and use [13], improving antenatal care (ANC) visits [12], enhancing postnatal care (PNC) visits [14], improve skilled birth attendance(SBA) [15], reduces decision errors in healthcare [16], perinatal mortality [17] and adverse birth outcomes [11]. Moreover, it also supports appointment compliance, data gathering, and networking among health workers [18], enhances work performance [19], creates motivation [20], and providing learning opportunities [20].

The body of literature from Ethiopia [21], Ghana [22], and Uganda [19] shows that mobile health improves efficiency and productivity among health workers [10, 23], improve health service delivery and health outcomes [2–4, 6–9] and strengthen healthcare industries [24–27]. Although mobile technology penetration is increasing, ensuring that digital technologies contribution to universal health coverage and digital health strategy is vital [28].

The World Health Organization (WHO) defines mobile health as using mobile phones, smartphones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices in medical and public health practice [26, 27]. It consists of voice calling, voice over internet protocol (VoIP), short message service (SMS), multimedia message service (MMS) and internet services [29].

Text messaging is mostly documented, widely available digital health approach improved health care system [30]. Thouh the effectiveness depends on contextual and cultural factors, there are available evidences on the effectiveness of short message service in low- and middle income countries. Thus, assessing the pooled effect of text messaging on maternal healthcare uptake could help to generate comprehensive evidence to inform policy and decision making.

In this review, we investigated the evidence of text messaging intervention on the improvement of optimal ANC, SBA, and PNC follow-up in low-and middle-income countries. Therefore, this study aimed to review the existing evidence in order to determine the pooled estimate of text message reminders on optimal ANC, SBA, and PNC visit improvement among pregnant women in low-and middle-income countries, as the evidence base is still unclear, inconsistent and inconclusive.

Methods

Protocol registration and reporting

This review was conducted according to the protocol that has been registered at PROSPERO: CRD42020206869 (available at https://www.crd.york.ac.uk/PROSPERO/# myprospero). The results of this review were reported based on the PRISMA reporting guideline to ensure transparent and complete reporting in review processes [31]. During the review, a broad range of databases were searched using electronic databases, reference lists of included studies, and cross-referencing to minimize the missing of relevant records.

Information sources and search strategy

PROSPERO and Cochrane libraries were checked to avoid duplication of the study. Initially, the search terms were defined using MeSH terms and Boolean operators, and phrases were used during record retrieval. A comprehensive search strategy was done on potential electronic databases, namely PubMed (Table 1), EMBASE, Cochrane, Scopus, Google, and Google Scholar to maximize the chance of including eligible records.

Eligibility criteria

The PICO approach was used to set inclusion and exclusion criteria during the eligibility assessment.

Population Studies involved antenatal, natal, and postnatal women in which reminder messages were delivered for antenatal care visits, skilled delivery, and appointment of postnatal checkups.

Intervention Interventions that provided text message reminders for consecutive antenatal care visits, skilled birth attendance, and postnatal visits.

Controls Population who received routine care/standard care in antenatal care visits, skilled birth attendance, and postnatal care visits.

Outcome Maternal health service includes antenatal care visits four and above, skilled birth attendance and postnatal care visits.

Operational definitions

Optimal antenatal care Attended four or more ANC contacts during pregnancy as recommended by the World Health Organization.

Skilled birth attendance Skilled health service providers include doctors, nurses, midwives, and health officers

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Table 1 Search strategy used in PubMed

((((((("pregnancy"[All Fields] OR "pregnant women"[All Fields]) OR "pregnant mother"[All Fields]) OR "pregnant"[All Fields]) OR "women"[All Fields]) OR "gestational women" [All Fields])) AND (("sms"[All Fields]) OR ("telemedicine"[MeSH Terms] OR "telemedicine"[All Fieldis] OR "mhealth"[All Fields]) OR reminder[All Fields] OR "short message"[All Fields] OR "Messaging Text"[All Fields] OR ("text messaging"[MeSH Terms] OR ("text"[All Fields] AND "messaging"[All Fields]) OR "text messaging"[All Fields] OR "texting"[All Fields] OR "Short Message service"[All Fields] OR "text message"[All Fields] OR "message Text"[All Fields] OR "messages text"[All Fields] OR "text Message"[All Fields] OR "text reminder"[All Fields] OR "short text message"[All Fields] OR "messages [All Fields] OR "messages text"[All Fields] OR "text Message"[All Fields] OR "text reminder"[All Fields] OR "short text message"[All Fields] OR "short text messages"[All Fields]) AND ("antenatal care"[All Fields] OR "shilled delivery attendance"[All Fields] OR "facility delivery"[All Fields] OR "institutional delivery"[All Fields] OR "postnatal care"[All Fields]))))

who have the skill to manage pregnancy, childbirth, and postnatal care and are able to make a referral of complications for women and newborns.

Postnatal care Postnatal check-up within 45 days of delivery that helps to prevent complications after childbirth.

mHealth Is health care delivered through mobile technology and devices that include smartphones, tablets, wearable devices, and sensor technologies.

Study selection and data extraction

Eligibility of included studies was assessed independently by two reviewers (TH, LD). Records were exported to the endnote by creating folders and copied to the internal duplicate library before removing the duplicates for further analysis. All the exported records were filtered by reading titles and abstracts, and selected records were assessed by reading full texts. Documentation was held, and a PRISMA flow diagram was used to justify reasons for exclusion (Fig. 1). A pilot test with a subset of eligible records was carried out. Disagreements between the two reviewers during the review process were discussed by another team member (AA) until consensus was reached. Inter-rater agreement was carried out to quantify the agreement by using the kappa statistics. Based on the inclusion criteria, an extensive review was made on the identified articles.

Risk of bias (quality) assessment

Two authors (TH and LD) independently assessed all articles included in the review for risk of bias by using the Joanna Briggs Institute (JBI) critical appraisal checklist for randomized controlled trials, which have 13 criteria [32] and for non-randomized experimental studies with 9 criteria [33]. The critical appraisal for randomized and non-randomized experimental studies were found in supplementary file 1 and 2, respectively. During bias assessment, the disagreement was resolved by discussing with the third author (AA). Studies with a low risk of bias, a score of 50% and above, were included in this review [34].

Data extraction and management

The data extraction process was conducted independently by two reviewers (TH and LD). Extracted data elements were cross-checked, and disagreements between the two reviewers were resolved by discussing it with the third team member (AA). The data entry was performed using a Microsoft Excel spreadsheet. Author of the studies, year of publication, country where the study has been conducted, study design, mobile health intervention in experimental and control/comparator groups, outcome measures (antenatal care visits four and above, skilled birth attendance, and postnatal care visits), events in intervention and control/comparator groups, and the main findings of the included studies were extracted (Supplementary file 3). Extracted data was saved in text tab-delimited file format and exported to STATA Version 14 software to conduct the meta-analysis. Log transformation was accounted to transform summary measures of each outcome.

Assessment of heterogeneity

During evidence generation in a meta-analysis, if the aggregated data deviate from homogeneity, the level of heterogeneity is described with a pooled estimate [35]. In the current review, the heterogeneity test was checked using the forest plot to ascertain whether the confidence intervals of studies overlap with each other and



Fig. 1 PRISMA flow diagram representing the study selection process

the Galbraith plot to check whether or not all the points lie within the 95% confidence bounds [36]. Objectively, we used Cochran's Q-statistic to test the significance of heterogeneity, and the p-value for the chi-square test and less than 0.1 was considered as the presence of statistical heterogeneity [36]. The presence of heterogeneity was described by using Higgins I-Squared (I²) and the percentage was leveled as low (0-40%), moderate (30-60%), substantial (50-90%), and considerable heterogeneity (75-100%) [35, 36].

Assessment of publication bias

In this review, we examined the presence of publication bias visually to check the presence of publication bias or

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asymmetry of funnel plots and by objective test using Egger's technique [35]. To verify the findings, two individuals (TH, LD) separately conducted the main statistical analysis and checked for consistency.

Measures of effect and reporting

Systematic reviews and meta-analyses are reliable types of research to synthesize all the available evidence. The measure of random effects was used to estimate the pooled effect size and expressed as RR (Relative Risk) with a 95% confidence interval. Moreover, we conducted a narrative synthesis to summarize findings based on the geographical distribution, income status, year of publication, sample sizes, and effect of short message service intervention on antenatal care utilization four or more visits, skilled birth attendance, and postnatal care utilization.

Quality assessment of the included studies

The JBI critical appraisal checklist was used for randomized controlled trials. Accordingly, randomization for participant assignment was 87%, delivering treatment blind to treatment assignment was 71%, an appropriate statistical analysis was 73%, and participants analyzed in the groups to which they were randomized was 26%. Records with low risk of bias and a score of 50% and above were included in the review.

The JBI critical appraisal checklist for quasi-experimental studies was used and followed similar procedures using yes, no, unclear, and not applicable parameters. All records with a low risk of bias and scores of 50% and above were included in the review. Finally, inter-rater agreement was carried out using the kappa statistics, and it was found to be substantial (k=0.795; p-value < 0.001).

The team members read the full text of all included studies. Finally, 26 studies were used in systematic review and meta-analysis, of which 15 records were randomized controlled trials studies [37–51] and 11 records were non-randomized experimental studies [52–62]. In general, 18 records were used for meta-analysis and 26 records for systematic review.

Assessment of certainty of evidence

We assessed the certainty of evidence using GRADE Pro (Grading of Recommendations, Assessment, Development, and Evaluation) software, and its score is leveled as high, moderate, low, and very low [36].

Results

Study selection

A total of 3192 studies were searched from different databases: 2005 from PubMed/Medline, 409 from Cochrane Library, 372 from Scopus, 325 from Ovid/EMBASE, and 81 from Google and Google Scholar. Of these, 773 duplicates were removed after reserving them for further analysis, and the remaining 2419 records were screened by reading the titles, and 2071 records were removed. From 348 records abstracted, 309 records were removed (not met the inclusion criteria). Full-text records (n=39) were assessed for eligibility criteria, and 13 full-text records were excluded from the review with the reasons explained in the search flow diagram (Fig. 1) [31].

Narrative synthesis

Of the studies reviewed, 17(two-thirds) were from sub-Saharan Africa, 6 were from Asia and the Pacific, 2 from Latin America and the Caribbean, and 1 study from the Middle East and North Africa. In terms of income status, 11 were from upper-middle-income countries, 9 from lower-middle-income countries, and 6 from low-income countries. Regarding publication years, 17 studies were published within the last five years, while 9 studies were published before five years.

The total sample sizes for ANC was 9305 participants (intervention group=5044, control group=4261); for SBA 9450 participants (intervention group=5242, control groups=4208); for PNC 5813 participants (intervention group=2987, control groups=2826).

The effect of short message service on ANC four and above was reported in 9 studies: 5 studies reported ANC four and above, 3 studies reported ANC four and above to PNC, and 1 study reported ANC four and above and SBA. For SBA, 9 studies reported effects: 4 studies reported SBA, 3 studies reported ANC four and above to PNC, 1 study reported ANC four and above and SBA, and 1 study reported SBA and PNC. Finally, the effect of short message service on PNC was reported in 9 studies: 5 studies reported PNC, 3 studies reported from ANC four and above to PNC, and 1 study reported SBA and PNC (Supplementary file 3).

According to the review, SMS reminder has significantly improved four or more ANC utilization. Studies from Kenya [42], Zanzibar [45], Ethiopia [47], Brazil [46], South Africa [55] showed that women in the intervention group were more likely to attend recommended ANC visits compared to those in the control group. In India [50], 57.5% of women in the SMS group attended the recommended ANC visits, compared to 23.5% in the control group. However, study from Ethiopia [56] showed a slight improvement among women in the intervention group as compared to the control group, 27.% versus 23.4%, respectively, yet the results were not statistically significant. Similarly, studies from Timor-Leste [54] and Kenya [57] showed that there is no significant improvement of ANC four or more visit among women who were in the intervention group compared to control group.

For skilled birth attendance, studies from Zanzibar [57], Kenya [42], India [50], Ethiopia [47], Tanzania [43],

and Timor-Leste [54] indicated significant improvements in the intervention group compared to control group. However, studies from Bangladesh [59] and Nigeria [39] reported that there are no significant differences in the skilled birth attendance between the intervention and control groups.

Regarding postnatal care utilization, studies from India [50], Kenya [49], South Africa [41], Ethiopia [38], Nigeria [61], and Ecuador [40] demonstrated a significant improvements among women who received SMS reminders. In contrast, studies from Bangladesh [59] and Timor-Leste [54] reported no significant effect of SMS reminders on postnatal care utilization.

The pooled effect estimates on antenatal care four and above

Mobile short message service reminders had a significant pooled effect on focused antenatal care visits (RR=1.34; 95% CI 1.12, 1.60) with substantial heterogeneity among studies (I^2 =96%; *P*<0.001) (Fig. 2).

The pooled effect estimates on skilled birth attendance

The pooled estimate revealed there was a significant effect of text message reminders on skilled birth attendance (RR=1.18; 95% CI 1.05–1.33) with substantial heterogeneity among studies (I^2 =92.6%; *P*<0.001) (Fig. 3).

The pooled effect estimates of postnatal care visits

The random effect model showed that short message service reminders had a statistically significant effect on postnatal care visits (RR=1.51; 95% CI 1.34–1.71) with substantial heterogeneity (I²=78.6%, p-value<0.001) (Fig. 4).

Sub-group analysis for antenatal care four and above

To address the heterogeneity among studies, subgroup analyses with random effect models were conducted. Subgroups were formed by both the income status of the countries where the studies were conducted and the study design employed. The pooled random effects on focused antenatal care were statistically significant (RR=1.22; 95% CI 1.08-1.39) for studies in middle income countries (I²=90.4%; P<0.001) and (RR=1.49; 95% CI 1.11-1.20) for studies in low-income countries ($I^2=93.3\%$; P < 0.001). Similarly, in subgroup analysis by study design, the effect of text messaging on focused antenatal care visits was statistically significant (RR=1.53; 95% CI 1.11, 2.10) for RCT studies (I²=98.2%; p-value<0.001) and (RR=1.12; 95% CI 1.00, 1.25) for quasi experimental studies ($I^2=68.5\%$; p-value<0.001). However, there was substantial heterogeneity among studies ($I^2=92.6\%$ and p-value<0.001). The subgroup analyses aimed to address the observed heterogeneity and showed that the effect of short message service was positive and statistically



Fig. 2 Forest plot of antenatal care four and above with random effect model



Fig. 3 Forest plot of skilled birth attendance with random effect model



Fig. 4 Forest plot of postnatal care visits with random effect model

 Table 2
 Assessment of certainty of evidence using GRADE Pro software

Outcomes	No of participants (studies) Follow up	Certainty of the evidence (GRADE)	Relative effect (95% Cl)	Anticipated absolute effects	
				Routine	Risk difference with
				care	SMS reminder
Antenatal care 4+visits	9305	$\Theta \Theta O O$	RR 1.33	410 per	135 more per 1,000
Assessed with: SMS Intervention	(4 Quasi-Experimental; 5 RCTs)	LOW	(1.16 to 1.52)	1,000	(66 more to 213 more)
Skilled Birth Attendance (SBA)	9450	$\Theta \Theta O O$	RR 1.18	518 per	93 more per 1,000
Assessed with: SMS Intervention	(4 Quasi-Experimental; 5 RCTs)	LOW	(1.06 to 1.31)	1,000	(31 more to 161 more)
Postnatal Care (PNC)	5811	$\Theta \Theta O O$	RR 1.51	412 per	210 more per 1,000
Assessed with: SMS Intervention	(3 Quasi-Experimental; 6 RCTs)	LOW	(1.34 to 1.70)	1,000	(140 more to 288 more)

significant (RR=1.16; 95% CI 1.06, 1.27) with substantial heterogeneity (I²=83.1%, p<0.001) for randomized controlled trials.

Sub-group analysis for skilled birth attendance

Though the pooled effect of short message service was not significant in non-randomized controlled trials (RR=1.22; 95% CI 0.84, 1.78) with considerable heterogeneity (I²=96.9%, p<=0.001), the chance of attending skilled delivery was increased by 1.22 times compared to the control group. The results showed that SMS reminders significantly increased skill birth attendance in low-income countries with moderate heterogeneity (RR=1.25; 95% CI 1.13, 1.39) (I2=77.9%, p=0.000). Though the intervention was not statistically significant in middle-income countries, the intervention group was more likely to have a birth in a health facility compared to the control group (RR=1.12; 95% CI 0.93, 1.34) (I²=92.6%, p=0.000).

Sub-group analysis for postnatal care

After conducting subgroup analysis by income status to address heterogeneity, SMS reminders showed a positive and statistically significant effect on postnatal care visits in middle-income countries (RR=1.46; 95% CI 1.29, 1.66) with moderate heterogeneity (I²=74.2%) and (RR=1.65; 95% CI 1.17, 2.33) with moderate heterogeneity (I²=84.2%) in low-income countries. Similarly, the effect of a text message on PNC was positive and statistically significant (RR=1.39; 95% CI 1.22, 1.59) with moderate heterogeneity (I²=57.5%) in randomized controlled trials and (RR=1.74; 95% CI 1.28, 2.37) with considerable heterogeneity (I²=91.6%) in quasi-experimental studies.

Assessment of publication bias

Egger's test indicated that there is no publication bias for focused antenatal care visits (p-value 0.12), skilled delivery (p-value=0.19), and postnatal care visits (p=0.28). The funnel plot assessments also confirmed the absence of publication bias in the review outcomes.

Certainty of evidence

The Grading of Recommendations, Assessment, Development, and Evaluation approach was used to ascertain the quality of review, categorizing it as high, moderate, low, or very low [63]. In this review, the level of evidence was determined to be low, with limited confidence in the effect estimates due to risk of bias and substantial heterogeneity across outcomes (Table 2).

Discussion

This systematic review and meta-analysis assessed the effect of short message service mobile health intervention on focused antenatal care, skilled birth attendance, and postnatal care visits in low-and middle-income countries. The key findings indicate that SMS interventions significantly improved utilization of antenatal care visits four and above, skilled birth attendance, and postnatal care visit; RR=1.34, 95% CI: 1.12-1.60, RR=1.18, 95% CI: 1.05–1.33, and RR=1.51; 95% CI: 1.34-s1.71, respectively. In a congruent large body of shared evidence reported globally [14, 64-66], our findings indicated that mobile health intervention significantly improved subsequent pregnancy follow-up, skilled birth attendance, and postnatal care utilization. The finding of this review was a bit lower than the effect of text messaging on focused antenatal care visits and skilled birth attendance. The possible justification for variations could be that the inclusion studies from both randomized trials and quasiexperimental. The variations across studies might elucidate various effect estimates and doses of intervention; time spectrum; settings where primary studies were conducted; and nature of the intervention could be possible reasons for discrepancies.

This systematic review and meta-analysis revealed that mobile-based text messaging interventions enhanced maternal health care utilization in low- and middleincome countries. These promising findings might be due to the benefits of mobile-based short message service intervention towards health care receivers, such as adherence to health service utilization, health-seeking behavior development, self-efficacy facilitation, service quality improvement, attendance of health care appointment, social support, improve clients and care providers relationship and health service accessibility [67–69].

Evidence from reviews conducted in related areas complemented our findings that text messaging had a significant effect in encouraging women to receive the recommended antenatal care [14] and maternal health services utilization during antenatal, delivery, and postnatal periods [65, 70, 71] as mobile health is an effective solution to change the health-seeking behavior of women and improve their health status [66, 72], increase the rate of adherence in antenatal and postnatal care visits [72], enhance women to have high frequencies of antenatal care contacts [73], and enable women to retain on pregnancy care follow up pathways [64].

In a similar way, the current review indicated that women in the mobile text messaging intervention group were more likely retained in pregnancy care visits, skilled birth attendance, and postnatal care contacts. Our findings were in agreement with previous studies [45, 71, 74]. The possible explanation might be that the pregnant women who were in the mobile-based intervention group could have the opportunity to receive maternity care appointment reminders [75] and access to health education regarding pregnancy and its related conditions during prenatal, natal, and postnatal periods, which could facilitate women's retention in maternity care uptake [75].

Literature show that short message service reminders had shown a significant result in improving maternal health service programs such as it increases motivation and willingness of women to attend health care appointments, influences service delivery perceptions, create conducive environment to deliver health education during pregnancy, childbirth, and the postnatal period, promotes women to have a recommended antenatal care visits, alert mothers to health care appointments, increases maternal health care service satisfaction, make women to be confident and it reduces anxiety during perinatal, natal and the postnatal periods [37, 48, 51, 53, 58, 62, 72, 76, 77]. Substantial heterogeneities observed in the current review might be due to the reasons geographical variations, study designs, duration of follow-up periods and frequency of text messages of included studies, characteristics of study participants, interventional challenges and approaches used to measure the outcome of interest, and the settings where primary studies were conducted.

In this review, the GRADE Profiler approach was used to assess the certainty of the evidence generated. Accordingly, the quality of evidence is low in focused antenatal care, skilled birth attendance, and postnatal care visits. This might be due to the risk of bias observed in included studies that could downgrade the evidence from yes to no and/or unclear. Likewise, the presence of substantial heterogeneity is also an indication of the lowering of the evidence in the current review. Due to the observed risk, the confidence in using the estimated effect could be limited and imply the implementation of interventional studies to poster more pieces of evidence of mobilebased text messaging interventions on pregnancy care follow up, skilled birth attendance, and postnatal care visits improvement.

Strength and limitation

The current review followed clear and rigorous eligibility criteria based on international guidelines, assessed the certainty of the evidence of included studies, and the increased number of participants could precise the effect size of the review. Excluding gray literature published other than in English was a limitation and worth considering while interpreting the findings of this review.

Conclusions

Short text messaging interventions demonstrated a significant positive effect on attending an optimal ANC, skilled birth attendance, and increasing the rate of postnatal attendance among the intervention groups as compared to the control/comparator groups in LMICs. Therefore, short service message reminders may have a potential role towards achieving improved maternal health care, so that attention should be given by governmental officials and decision-makers in resource-limited settings in considering mobile based health technology as a trend changing tool to achieve local and national targets towards maternal health care improvement.

Implications for practice

Implementing effective technology is an essential component to enhance health care improvement, especially on focused antenatal care visits, skilled birth attendance, and postnatal care visits. It is justifiable to use mobile health intervention to improve maternal health service use in low- and middle-income countries where high maternal mortality and morbidity are recorded. The current systematic review and meta-analysis is pivotal to strengthening public and clinical health evidence-based practice by implementing mobile health technology. Hence, the finding has a broad implication for designing and implementing mobile health technology to promote maternal healthcare utilization in resource-constrained settings where the mobile health penetration is growing rapidly.

Implications for future research

Our review demonstrates sufficient evidence that support short message reminder service is beneficial to improve maternal healthcare utilization. Future research should focus on implementation research on how to scale short message reminder interventions.

Abbreviations

ANC	Antenatal care.
CHWs	Community Health Workers.
CI	Confidence interval.
GRADE	Grading of Recommendations, Assessment, Development and
	Evaluation.
LMICs	Low- and Middle-Income Countries.
MeSH	Medical Subject Headings.
PNC	Postnatal care.
PRISMA	Preferred Reporting Items for Systematic Reviews and
	Meta-Analysis.
RCT	Randomized Controlled Trials.
RR	Relative risk.
SBA	Skilled Birth Attendance.
SMS	Short Message Service.
SRMA	Systematic review and meta-analysis.
WHO	World Health Organization.

Supplementary Information

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Supplementary Material 1
Supplementary Material 2
Supplementary Material 3

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Data availability

The datasets supporting the findings of this article are available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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