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Effects of mHealth on the psychosocial health of pregnant women and mothers: a systematic review

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ABSTRACT

Objective To investigate the roles of mobile health, or mHealth, in the psychosocial health of pregnant women and mothers.

Methods A systematic search was conducted in databases and grey literature including MEDLINE, Web of Science, CINAHL, PsycINFO, PsycARTICLES, Academic Search Complete, SocINDEX, Central Register of Controlled Trials, The Database of Abstracts of Reviews of Effects, NHS Economic Evaluation Database, Health Technology Assessment, UNICEF and WHO databases. Two searches were conducted to include original research articles published in English until 15 November 2021. Several tools were used to assess the risk of bias: revised Cochrane risk of bias tool for randomised trials, Risk of Bias in Non-randomized Studies of Interventions, National Heart, Lung, and Blood Institute quality assessment tool for cohort and cross-sectional studies, Critical Appraisal Skills Program checklist for qualitative studies and Mixed Methods Appraisal Tool for mixed-methods studies. Certainty of evidence was assessed using Grading of Recommendations Assessment, Development and Evaluation approach. Due to the high heterogeneity and variability of the included studies, data synthesis was conducted narratively.

Results 44 studies were included among 11 999 identified articles. Most studies reported mixed findings on the roles of mHealth interventions in the psychosocial health of pregnant women and mothers; mHealth improved self-management, acceptance of pregnancy/motherhood and social support, while mixed results were observed for anxiety and depressive symptoms, perceived stress, mental well-being, coping and self-efficacy. Furthermore, pregnant women and mothers from vulnerable populations benefited from the use of mHealth to improve their psychosocial health.

Conclusions The findings suggest that mHealth has the potential to improve self-management, acceptance of pregnancy/motherhood and social support. mHealth can also be a useful tool to reach vulnerable pregnant women and mothers with barriers to health information and facilitate access to healthcare services. However, the high heterogeneity limited the certainty of evidence of these findings. Therefore, future studies should identify the context under which mHealth could be more effective.

Strengths and limitations of this study

- ► The current study comprehensively reviewed evidence on the roles of mobile health in the psychosocial health of pregnant women and mothers by including multiple domains of psychosocial health outcomes.
- ► The study followed Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols guidelines and Synthesis Without Meta-analysis guidelines.
- ► The high heterogeneity and uncertainty across the studies regarding the setting, study design and outcome measures make it difficult to draw firm conclusions.
- ► Only English databases and articles were included in the review and may have limited the interpretation of the study findings.

INTRODUCTION

Psychosocial health refers to the interrelations of the social environment and psychological health of an individual.[1 2] It is multidimensional and covers areas such as depression, stress, self-sufficiency and social support.[3] During the pregnancy and postpartum period, women are especially vulnerable to facing psychological problems, particularly stress and anxiety disorder with comorbidity of depression.[4–6] According to a study that systematically reviewed the global prevalence of antenatal and postnatal anxiety, 19.4% of pregnant women experienced antenatal anxiety across the three trimesters and 13.7% of mothers experienced postnatal anxiety in the first 6 months following delivery in high-income countries.[7] In low-income and middle-income countries, the prevalence was significantly higher—34.4% and 25.9%, respectively.[7] Experiencing pregnancy and childbirth, especially for the first time, is a drastic transition for women as they grow into the role of becoming a mother.[8] This psychological ambivalence can

cause problems for both pregnant women and mothers. Furthermore, psychosocial health among pregnant women is crucial for their well-being and the health of the infant. Anxiety during pregnancy has been associated with adverse effects on infants' and children's development, including premature birth, hyperactivity, cleft lip and impaired brain development.[9 10]

Using mobile health (mHealth) to deliver pregnancy and postpartum care health services has become more familiar with the advancement of information and communication technologies. mHealth can be delivered through various electronic devices, such as mobile phones, tablet computers, personal digital assistants, and other wearable devices or wireless infrastructure. It is an effective tool to deliver perinatal care interventions because of its cost-effectiveness and scalability, which can benefit both the individual users and the health system.[11 12] Moreover, delivering interventions via mobile devices is beneficial because of their computational power, portability and price, and the tendency of owners to keep them nearby at all times.[13] Due to these advancements and the increasing use of mobile phones and the internet, pregnant women and mothers rely on the internet and mHealth applications (apps) to seek sources of health information and services for self-care and child care for a multitude of reasons, such as their desire to connect with other women going through the same experiences and instant professional consultation and reassurance at little or no cost.[14] mHealth apps can also support pregnant women and mothers to manage their own health, promote a healthy lifestyle, and encourage access to information at any time and place.[15]

Despite the potentials of mHealth, there are also its challenges that remain to be tackled. In low-resource settings, potential barriers to mHealth interventions include the limited level of literacy, access to mobile data, knowledge of technology, cultural beliefs and availability of mobile devices.[16] The culture and cultural beliefs surrounding the women may have restricted opportunities to learn about technology and therefore limited their skills to navigate mobile services. Other barriers include unstable power supply and poor infrastructure and connectivity to internet, especially in rural or conflict-affected areas.[17 18] Furthermore, due to the variability in the quality of mHealth services, pregnant women's and mothers' distrust and worry on the security issues and lack of evidence-based information provided to them could also act as a barrier in mHealth interventions.[19]

A study by Dol *et al* systematically reviewed the impact of mHealth interventions during the perinatal period on maternal psychosocial health outcomes.[20] The findings suggest that mHealth interventions for supporting breastfeeding and newborn care practices that could improve perceived social support and interventions targeting postpartum depression had an impact in reducing postpartum depression. However, the review included only four psychosocial health outcomes: self-efficacy, social support, anxiety and depression. Although they are considered as common psychosocial health outcomes, other aspects of psychosocial health, such as perceived stress and coping that are often experienced during the perinatal period, should also be considered. Moreover, the review included studies with either a quasi-experimental or randomised controlled study design and focused exclusively on high-income countries. They may have missed valuable information on the advantages and disadvantages of mHealth interventions among pregnant women and mothers that could be observed only through observational and qualitative studies. In addition, it makes it challenging to comprehensively understand the global situation of mHealth interventions in the field of maternal and child health when excluding studies from low-income and middle-income countries.

Furthermore, several other systematic reviews and meta-analyses have also investigated the effectiveness of mHealth on pregnancy and postpartum care. The findings showed that using mHealth to support pregnancy and postpartum care was feasible and appropriate. However, the reviews focused on the roles of mHealth in clinical/health outcomes,[14 21] lifestyle behaviours[22] or the specific perinatal period.[23] Some reviews were conducted only among either low/middle-income countries or high-income countries[24–26] or a specific type of mHealth service, such as mobile apps or short messaging services (SMS).[14 15 22 24] Therefore, this study aimed to review evidence from all studies designs conducted in countries of varying income levels to comprehensively investigate the roles of mHealth in the psychosocial health of pregnant women and mothers.

METHODS

Patient and public involvement

Patients and/or the public were not involved in the current systematic review.

Search strategy

The current systematic review initially followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines (see online supplemental file 1).[27] It was written in accordance with the registered review protocol on PROSPERO (no. CRD42020188975) (see online supplemental file 2). Eleven online bibliographical databases were searched: MEDLINE, Web of Science, CINAHL, PsycINFO, PsycARTICLES, Academic Search Complete, SocINDEX, Cochrane Central Register of Controlled Trials, The Database of Abstracts of Reviews of Effects, NHS Economic Evaluation Database and the Health Technology Assessment. Grey literature from the UNICEF and WHO databases was also searched. The first two authors (JLS and RRC) developed the search strategy in MEDLINE using a combination of Medical Subject Headings terms and keywords (see online supplemental file 3) and applied no date restriction. The search strategy was improved after using article identification numbers to maximise

the sensitivity and specificity for identifying relevant articles. The search was conducted at two time points where the initial search was conducted on 31 May 2020 and an updated search on 15 November 2021. Included in the search were original research articles written in English published on or before 15 November 2021. The reference lists of eligible articles were manually searched to screen for additional studies.

Eligibility criteria

The studies were considered eligible if they described or delivered an mHealth intervention (eg, through mobile apps or SMS) targeted to improve at least one aspect of psychosocial health (eg, depression, stress, anxiety, social support, self-efficacy) among pregnant women and mothers of infants and children aged 0–5 years. Exclusion criteria were mHealth interventions that (1) were not mobile or tablet based and (2) did not focus on psychosocial health outcomes. We did not include eHealth interventions, such as telemedicine and telehealth interventions that were not exclusively delivered via portable and handheld devices. For example, interventions using telephone for delivering interventions were excluded for the reason that telephones could indicate either cell phones or landline telephones, or both. Eligible study designs included randomised controlled trials (RCTs), quasi-experimental, cohort, observational, cross-sectional and other comparative studies, as well as case studies and evaluation reports. Letters, editorials, reviews, conference abstracts and posters, dissertations and books were excluded. All eligible studies found on the databases were exported to the reference-managing software EndNote to facilitate the study selection process and screen for duplicate records.

Data extraction

After removing the duplicates, the first two authors (JLS and RRC) screened the titles and abstracts of identified studies for relevance. Next, full-text copies of papers were assessed for eligibility by three authors (JLS, RRC and MK), with any disagreements resolved through discussions; if a consensus was not reached, a fourth author was brought in for discussion at each stage (AS or MJ). Finally, the original three authors (JLS, RRC and MK) extracted data using a standardised extraction form following the Population, Intervention, Comparison and Outcome format on Microsoft Excel to ensure the capture of all necessary information, including title, citation (author, publication, year and source), study area, study objectives, study design, study setting, study population, sample size, types of mHealth interventions, comparison group and summary of reported outcomes.

Risk of bias assessment and certainty of evidence

After data extraction, three authors (JLS, RRC and MK) independently assessed the risk of bias and methodological rigour of the included studies. Revised Cochrane risk of bias tool for randomised trials (RoB 2.0) developed by Cochrane Collaboration for RCTs[28] was used to assess RCT-designed studies. The RoB 2.0 tool comprises a series of signalling questions that elicited information on the features of RCTs relevant to assessing the risk of bias. Once the signalling questions were answered, the RCTs were judged and assigned as *low*, *some concerns* or *high risk of bias*. For non-RCTs, four of the following tools were used for the risk of bias assessment: Risk of Bias in Non-randomized Studies of Interventions for non-randomised studies of intervention,[29] National Heart, Lung, and Blood Institute quality assessment tool for cohort and cross-sectional studies,[30] Critical Appraisal Skills Program checklist for qualitative studies[31] and Mixed Methods Appraisal Tool for mixed-methods studies.[32] Any disagreements were settled through discussion to arrive at a consensus among the reviewers. The certainty of the evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[33]

Data synthesis

Due to the broad inclusion criteria, high heterogeneity was observed among the included studies regarding the study designs, measurement tools, statistical analyses and outcomes. Therefore, the current review did not pursue a meta-analysis. Instead, we used Synthesis Without Meta-analysis reporting guidelines (see online supplemental file 4) to conduct data synthesis.[34] A detailed examination was conducted on the numerical and textual summary findings of the included studies. Findings were then synthesised narratively and the studies were grouped according to psychosocial health outcomes. Summary of findings was presented in a table including psychosocial health outcomes, types of mHealth services, total number the outcome was reported, and whether the finding had no effect, mixed effect, or positive effect. Conclusions were reached in each study for the effects of mHealth intervention. We considered an outcome to have a 'positive effect' if the mHealth intervention showed a significant effect (eg, improvement in anxiety/depressive symptoms, increase in mental well-being/self-efficacy) and narrative findings indicated positive results (ie, benefits of using mHealth services). An outcome was considered to have a 'mixed effect' when it showed positive changes but were not necessarily statistically significant (eg, Multidimensional Scale of Perceived Social Support mean score: pre-intervention 23.3, post-intervention 25.0, p=0.80). When there was no significant effect and narrative findings reported negative results, the outcome was considered as 'no effect'.

RESULTS

Study selection

A total of 11 999 records were identified from all the databases, grey literature and through hand-search at two time points. After removing the duplicates, 11 120 records were retained. Of these, 135 articles were

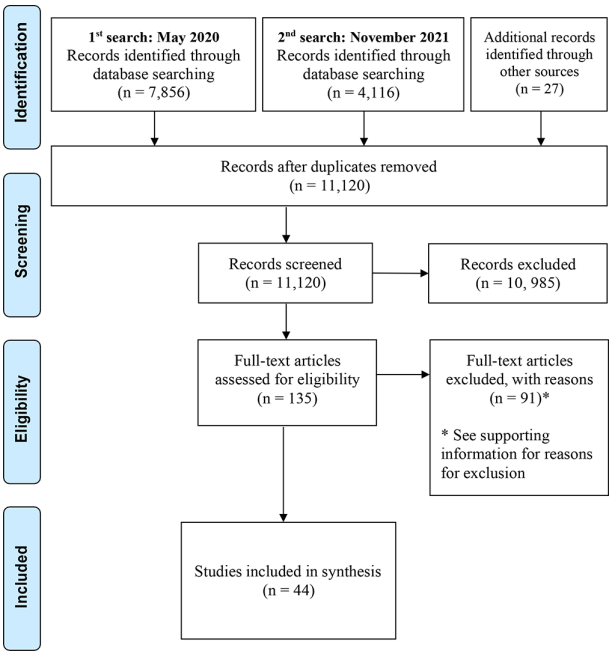

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow chart.

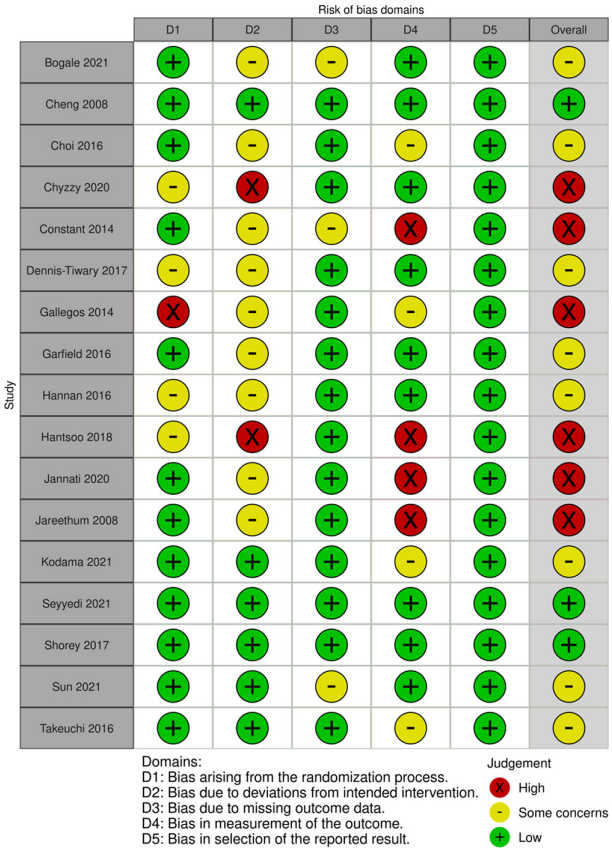

Figure 2 Risk of bias summary for randomised controlled trials based on authors' judgements (*low, some concerns, high*) about each risk of bias item of the included study.

identified as potential studies for inclusion. The reviewers then assessed the full text of the identified studies and excluded 91 articles (see online supplemental file 5). Finally, a total of 44 articles were included in the final data synthesis. The screening process is depicted in the PRISMA flow diagram (figure 1).

Risk of bias and methodological rigour of included studies

The risk of bias and the methodological rigour varied across the included studies. Forty-four studies were eligible for the assessment of methodological quality. Out of 44 studies, 17 studies were RCTs[35–51] and their risk of bias assessment is depicted in figure 2.[52] Six out of 17 RCTs were assessed as having a high overall risk of bias due to bias arising from randomisation process, deviations from the intended intervention and unclear measurement outcome.[38 39 41 44–46] Most of the studies were assessed as having some concerns for mainly not being able to blind the participants/outcome assessors due to the nature of the intervention conducted in the studies.[35 37 40 42 43 47 50 51] The remaining three studies were considered low risk of bias.[36 48 49]

Online supplemental file 6 shows the results of the risk of bias assessment for the non-RCTs. Among the 11 quasi-experimental studies, 4 had a serious risk of bias,[53–56] 4 had a moderate risk[57–60] and 3 were assessed as low risk.[61–63] The two observational studies did not have clear information on confounding variables and blinding of the outcome assessors.[64 65] A few studies among the seven qualitative studies[66–72] lacked information on the positionality of researchers and potential bias may have risen due to the recruitment strategy. Seven mixed-methods study[73–79] also did not provide any information on confounding. Furthermore, online supplemental file 7 shows the results of the GRADE certainty of evidence assessment.

Study characteristics

The summary of study characteristics is presented in online supplemental file 8.

Study countries

The World Bank income level classification as of June 2021 was incorporated to categorise the countries according to their income level.[80] Most of the included studies were conducted in high-income countries (31 of 44; 70%), including the US (n=15), Australia (n=3), Japan (n=3), UK (n=2), Singapore (n=1), Taiwan (n=1), Israel (n=1), Norway (n=1), Korea (n=1), Italy (n=1), Canada (n=1) and Germany (n=1). Six studies (6 of 44; 14%) were conducted in upper middle-income countries: South Africa (n=1), Turkey (n=1), Thailand (n=1), China (n=1), Brazil (n=1) and Dominican Republic (n=1). Six studies (6 of 44; 14%) were conducted in lower middle-income countries: Iran (n=2), Kenya (n=1), Zambia (n=1), India (n=1) and Palestine (n=1). Only one study (1 of 44; 2%) was conducted in a low-income country, Uganda (n=1).

Study participants

A slight majority of the studies recruited pregnant women (26 of 44; 59%) and the recruited population varied from generally healthy pregnant women to at-risk pregnant

women. Other studies recruited mothers (14 of 44; 32%), including adolescent mothers and mothers who screened positive for perinatal depression. Few studies recruited both pregnant women and mothers (4 of 44; 9%). The inclusion criteria for the gestational age of pregnant women and the timeline of the perinatal period varied across studies.

Types of mHealth services and interventions

There were differences in the mHealth technologies used to facilitate interventions. Twenty-six studies used mobile apps (26 of 44; 59%) while 11 used SMS (11 of 44; 25%). Two studies used both SMS and voice calling on mobile phones (2 of 44; 5%). A few of the mHealth interventions were delivered using other mHealth services, such as instant messaging services (eg, WhatsApp Messenger) (2 of 44; 5%), e-learning service via cellphone internet (1 of 44; 2%), smartphone website (1 of 44; 2%) and mobile-based interactive voice response system (1 of 44; 2%).

The types of mHealth interventions were widely diverse. The interventions were categorised into 10 types incorporating the mHealth and Information and Communications Technology (ICT) Framework[81] and its adaptation.[21] Studies were counted in more than one category type if the mHealth intervention included multiple functions. The 10 types include health education or promotion (19 of 44; 43%), communication and support (15 of 44; 34%), psychoeducation or therapy (11 of 44; 25%), self-monitoring system (6 of 44; 14%), reminders (4 of 44; 9%), decision guideline (3 of 44; 7%), behaviour change (3 of 44; 7%), laboratory results (1 of 44; 2%), registries/vital events tracking (1 of 44; 2%) and electronic health records (1 of 44; 2%).

Study outcomes

In total, 77 comparisons were made across the 44 included studies that examined the roles of mHealth interventions in psychosocial health outcomes among pregnant women

Table 1 Summary of the effect of mHealth interventions on psychosocial health outcomes of pregnant women and mothers

Psychosocial health outcomes	Types of mHealth services (n)	No effect, (n)	Mixed effect, (n)	Positive effect, n (%)	Total number outcome reported, (n)
Anxiety symptoms (35 36 39 40 44 46 47 50 54 61–63 73)	SMS (6) App (7)	3	6	4 (31)	13
Depressive symptoms (37 44 45 49 50 54–56 60 61 63 70)	SMS (1) App (9) IVRS (1) IM (1)	3	4	5 (42)	12
Perceived stress (39 40 43 50 55 59 60)	SMS (3) App (4)	2	2	3 (43)	7
Mental well-being (55 64)	SMS (1) App (1)	1	0	1 (50)	2
Coping (41 59)	SMS (1) App (1)	1	1	0 (0)	2
Self-efficacy (37 41 42 46 48 49 51 53 54 57 58 64 66 69 71 78)	SMS (5) App (9) e-learning (1) Smartphone website (1)	7	2	7 (41)	16
Self-management (44 71 72 74 77)	SMS (1) App (4)	0	0	5 (100)	5
Acceptance (53 65 69)	SMS (0) App (3)	0	0	3 (100)	3
Social support from partners (49 65 68 75)	SMS (1) App (3)	0	0	4 (100)	4
Social support from healthcare providers (55 72 76)	SMS (1) App (2)	0	0	3 (100)	3
Social support from other sources (37 38 41 43 56 67 69 74 78 79)	SMS (3) App (3) SMS/voice call (2) IM (2)	1	3	6 (71)	10

app, mobile application; IM, instant messaging service; IVRS, interactive voice response system; mHealth, mobile health; SMS, short messaging service.

and mothers (see table 1). Some studies assessed multiple psychosocial health outcomes. Therefore, results are reported based on the number of comparisons made for each outcome.

Anxiety symptoms

Thirteen studies assessed the roles of mHealth in anxiety symptoms among pregnant women and mothers.[35 36 39 40 44 46 47 50 54 61–63 73] Four studies found positive effects, six studies had mixed findings and three studies found no significant effect (GRADE certainty of evidence: low). Jareethum *et al* conducted an RCT study in Thailand which sent two SMS messages per week containing information and warnings on abnormal symptoms appropriate to the women's gestational age.[46] As a result, pregnant women who received an SMS had lower anxiety levels during the antenatal and perinatal period than those who did not receive any SMS; however, it was only significant during the antenatal period (M=2.78 vs 4.93, p=0.002). Another RCT study conducted by Constant *et al* in South Africa sent 13 automated text messages with reminders to take medication and information about side effects to women undergoing medical abortion.[40] Between baseline and follow-up, women who received the messages reported a decrease in their Hospital Anxiety and Depression Scale (HADS) score compared to the control group (M=11.40 vs 7.80, p=0.013).[39]

A pilot RCT conducted by Dennis-Tiwary *et al* in the US investigated the effectiveness of an attention bias modification training app to reduce pregnancy threat, anxiety and stress, and did not find any significant changes in the anxiety domain of Depression, Anxiety and Stress Scale between intervention (M=3.20, SD=3.00) and control group (M=2.07, SD=3.60) at 1-month follow-up.[40] They also did not find any change in the Hamilton Anxiety Scale scores between intervention (M=9.20, SD=6.71) and control groups (M=6.93, SD=9.10). Similarly, Baumel *et al* conducted a quasi-experimental study to examine the effectiveness of an app that provided self-help tools and emotional support delivered by trained volunteers to pregnant women diagnosed with postpartum depression. They found no significant changes in the Beck Anxiety Inventory (BAI) scores between baseline (M=20.47, SD=13.15) and at 1-month follow-up (M=16.65, SD=7.52, p=0.11).[61]

Depressive symptoms

Twelve studies assessed the roles of mHealth in self-reported levels of depressive symptoms.[37 44 45 49 50 54–56 60 61 63 70] Five studies found a positive effect, four studies had mixed findings and three studies found no significant effect (GRADE certainty of evidence: low). Song *et al* conducted a quasi-experimental study to test the effectiveness of a two-way text-messaging system to distribute health-related information to pregnant women with low socioeconomic status living in the US. They reported a reduction in the Center for Epidemiological Studies Scale score after the intervention (t (19)=2.991, p<0.01).[55]

Mixed results were reported among studies assessing the roles of mHealth in improving depressive symptoms using the Edinburgh Postnatal Depression Scale (EPDS). In Singapore, Shorey *et al* examined the effectiveness of a psychoeducational app to improve parenting outcomes. Parents in the intervention group reported no significant difference in the EPDS scores compared with the control group (Mean difference =7.00 vs 7.60).[49] Similarly, Dalton *et al* reported no changes in EPDS scores between intervention and control group (detailed results of analyses not reported) and when comparing pre-intervention and post-intervention (M=6.08 vs 5.66, p=0.635).[54] However, Baumel *et al* reported significant decline in EPDS scores after conducting an intent-to-treat analysis from baseline (M=17.32, SD=5.96) and after 30-day follow-up (M=13.53, SD=4.65, p=0.005). Beck Depression Inventory II scores also significantly improved (M=26.11, SD=13.34; M=19.18, SD=9.23, p=0.01).[61]

Perceived stress

Perceived stress was assessed in seven studies.[39 40 43 50 55 59 60] Three studies found positive effects, two studies had mixed findings and two studies found no significant effect (GRADE certainty of evidence: very low). Constant *et al* reported lower scores on the Impact of Event Scale-Revised, which indicated lower levels of emotional stress (β=−1.8, 95% CI=−3.2 to −0.4, p=0.015) among the intervention group than those in the control group when adjusted for baseline anxiety.[39] Furthermore, Jallo *et al* conducted a quasi-experimental study to investigate the effectiveness of a stress coping app to reduce stress in a sample of pregnant women staying in an obstetrical antepartum high-risk unit. They reported an immediate drop in their Visual Analog Stress Scale score when comparing before and after listening to the app with guided imagery audio (M=44.13 vs 22.04, p<0.0001). However, no differences were found when comparing Perceived Stress Scale scores between pre-intervention and post-intervention (median score=22.0 vs 22.0, p=0.750).[59]

Mental well-being

Two studies assessed mental well-being.[55 64] One study found a positive effect, while one study did not find any significant effect (GRADE certainty of evidence: very low). Song *et al* reported improvement in RAND Mental Health Inventory scores between pre-intervention and post-intervention (t (19)=−4.241, p<0.001).[55] However, Deave *et al* reported no significant difference in Warwick-Edinburgh Mental Well-Being Scale score between app and non-app users (median score=54.5 vs 55, p=0.284).[64]

Coping

Coping outcomes were assessed in two studies; one study reported mixed findings, while one study reported no significant effect (GRADE certainty of evidence: very low).[41 59] Gallegos *et al* assessed the role of mHealth in coping among breastfeeding Australian mothers. The automated text message asked the mothers about

their breastfeeding experience, and if their responses expressed some level of distress, a breastfeeding counsellor contacted the woman. As a result, mothers expressed higher levels of active coping (p=0.01) and lower levels of emotion-focused coping (p=0.001) on the Ways of Coping Checklist.[41] However, no significant change in the Coping Self-Efficacy Scale scores was reported between pre-intervention and post-intervention in the study conducted by Jallo *et al* (median score=148.5 vs 155, p=0.129).[59]

Self-efficacy

Self-efficacy outcomes were assessed in 16 studies.[37 41 42 46 48 49 51 53 54 57 58 64 66 69 71 78] Seven studies found positive effects, two studies had mixed findings and seven studies found no significant effect (GRADE certainty of evidence: low). Positive findings were often mentioned during qualitative interviews. Adolescent mothers in the US described a sense of fulfilment, competence and confidence from interacting with text messages, which validated their motherhood role.[66] A formula feeding mother in Australia also described a sense of enhanced confidence by using the app.[69]

However, some quantitative studies reported no change in self-efficacy. Deave *et al* did not report any change in the Tool to Measure Parenting Self-Efficacy score between baseline and 3-month follow-up (adjusted OR=1.12, 95% CI=0.59 to 2.13, p=0.730).[64] Moreover, breastfeeding mothers reported no changes in the Breastfeeding Self-Efficacy Scale score between baseline and 2-month follow-up (M=4.00 vs 4.15) and no significant differences in change over time between intervention and control group (p=0.25).[41]

Self-management

Self-management was assessed in five studies[44 71 72 74 77] of which all reported positive findings (GRADE certainty of evidence: low). Hantsoo *et al* reported that the intervention group rated their ability to manage their health significantly better than the control group (F=4.03, df=4 and 49, p=0.007) at 8-week follow-up.[44] Blackwell *et al* conducted a mixed-methods study in the US and reported that the proportion of minority immigrant pregnant women likely to strongly agree that the text messages allowed them to have greater control over their prenatal healthcare increased from pre-intervention to post-intervention (28.6% vs 51%, p=0.02).[74] In Norway, women with gestational diabetes mellitus who used an app described an increase in feeling of control to manage their own health: 'I felt that to record [information] in the app was very important…. In that way the app was very important because it gave me a feeling of control' (p. 105).[71]

Acceptance

Three studies assessed positive outcomes of acceptance regarding pregnancy and motherhood (GRADE certainty of evidence: very low).[53 65 69] In Turkey, Özkan Şat *et al* reported in the mean subscale score of Prenatal Self Evaluation Questionnaire (PSEQ) that pregnant women who used apps had a better adaptation level to pregnancy than those who did not use any apps (M=18.99 vs 20.86, p=0.005).[65] Litterbach *et al* reported that the app reassured infant-feeding mothers of their feeding decisions and help accept that they were doing the 'right thing' for their baby.[69]

Social support from partners

Partner social support outcomes were assessed in four studies, all presenting positive findings (GRADE certainty of evidence: very low).[49 65 68 75] In Kenya, Harrington *et al* conducted a qualitative study and found that pregnant women and mothers who received text messages on family planning felt improved communication with their partners, which allowed them to start a conversation about family planning.[68] Shorey *et al* reported that parents showed a significant difference in the Perceived Social Support for Parenting score from their spouses compared with the control group who did not use the app (mean difference=27.08, 95% CI=20.94 to 34.80, p<0.001).[49] Pregnant women in Turkey who used apps reported lower mean subscale score for the relationship with their husband on the PSEQ compared with those who did not use apps (M=13.28 vs 15.69, p=0.001).[65]

Social support from healthcare providers

Three studies examined the roles of mHealth intervention in providing social support from healthcare providers (GRADE certainty of evidence: very low).[55 72 76] Sixty per cent of low-income pregnant women reported that the two-way SMS encouraged them to put forward more questions to discuss with their healthcare providers and they felt more prepared to see their healthcare provider.[55] Pregnant women with diabetes who received informational, motivation and logistical messages via SMS reported that they felt more connected with their healthcare providers.[72]

Social support from other sources

Ten studies reported on the roles of mHealth in social support from other sources (eg, family, friends and online community).[37 38 41 43 56 67 69 74 78 79] Six studies found a positive effect, while three reported mixed findings and one study reported no significant effect (GRADE certainty of evidence: low). Litterbach *et al* found that the app gave support to infant-feeding mothers during times of need, such as when they were questioning their milk supply and when it was impossible to seek advice from others (eg, in the middle of the night). Mothers who were formula feeding or mixed feeding indicated that the programme allowed them to receive support without fear of judgement regarding their decision to use formula.[69] Moreover, Connor *et al* reported that the app allowed pregnant women and mothers to receive support from the online community through message boards when they could not rely on friends or family.[67]

DISCUSSION

Findings suggest that mHealth interventions had a positive effect on improving self-management of health and acceptance of pregnancy and motherhood. However, it had mixed effects in anxiety and depressive symptoms, perceived stress, mental well-being, coping, and self-efficacy among pregnant women and mothers. Moreover, mHealth interventions had largely a positive effect on social support from partners, healthcare providers and other sources. Pregnant women and mothers from a socially disadvantaged background, having pre-existing health conditions and behaviours, or dealing with sensitive perinatal issues benefited especially from the mHealth interventions.

mHealth interventions improved self-management and acceptance of pregnancy and motherhood among pregnant women and mothers. This finding is new as Dol *et al*[20] did not report the roles of mHealth interventions in neither outcome. The intervention populations included: pregnant women who are minority immigrants,[74] with low socioeconomic status and having depressive symptoms,[44] and postpartum women diagnosed with gestational diabetes mellitus.[71] These findings suggest that mHealth interventions has the potential to improve self-management of health among pregnant women and mothers who may have pre-existing health conditions and living in resource-limited settings. mHealth can provide ease of access to health education materials and self-monitoring systems where the users can track their own behaviour or health data while also being supported by healthcare providers. Furthermore, three studies reported on the positive roles of mHealth interventions in improving acceptance of pregnancy and motherhood.[53 65 69] In Australia, infant-feeding mothers reported that the mHealth intervention provided reassurance to their feeding decisions.[69] Infant-feeding mothers could often face difficulties in deciding feeding practices and feel anxious if they made the right decision, especially if they are first-time mothers. mHealth services can potentially provide both informational and emotional reassurance during such decisions.

The use of mHealth largely improved social support from partners, healthcare providers and other sources. This finding is new because Dol *et al*[20] reported that mHealth interventions showed benefits to perceived social support but did not specifically address the source of the social support. A two-way text messaging system in Kenya that provided family planning education to pregnant/postpartum women and their partners improved communication and support between them.[68] When family planning education messages are sent directly to men, it is easier for women to communicate effectively with their partners about contraception and partners may gain a better understanding from such communication, leading to more positive attitudes and increased use of contraception.[82] Moreover, although the service is not provided in person, mHealth could provide pregnant women and mothers opportunity to use online forums and join groups where they can share and learn from others' experiences.

mHealth can act as a support system for vulnerable pregnant women and mothers. In South Africa, women undergoing the home phase of medical abortion who received text messages providing timely information on managing their abortion symptoms were more likely to report improved anxiety symptoms than those who did not.[39] The messages guided the women through the medical abortion process using a supportive tone without overtly addressing negative emotions. Mothers in Australia who received tailored SMS messages about infant feeding reported that the messages provided support without judgement about their decision to use formula.[69] The mothers were reluctant to discuss formula use with healthcare providers because of the fear of being judged. Young women encountering decisions about abortion and infant feeding are at risk of social judgements and discrimination.[83 84] Fear of judgement could prevent women from openly discussing their health concerns and delay help-seeking during the perinatal period.[85] Findings suggest that mHealth interventions can provide support to pregnant women and mothers who may feel hesitant to seek support in person due to the fear of being judged. The flexible nature of mHealth interventions enables accommodating users' specific needs and tailoring the programme to their preferences (eg, cultural, literacy, language preferences). This makes it particularly useful for vulnerable populations who often have specific physical and mental health needs.[86] The findings add to the existing literature that mHealth interventions reduce access barriers among populations vulnerable to health disparities.[87–89]

The current systematic review has several limitations. First, high heterogeneity of outcomes was observed among the included studies due to the broad inclusion criteria and search strategy, making it difficult to conduct a meta-analysis. Studies had a wide range of study designs, sample sizes (n=4 to n=2782) and outcome measures (eg, anxiety was assessed with Generalized Anxiety Disorder-7, BAI, HADS), which made the comparison of results difficult. Moreover, positive effects may have been emphasised in qualitative studies and studies with small sample sizes may have reported larger effect sizes.[14] Thus, the findings should be interpreted cautiously. Second, environmental factors, such as neighbourhood environment, were not included in our review scope, which could have been important factors affecting the psychosocial health of the given population.[90] Third, the current review exclusively searched for articles in English and this may have limited the number of articles identified during our search. Fourth, non-binary terms were not included as search terms and this may have excluded non-binary people from our study. Lastly, the interaction between individual domains of psychosocial health outcomes was not assessed in the current review as it was beyond the scope of the study. Some findings may be a result of the interaction of the outcomes and not necessarily the effect

of the mHealth intervention. Despite those limitations, this review addresses research gaps concerning mHealth and pregnancy and postpartum care.

Although the advantages of mHealth interventions have been highlighted, some studies discussed their limitations. Pregnant mothers and women who participated in the mHealth interventions may have been actively seeking help[44 46] and may have come from a well-resourced environment with higher socioeconomic status.[39 49] Despite the advancement of technology, the digital divide and digital literacy barriers might have prevented socially disadvantaged pregnant women and mothers from participating in the intervention. Moreover, technical difficulties were also reported in a few studies. Such difficulties included operating system limitations (eg, Google's Android or Apple's iOS),[54] app failure, which reduced engagement,[69] and answerability of the system, which created frustration for participants.[55] Concerns for data security were also expressed.[67] These technical difficulties could have negatively affected the use of mHealth services,[91] thus affecting health outcomes. Future studies should consider preventing such difficulties for an effective mHealth intervention.

CONCLUSIONS

mHealth plays a positive role in improving self-management and acceptance of pregnancy and motherhood. It also has the potential to provide social support from partners, healthcare providers and other sources. mHealth interventions were especially crucial in improving the psychosocial health among vulnerable pregnant women and mothers. However, some studies reported mixed findings on the effectiveness of mHealth on psychosocial health outcomes. The high heterogeneity and uncertainty across the studies regarding the setting, study design and outcome measures make it difficult to draw firm conclusions; thus, these findings should be interpreted with caution. Future studies using mHealth interventions should consider investigating the context under which mHealth could be more effective while considering its technical limitations in improving psychosocial health among pregnant women and mothers. Furthermore, future studies should also consider the psychosocial health of men transitioning into fatherhood and of same-sex and transgender partners.

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PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Pages 3-5
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Pages 6-7
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 5; Supplementary File 3
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Pages 6-7
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 7
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 7
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Page 7
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Pages 6-7

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Pages 6-7
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Supplementary File 5
Study characteristics	17	Cite each included study and present its characteristics.	Supplementary File 8
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 8; Fig 2; Supplementary File 6
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Page 8-14; Supplementary File 8
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 8-14
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Table 1
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Page 8-9; Supplementary File 8
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Page 8
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Supplementary File 7
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Pages 15-16
	23b	Discuss any limitations of the evidence included in the review.	Page 17
	23c	Discuss any limitations of the review processes used.	Page 17
	23d	Discuss implications of the results for practice, policy, and future research.	Page 17
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Supplementary File 2
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 18
Competing	26	Declare any competing interests of review authors.	Page 18

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
interests			
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 18

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

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PROSPERO
International prospective register of systematic reviews

To enable PROSPERO to focus on COVID-19 submissions, this registration record has undergone basic automated checks for eligibility and is published exactly as submitted. PROSPERO has never provided peer review, and usual checking by the PROSPERO team does not endorse content. Therefore, automatically published records should be treated as any other PROSPERO registration. Further detail is provided here.

Citation

Jennifer Lisa Sakamoto, Rogie Royce Carandang, Madhu Kharel, Akira Shibanuma, Ekaterina Yarotskaya, Milana Basargina, Masamine Jimba. Roles of mHealth interventions for maternal, newborn and child health in psychosocial and behavior change: A systematic review. PROSPERO 2020 CRD42020188975 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020188975

Review question

What are the roles of maternal, newborn, and child health-related mobile health (mHealth) interventions in psychosocial and behavior change among pregnant women, mothers, fathers, and health workers?

Searches

We will search the following electronic databases: PubMed/MEDLINE, Web of Science, CINAHL, PsycINFO, PsycARTICLES, Academic Search Complete, SocINDEX, Cochrane Central Register of Controlled Trials, DARE, NHS EED, HTA, and Grey Literature (WHO, CDC, ECDC, JICA, UNAIDS, among others). Additional studies will be hand searched from the reference lists of articles. We will include all published papers in the English language up till May 2020.

Our search strategy will combine both Medical Subject Headings (MeSH) terms and free text terms.

Search strategy

https://www.crd.york.ac.uk/PROSPEROFILES/188975_STRATEGY_20200528.pdf

Types of study to be included

Original research articles in all study designs such as randomized controlled trial (RCT), quasi-experimental, cohort, observational, cross-sectional, and other comparative studies as well as multiple case studies and evaluation reports will be included in the study. Case studies, letters, editorials, reviews, conference abstracts, and books will not be included.

Condition or domain being studied

Mobile health (mHealth) interventions for maternal, newborn, and child health (MNCH) are increasing worldwide. While there is evidence that these interventions improved MNCH outcomes, research has been restricted to pilot and small studies with limited generalizability. Moreover, little is known about the psychosocial and behavioral impact of mHealth interventions on different targeted groups.

The current study will examine the roles and utilization of mHealth to improve psychosocial and behavioral health among pregnant women, mothers, fathers, and health workers.

Participants/population

Participants will include pregnant women, mothers and fathers of children 0-5 years, and health workers.

Intervention(s), exposure(s)

The intervention of interest is mHealth interventions.

Inclusion criteria:

• The intervention should be mobile or tablet-based interventions, such as mobile applications (apps), games, short message service (SMS), among others.

• The intervention should be intended to improve at least one aspect of the psychosocial and behavioral

health of pregnant women, mothers and fathers of children 0-5 years of age, and health workers.

Exclusion criteria:

• Interventions that are not mobile or tablet-based, such as websites or social networking services (SNS).

• Interventions that involve telemedicine, telepsychiatry, and telehealth, such as emails, telephone, among others.

• Interventions that do not focus on psychosocial and behavioral outcomes.

Comparator(s)/control
The comparator will be participants who received standard care and did not receive any type of mHealth interventions.

Context
We will consider all health settings.

Main outcome(s)
Changes in psychosocial health (such as mitigation of depressive symptoms, anxiety symptoms or increase in life satisfaction, quality of life)

Changes in high-risk health behaviors (such as smoking and alcohol cessation, improvement in nutritional intake and physical exercise)

Measures of effect

Not applicable

Additional outcome(s)
Not applicable

Measures of effect

Not applicable

Data extraction (selection and coding)
Two review authors will be involved in the process of literature search, article screening, and data extraction. The databases will be independently searched using the aforementioned search strategy and identify the studies by title and abstract screening. The team will review the list of articles for eligibility. We will discuss disagreements on the eligibility of study until a consensus is reached. If required, we will consult our supervisor for the final decision.

The data to be extracted include:

title, citation (author, publication year, source), study location, objectives, study design, study setting, study population, sample size, types of mHealth interventions, comparison group, and reported outcomes

Risk of bias (quality) assessment
The quality of studies included in the research will be assessed using the risk of bias tools from the Cochrane Handbook. GRADE approach will be used to assess the certainty of the evidence of the studies. For qualitative studies, we will use the Critical Appraisal Skill Programme (CASP) tool.

Strategy for data synthesis
We will follow the PRISMA checklist for appropriate data synthesis. We will construct a PRISMA flowchart to show the search strategy results at each stage of review. We will conduct a descriptive analysis of individual studies according to the type of intervention, sample size, duration, outcome, quality, and risk of bias. We will analyze the effectiveness of the intervention, based on the nature of reported outcomes. If we find enough studies with quality data, we will conduct a meta-analysis to examine the effectiveness of mHealth interventions in psychosocial and behavior change among pregnant women, mothers, fathers, and health

workers.

Analysis of subgroups or subsets
None

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http://www.ich.m.u-tokyo.ac.jp/en/index.html

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Professor Masamine Jimba. Department of Community and Global Health, Graduate School of Medicine, The University of Tokyo, Tokyo

Type and method of review
Meta-analysis, Systematic review

Anticipated or actual start date
01 June 2020

Anticipated completion date
30 December 2020

Funding sources/sponsors
Department of Community and Global Health, Graduate School of Medicine, The University of Tokyo, Japan

Conflicts of interest

Language
English

Country
Japan, Russian Federation

Stage of review
Review Ongoing

Subject index terms status
Subject indexing assigned by CRD

Subject index terms
MeSH headings have not been applied to this record

Date of registration in PROSPERO

NIHR | National Institute for Health Research

PROSPERO
International prospective register of systematic reviews

05 July 2020

Date of first submission
28 May 2020

Stage of review at time of this submission

Stage	Started	Completed
Preliminary searches	Yes	No
Piloting of the study selection process	Yes	No
Formal screening of search results against eligibility criteria	No	No
Data extraction	No	No
Risk of bias (quality) assessment	No	No
Data analysis	No	No

The record owner confirms that the information they have supplied for this submission is accurate and complete and they understand that deliberate provision of inaccurate information or omission of data may be construed as scientific misconduct.
The record owner confirms that they will update the status of the review when it is completed and will add publication details in due course.

Versions
05 July 2020

Supplementary File 3. Search strategy

mothers OR pregnant women

mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH

maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health

psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being

behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle

PubMed/MEDLINE

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

Web of Science

mothers OR pregnant women (Topic) and mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH (Topic) and maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health (Topic) and psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being (Topic) and behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle (Topic) and Articles (Document Types) and English (Languages)

CINAHL

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

Academic Search Complete

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

PsycINFO

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

PsycArticles: 213

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial

OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

SocINDEX: 324

"TX (mothers OR pregnant women) AND TX (mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH) AND TX (maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health) AND TX (psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being) AND TX (behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

Cochrane: 109

mothers OR pregnant women in All Text AND mHealth OR m-health OR mhealth OR mobile health OR mobile app OR mobile applications OR mobile technology OR mobile phone OR smartphone OR smartphone app OR smartphone application OR cell phone OR iPhone OR iPad OR phone OR SMS OR MMS OR text messaging OR voice messaging OR voicemail OR tablet computer OR handheld computers OR personal digital assistant OR PDA OR smart watch OR digital health OR e-MCH OR digital MCH in All Text AND maternal health OR pregnancy OR childbirth OR obstetric delivery OR antenatal OR prenatal care OR antepartum OR postnatal care OR postpartum period OR perinatal care OR motherhood OR reproductive health OR family planning services OR newborn health OR neonate health OR infant health OR child health OR children health in All Text AND psychosocial OR psychological OR mental health OR social OR social networking OR social capital OR social participation OR sociological OR sociocultural OR communication OR relations OR emotional OR welfare OR wellbeing OR well-being in All Text AND behavioral OR behavior OR health-seeking OR information seeking behavior OR patient acceptance of health care OR self care OR self-management OR self-efficacy OR attitude OR conduct OR manner OR demeanor OR disease management OR nature OR performance OR actions OR approach OR practice OR lifestyle)

First search period: until May 31, 2020

Database	Initial search	After removing duplicates
PubMed/MEDLINE	696	682
Web of Science	63	63
CINAHL	3,059	3,064
Academic Search Complete	1,328	843
PsycArticles	683	683
PsycINFO	4	2
SocINDEX	1,992	1,857
CENTRAL	4	3
TOTAL	**7,856**	**7,224**

Number of duplicates: 632

Second search period: June 1, 2020 – November 15, 2021

Database	Initial search	After removing duplicates
PubMed/MEDLINE	587	585
Web of Science	315	315
CINAHL	54	50
Academic Search Complete	2,502	2,444
PsycArticles	213	211
PsycINFO	12	6
SocINDEX	324	149
CENTRAL	109	109
TOTAL	**4,116**	**3,869**

Number of duplicates: 247

Synthesis Without Meta-analysis (SWiM) reporting items

The citation for the Synthesis Without Meta-analysis explanation and elaboration article is: Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, Hartmann-Boyce J, Ryan R, Shepperd S, Thomas J, Welch V, Thomson H. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline BMJ 2020;368:l6890 http://dx.doi.org/10.1136/bmj.l6890

SWiM is intended to complement and be used as an extension to PRISMA			
SWiM reporting item	**Item description**	**Page in manuscript where item is reported**	**Other***
Methods			
1 Grouping studies for synthesis	1a) Provide a description of, and rationale for, the groups used in the synthesis (e.g., groupings of populations, interventions, outcomes, study design)	7	
	1b) Detail and provide rationale for any changes made subsequent to the protocol in the groups used in the synthesis	7	
2 Describe the standardised metric and transformation methods used	Describe the standardised metric for each outcome. Explain why the metric(s) was chosen, and describe any methods used to transform the intervention effects, as reported in the study, to the standardised metric, citing any methodological guidance consulted	7	
3 Describe the synthesis methods	Describe and justify the methods used to synthesise the effects for each outcome when it was not possible to undertake a meta-analysis of effect estimates	7	
4 Criteria used to prioritise results for summary and synthesis	Where applicable, provide the criteria used, with supporting justification, to select the particular studies, or a particular study, for the main synthesis or to draw conclusions from the synthesis (e.g., based on study design, risk of bias assessments, directness in relation to the review question)	5-7	

Synthesis Without Meta-analysis (SWiM) reporting items

SWiM reporting item	**Item description**	**Page in manuscript where item is reported**	**Other***
5 Investigation of heterogeneity in reported effects	State the method(s) used to examine heterogeneity in reported effects when it was not possible to undertake a meta-analysis of effect estimates and its extensions to investigate heterogeneity	7, Supplementary File 1 and 4	
6 Certainty of evidence	Describe the methods used to assess certainty of the synthesis findings	7, Supplementary File 7	
7 Data presentation methods	Describe the graphical and tabular methods used to present the effects (e.g., tables, forest plots, harvest plots). Specify key study characteristics (e.g., study design, risk of bias) used to order the studies, in the text and any tables or graphs, clearly referencing the studies included	7-8, Figures 1 and 2	
Results			
8 Reporting results	For each comparison and outcome, provide a description of the synthesised findings, and the certainty of the findings. Describe the result in language that is consistent with the question the synthesis addresses, and indicate which studies contribute to the synthesis	8-15, Table 1	
Discussion			
9 Limitations of the synthesis	Report the limitations of the synthesis methods used and/or the groupings used in the synthesis, and how these affect the conclusions that can be drawn in relation to the original review question	16-17	

PRISMA=Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
*If the information is not provided in the systematic review, give details of where this information is available (e.g., protocol, other published papers (provide citation details), or website (provide the URL)).

Supplementary File 5. List of excluded studies

Reference	Reasons for exclusion
1. Abroms (2017)	Not psychosocial health outcomes
2. Al Hashmi (2017)	Ph.D. dissertation
3. Ashcroft (2017)	Not psychosocial health outcomes
4. Atkinson (2016)	Not psychosocial health outcomes
5. Atnafu (2017)	Not psychosocial health outcomes
6. Baggett (2020)	Did not meet PICO criteria
7. Baggett (2021)	Did not meet PICO criteria
8. Bhat (2018)	Intervention not exclusively mobile health
9. Bhati (2014)	Conference poster
10. Brown (2018)	Ph.D. dissertation
11. Bush (2017)	Not psychosocial health outcomes
12. Castaño (2012)	Not psychosocial health outcomes
13. Crawford (2014)	Not psychosocial health outcomes
14. Dalfra (2009)	Unclear if exclusively using mobile devices
15. Dehlendorf (2019)	Not psychosocial health outcomes
16. Dodd (2017)	Not psychosocial health outcomes
17. Evans (2015)	Not psychosocial health outcomes
18. Fjeldsoe (2010)	Not psychosocial health outcomes
19. Fletcher (2017)	Not targeting pregnant women and mothers
20. Fletcher (2019)	Not targeting pregnant women and mothers
21. Forinash (2018)	Not psychosocial health outcomes
22. Gold (2021)	Unclear if exclusively using mobile devices
23. Gray (2017)	Not psychosocial health outcomes
24. Hackett (2019)	Not targeting pregnant women and mothers
25. Haile (2018)	Not psychosocial health outcomes
26. Hamdani (2021)	Participants' age did not meet inclusion criteria
27. Henkemans (2018)	Not targeting pregnant women and mothers
28. Huberty (2017)	Not psychosocial health outcomes
29. Ilozumba (2018)	Not psychosocial health outcomes
30. Jiskoot (2020)	Not targeting pregnant women and mothers
31. Johnson (2017)	Not psychosocial health outcomes
32. Jones (2020)	Not psychosocial health outcomes
33. Kennelly (2018)	Not psychosocial health outcomes
34. Kiani (2021)	Not psychosocial health outcomes
35. Kinuthia (2021)	Not psychosocial health outcomes
36. Kurti (2020)	Not psychosocial health outcomes
37. Ladley (2018)	Not psychosocial health outcomes
38. Ledford (2016)	Not psychosocial health outcomes
39. Letourneau (2015)	Unclear if exclusively using mobile devices
40. Levine (2021)	Not psychosocial health outcomes
41. Li (2020)	Not psychosocial health outcomes
42. Li (2021)	Not psychosocial health outcomes
43. Lund (2012)	Not psychosocial health outcomes
44. Lund (2014)	Not psychosocial health outcomes
45. MacDonald (2019)	Not targeting pregnant women and mothers

46. Mascarenhas (2018)	Participants' age did not meet inclusion criteria
47. Medhanyie (2015)	Not targeting pregnant women and mothers
48. Miremberg (2018)	Not psychosocial health outcomes
49. Mohan (2021)	Not psychosocial health outcomes
50. Moniz (2013)	Not psychosocial health outcomes
51. Moulaei (2021)	Not psychosocial health outcomes
52. Murthy (2020)	Not psychosocial health outcomes
53. Naughton (2012)	Not psychosocial health outcomes
54. Naughton (2013)	Not psychosocial health outcomes
55. Naughton (2017)	Not psychosocial health outcomes
56. Ngai (2015)	Unclear if exclusively using mobile devices
57. Niederhauser (2015)	Not psychosocial health outcomes
58. Odeny (2019)	Not psychosocial health outcomes
59. Pandya (2021)	Participants' age did not meet inclusion criteria
60. Perricone (2021)	Unclear if exclusively using mobile devices
61. Pollak (2013)	Not psychosocial health outcomes
62. Pollak (2014)	Not psychosocial health outcomes
63. Potzel (2021)	Not psychosocial health outcomes
64. Prasad (2018)	Ph.D. dissertation
65. Ragesh (2020)	Not psychosocial health outcomes
66. Raj (2021)	Not targeting pregnant women and mothers
67. Redman (2017)	Not psychosocial health outcomes
68. Scheepers (2021)	Not psychosocial health outcomes
69. Schoeppe (2020)	Not psychosocial health outcomes
70. Scott (2021)	Not targeting pregnant women and mothers
71. Shelus (2017)	Not psychosocial health outcomes
72. Sloan (2017)	Not psychosocial health outcomes
73. Smith (2020)	Telehealth; unclear if exclusively using mobile devices
74. Soltani (2015)	Not psychosocial health outcomes
75. Stonbraker (2020)	Not psychosocial health outcomes
76. Suryavanshi (2020)	Not targeting pregnant women and mothers
77. Sun (2017)	Not psychosocial health outcomes
78. Tinius (2021)	Not psychosocial health outcomes
79. Tombor (2018)	Not psychosocial health outcomes
80. Toohill (2014)	Unclear if exclusively using mobile devices
81. Trafford (2020)	Not psychosocial health outcomes
82. Walter (2021)	Not psychosocial health outcomes
83. Willcox (2017)	Not psychosocial health outcomes
84. Wouldes (2021)	Report/review
85. Wu (2020)	Not psychosocial health outcomes
86. Wu (2021)	Not psychosocial health outcomes
87. Ye (2018)	Not psychosocial health outcomes
88. Yee (2021)	Not psychosocial health outcomes
89. Yudin (2017)	Not psychosocial health outcomes
90. Zakus (2019)	Not targeting pregnant women and mothers
91. Zuccolo (2021)	Study protocol

Supplementary File 6. Risk of bias assessment of quasi-experimental studies
(Please indicate whether low, moderate, serious, critical, no information)

Author (year)	Selection of participants	Confounding variables	Classification of interventions	Deviations from intended interventions	Missing data	Measurement of the outcome	Selection of the reported result	Overall risk of bias
Abroms et al. (2015)	Moderate	No information	Low	Low	Moderate	Low	Low	Moderate
Baumel et al. (2018)	Low	Low	Low	Low	Low	Low	Low	Low
Carissoli et al. (2021)	Low	Serious	Low	Low	Serious	Low	Low	Serious
Dalton et al. (2018)	Moderate	No information	Low	Low	Moderate	Serious	Low	Serious
Fujioka et al. (2012)	Low	Moderate	Low	Low	Low	Moderate	Low	Moderate
Globus et al. (2016)	Low	Low	Low	Low	Low	Low	Low	Low
Goetz et al. (2020)	Low	Low	Low	Low	Low	Low	Low	Low
Jallo et al. (2017)	Low	Moderate	Low	Moderate	Moderate	Moderate	Low	Moderate
Kubo et al. (2021)	Low	Moderate	Low	Low	Moderate	Low	Low	Moderate
Song et al. (2013)	Low	Moderate	Low	Moderate	Low	Serious	Low	Serious
Trude et al. (2021)	Low	Low	Low	Low	Serious	Low	Low	Serious

Risk of bias assessment of observational cohort and cross sectional studies
(Please indicate whether yes, no, CD [cannot determine], NA [not applicable], NR [not reported])

Author	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Deave et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Özkan Şat et al. (2018)	Yes	Yes	Yes	Yes	Yes	Yes	CD	Yes	Yes	No	Yes	NR	NA	NR

1: Was the research question or objective in this paper clearly stated? **2:** Was the study population clearly specified and defined? **3:** Was the participation rate of eligible persons at least 50%? **4:** Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants? **5:** Was a sample size justification, power description, or variance and effect estimates provided? **6:** For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured? **7:** Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed? **8:** For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)? **9:** Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? **10:** Was the exposure(s) assessed more than once over time? **11:** Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants? **12:** Were the outcome assessors blinded to the exposure status of participants? **13:** Was loss to follow-up after baseline 20% or less? **14:** Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?

Risk of bias assessment of qualitative studies
(Please indicate whether yes, no, or can't tell)

Author (Year)	1	2	3	4	5	6	7	8	9	10
Brown et al. (2014)	Yes	Yes	Yes	Yes	Yes	CT	Yes	Yes	Yes	Yes
Connor et al. (2018)	Yes	Yes	Yes	No	Yes	CT	Yes	Yes	Yes	Yes
Harrington et al. (2019)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

Litterbach et al. (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seshu et al. (2021)	Yes	Yes	Yes	CT	Yes	CT	Yes	Yes	Yes	Yes
Skar et al. (2018)	Yes	Yes	No	Yes	Yes	CT	Yes	Yes	Yes	Yes
Yee et al. (2020)	Yes	Yes	Yes	CT	Yes	CT	Yes	Yes	Yes	Yes

1: Was there a clear statement of the aims of the research? **2:** Is a qualitative methodology appropriate? **3:** Was the research design appropriate to address the aims of the research? **4:** Was the recruitment strategy appropriate to the aims of the research? **5:** Was the data collected in a way that addressed the research issue? **6:** Has the relationship between researcher and participants been adequately considered? **7:** Have ethical issues been taken into consideration? **8:** Was the data analysis sufficiently rigorous? **9:** Is there a clear statement of findings? **10:** How valuable is the research?

Risk of bias assessment of mixed methods studies
(Please indicate whether yes, no, or CT [can't tell])

Author (Year)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Avalos et al. (2020)	Yes	Yes	Yes	Yes	CT	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Blackwell et al. (2020)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Musiimenta et al. (2020)	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	CT	No	CT	No
Rhodes et al. (2020)	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Seo et al. (2021)	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
Simpson et al. (2021)	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Stonbraker et al. (2020)	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes

1: Is there an adequate rationale for using a mixed methods design to address the research question? **2:** Are the different components of the study effectively integrated to answer the research question? **3:** Are the outputs of the integration of qualitative and quantitative components adequately interpreted? **4:** Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? **5:** Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? **6:** Is the qualitative approach appropriate to answer the research question? **7:** Are the qualitative data collection methods adequate to address the research question? **8:** Are the findings adequately derived from the data? **9:** Is the interpretation of results sufficiently substantiated by data? **10:** Is there coherence between qualitative data sources, collection, analysis and interpretation? Questions 11-15 depends on whether it involves RCT, non-randomized, or quantitative descriptive studies.

Supplementary File 7. GRADE Summary of Findings

Patient or population: Pregnant women and mothers
Intervention: Use of mobile health
Comparison: Standard care

Outcomes	Impact	No. of participants (studies)	Quality of evidence (GRADE)
Anxiety symptoms	Four studies found positive impact on anxiety symptoms, six studies had mixed findings, and three studies found no significant change.	4497 (8 RCT; 5 quasi-experimental)	⊕⊕◯◯ LOW
Depressive symptoms	Five studies found positive impact on depressive symptoms, two studies had mixed findings, and four studies found no significant change.	892 (5 RCT; 5 quasi-experimental; 1 mixed methods; 1 qualitative)	⊕⊕◯◯ LOW
Perceived stress	Three studies found positive impact on perceived stress, two studies had mixed findings, and two studies found no significant change.	857 (4 RCT; 3 quasi-experimental)	⊕◯◯◯ VERY LOW
Mental well-being	One study found a positive impact on mental well-being, while one study did not find a significant change.	508 (1 quasi-experimental; 1 cohort)	⊕◯◯◯ VERY LOW
Coping	One study reported mixed impact on coping, while one study reported no significant change.	215 (1 RCT; 1 quasi-experimental)	⊕◯◯◯ VERY LOW
Self-efficacy	Seven studies found positive impact on self-efficacy, two studies had mixed findings, and seven studies found no significant change.	1744 (7 RCT; 4 quasi-experimental; 3 qualitative; 1 mixed methods; 1 cohort)	⊕⊕◯◯ LOW
Self-management	All five studies found a positive impact on self-management of health.	182 (1 RCT; 2 mixed methods; 2 qualitative)	⊕⊕◯◯ LOW

Acceptance	Three studies found a positive impact on acceptance of pregnancy and motherhood.	328 (1 quasi-experimental; 1 descriptive; 1 qualitative)	⊕◯◯◯ VERY LOW
Social support from partners	Four studies found a positive impact on social support from partners.	560 (1 RCT; 2 qualitative; 1 descriptive)	⊕◯◯◯ VERY LOW
Social support from healthcare providers	Three studies found a positive impact on social support from healthcare providers.	519 (1 quasi-experimental; 1 mixed methods; 1 qualitative)	⊕◯◯◯ VERY LOW
Social support from other sources	Six studies found a positive impact on social support from other sources, while three studies reported mixed findings and one study reported no significant change.	622 (3 RCT; 4 mixed methods; 2 qualitative; 1 descriptive)	⊕⊕◯◯ LOW

RCT: randomized controlled trial

GRADE Working Group grades of evidence:
High quality: We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Supplementary File 8. Characteristics of included studies

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Avalos et al. (2020), US	Quasi-experimental, clinics	Postpartum women (up to 6 months) with moderate to moderately severe depressive symptoms	n = 27	App (Headspace)	Psychoeducation or therapy (mindfulness-based program)	N/A	Patient Health Questionnaire-8 (PHQ-8; adapted from PHQ-9 and excluded question regarding suicidal thoughts); Perceived Stress Scale (PSS)	PHQ-8 score improved significantly between baseline and 6-week follow-up (MD = -3.8, SD = 5.0, p = 0.004). PSS score improved significantly between baseline and 6-week follow-up (MD = -6.0, SD = 7.9, p = 0.005).
Abroms et al. (2015), US	Quasi-experimental, general population	Pregnant women who were current smokers or had quit smoking in the last 4 weeks (gestational requirement not specified)	n = 20	SMS (Quit4baby)	Behavior change (smoking cessation program)	N/A	Attitude-Social Influence-Efficacy Model (ASE)	Average rating of self-efficacy was M = 3.6, SD = 1.2 at baseline and M = 4.8, SD 0.5 at the 4-week follow-up. However, this result was limited to 65% (13/20) of the participants due to the overall low response rate.
Baumel et al. (2018), US	Quasi-experimental, hospital	Mothers diagnosed with postpartum depression	n = 19	App (7Cups of Tea)	Psychoeducation or therapy (mindfulness-based program); communication and support (trained volunteers)	N/A	Edinburgh Postnatal Depression Scale (EPDS); Beck Depression Inventory II (BDI-II); Beck Anxiety Inventory (BAI)	Intent-to-treat analyses showed that among intervention group EPDS score was M = 17.32, SD = 5.96 at baseline and M = 13.53, SD = 4.65 at one-month follow-up (p = 0.005). BDI-II score was M = 26.11, SD = 13.34 at baseline and M = 19.18, SD = 9.23 at follow-up (p = 0.01). BAI score was M = 20.47, SD 13.15 at baseline and M = 16.65, SD 7.52 at follow-up (p = 0.11). However, no significant difference in EPDS decrease over time was found between intervention and control group. However, there was a medium effect size favoring the intervention group (Cohen d = 0.58, p = 0.05).
Blackwell et al. (2020), US	Mixed methods, hospital	Pregnant women who are urban African American and Afro-Caribbean immigrants (gestational requirement not specified)	Qualitative: n = 9 Quantitative: n = 49	SMS (Text4baby)	Health education or promotion (via text messaging); communication and support	N/A	Qualitative: Focus group discussion (FGD) and in-depth interview (IDI) Quantitative: Questionnaire evaluating attitudes, beliefs, perceived usefulness, perceived ease of use, compatibility, relative advantage, visibility, and behavioral intent	Qualitative: Three themes were identified (1) inadequate patient-provider engagement, (2) social support, and (3) acculturation. Quantitative: Participants reported that the text messages allowed them to have greater control over the prenatal health care (pre = 28.6%, post = 51%, p = 0.02).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Bogale et al. (2021), Palestine	RCT (cluster), primary healthcare clinics	Pregnant women in 38 weeks' gestation	n = 454 (131 clusters)	SMS	Registries/vital events tracking (tailored messages via SMS from MCH eRegistry)	Standard care	Cambridge Worry Scale 13-item (CWS) via interview	Unadjusted CWS score was M = 1.8, SD = 1.9 for intervention group and M = 2.0, SD = 1.9 for control group. After adjusting for the clustering effects, the MD was -0.16 (95% CI = -0.31 to -0.01) which was below the predefined non-inferiority margin of 0.3.
Brown et al. (2014), US	Qualitative, community health center	Low-income, adolescent, minority postpartum women (up to 6 months)	n = 5	SMS	Health education or promotion (via text blasts)	N/A	Semi-structured interviews	Participants described a sense of fulfillment, competence, and confidence from interacting with texts which provided validation of their motherhood role.
Carissoli et al. (2021), Italy	Quasi-experimental, hospital	Primigravida women in third pregnancy trimester	n = 74	App (BenEssere Mamma)	Psychoeducation or therapy (mindfulness-based program); Self-monitoring system (mood)	Standard care	Psychological Well-being (PWB) Scale 84-item	Sense of Autonomy component of the PWB Scale showed a significant increase in the intervention group (M = 4.29, SD = 0.52) compared to the control group (M = 4.43, SD = 0.71) immediately after the 4-week intervention (p = 0.05). Similar effectiveness was found at postpartum assessment between intervention (M = 4.40, SD = 0.60) and control group (M = 4.36, SD = 0.93, p = 0.046). Self-acceptance component showed a significant increase in the intervention group (M = 4.84, SD = 0.60) compared to the control group (M = 4.33, SD = 1.13) at postpartum assessment (p = 0.011).
Cheng et al. (2008), Taiwan	RCT, hospital	Pregnant women between 14–18 weeks' gestation	n = 2782	SMS	Laboratory results (Down syndrome screening results via SMS)	Report at the time of routine clinic appointment	State-Trait Anxiety Inventory (STAI)	For pregnant women who received negative results for Down Syndrome screening, STAI-S scores did not significantly differ between intervention and control groups before screening (M = 38.9, SD = 9.9 vs. M = 37.8, SD = 11.3, p = 0.51) and three days after the appointed clinic (M = 35.3, SD = 12.5 vs. M = 34.9, SD = 9.8, p = 0.37). However, it declined significantly on the second occasion (when the SMS report had already been sent to intervention group) for the intervention group (M = 33.8, SD = 7.9) compared to the control group (M = 39.1, SD = 10.1) (p = 0.02). For pregnant women who received positive results for Down Syndrome screening, STAI-T scores did not significantly differ between intervention group (M = 38.7, SD = 8.8) and control group (M = 40.1, SD = 13.2, p = 0.57). STAI-S scores did not significantly differ between the intervention and control groups before screening (M = 39.2, SD = 11.4 vs. M = 39.9, SD = 9.4, p = 0.66), second occasion (M = 44.1, SD = 13.4 vs. M = 42.9, SD = 11.5, p = 0.21), and three days after the appointed clinic (M = 43.4, SD = 9.6 vs. M = 43.1, SD = 10.6, p = 0.52).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Choi et al. (2016), US	RCT (pilot evaluation), clinics and communities	Pregnant women between 10–20 weeks' gestation with a sedentary life style	n = 30	App	Behavior change (physical activity)	Fitbit Ultra only (No app)	Self-Efficacy for Physical Activity (SEPA); Social Support and Exercise Survey; Center for Epidemiologic Studies Depression Scale (CES-D)	SEPA score was M = 18.7, SD = 4.4 for intervention group and M = 17.1, SD 5.2 for control group at 12-week follow-up (p = 0.58). Social Support and Exercise Survey score for family support was M = 42.0, SD = 11.5 for intervention group and M = 38.5, SD = 10.4 for control group (p = 0.28). For friend support, it was M = 37.2, SD = 9.6 for intervention group and M = 32.1, SD = 8.6 for control group at 12-week follow-up (p = 0.64). CES-D score was M = 8.8 (SD 2.7) for intervention group and M = 11.1 (SD 6.9) for control group (p = 0.56) at 12-week follow-up.
Chyzzy et al. (2020), Canada	Descriptive (drawn from pilot RCT), general population	Pregnant adolescent women over 28 weeks' gestation	n = 16	SMS and voice calling	Communication and support (peer support)	N/A	Peer Support Evaluation Inventory (PSEI)	Participants perceived positive support from their peer mentors such as trustworthiness (94%), acceptance (75%), empathy (81%), and commitment (81%). All of the participants were satisfied with their peer support experience.
Connor et al. (2018), US	Qualitative, general population	Pregnant and postpartum women (up to 6 months)	n = 16	App	N/A (general use of mHealth)	N/A	Semi-structured interviews	Participants felt supported when they used mHealth apps because the information was personalized and they could use the apps to connect with family and the online community.
Constant et al. (2014), South Africa	RCT, NGOs and primary care clinics	Women scheduled to undergo early medical abortion	n = 469	SMS	Health education or promotion (via automated SMS)	Standard care (receiving abortion counseling and administration of mifepristone)	Hospital Anxiety and Depression Scale (HADS); Adler's 12-item emotional scale; Impact of Event Scale-Revised (IES-R)	For anxiety measured by HADS, intention-to-treat analysis showed that anxiety decreased more in the intervention group from baseline (MD = -3.6, SD = 5.3) than the control group (MD = -2.3, SD = 5.0, p = 0.013). For IES-R scores, two subscales of avoidance (IES-A) and intrusion (IES-I) did not show any significant difference for intervention group (IES-A: M = 13.1, SD = 7.3; IES-I: M = 9.0, SD = 9.1) and control group (IES-A: M = 14.4, SD = 7.4; IES-I: M = 9.5, SD = 8.3). Both IES-A (p = 0.085) and IES-I (p = 0.541) were not statistically significant. However, when IES-A scores was adjusted for baseline anxiety, it was lower for the intervention group than the control group (β = -1.8, 95% CI = -3.2 to -0.4, p = 0.015), however this was not the case of adjusted IES-I scores (β = -1.4, 95% CI = 2.9 to 0.2, p = 0.083).
Dalton et al. (2018), Australia	Quasi-experimental, tertiary hospital in low socioeconomic community	Pregnant women between 10–14 weeks' gestation	n = 124	App (Health-e Babies)	Health education or promotion	Those who did not complete the exit questionnaire	EPDS; STAI; Generalized Anxiety Disorder (GAD-7); Parenting Sense of Competence (PSoC)	No significant difference change between EPDS, GAD-7, STAI scores, before and after the intervention. For PSoC scores, there were no significant difference between the intervention (M = 39.4, SD = 1.9) and control (M = 39.9, SD = 1.1) groups.

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Deave et al. (2019), UK	Cohort, maternity units	Primigravida women between 12–16 weeks' gestation	n = 488	App (Baby Buddy)	Health education or promotion (via personalized daily messages); Reminders (appointment); Decision guideline (list of questions to ask at appointment); Self-monitoring system (via diary)	Non-app users	Tool to Measure Parenting Self-Efficacy (TOPSE); Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)	No significant difference in TOPSE scores (AOR = 1.12, 95% CI = 0.59 to 2.13, p = 0.730) and WEMWBS scores (AOR = 1.02, 95% CI = 0.55 to 1.89, p = 0.943) were found between baseline and 3-month follow-up.
Dennis-Tiwary et al. (2017), US	RCT (pilot evaluation), urban hospital	Pregnant women between 19–29 weeks' gestation	n = 29	App	Psychoeducation or therapy (attention bias modification training)	Placebo training version of app	Depression, Anxiety, and Stress Scale (DASS-21); Hamilton Anxiety Scale (HAM-A)	No significant differences in DASS-21 anxiety score and HAM-A score were found at one-month follow-up: DASS-21 anxiety score: intervention (M = 3.20, SD = 3.00) and control (M = 2.07, SD = 3.60); HAM-A score: intervention (M = 9.20, SD = 6.71) and control (M = 6.93, SD = 9.10) (p-value was not reported). No significant change in DASS-21 depression score at follow-up: intervention (M = 2.07, SD = 2.63) and control (M = 2.29, SD = 3.20) (p-value was not reported). No significant changes in DASS-21 stress score at follow-up: intervention (M = 6.00, SD = 2.83) and control (M = 4.36, SD = 4.18) (p-value was not reported).
Fujioka et al. (2012), Japan	Quasi-experimental (descriptive), hospitals and clinic	Pregnant women over 20 weeks' gestation who were current smokers	n = 52	e-learning using cell phone internet	Behavior change (smoking cessation program)	N/A	Japanese version of the Self Efficacy Scale from the Life-Span Perspective	Self-efficacy was much higher in the group that quit smoking than those who continued to smoke first and third months of post-intervention (not statistically significant and data were narratively reported).
Gallegos et al. (2014), Australia	RCT, general population	Breastfeeding postpartum women with infant younger than 3 months	n = 200	SMS (MumBub Connect)	Health education or promotion (via automated two-way text messaging system); Communication and support (breastfeeding counselor)	Standard care	Breastfeeding Self-Efficacy Scale (BSES), Ways of Coping Checklist (WCCL): current levels of social support from family, peers, professionals, and organizations	For breastfeeding self-efficacy, there was +0.15 change between baseline (M = 4.00, SD = 0.74) and 8-week follow-up for intervention group (M = 4.15, SD = 0.72) and a +0.07 change for the control group (M = 4.22, SD = 0.66 vs. M = 4.29, SD = 0.67), but this was not statistically significant (p = 0.25).For perceived social support, there was +0.24 change between baseline (M = 3.64, SD = 1.05) and 8-week follow-up for intervention group (M = 3.86, SD = 0.88) and a -0.02 change for the control group (M = 3.91, SD = 0.86 vs. M = 3.89, SD = 0.68), which was statistically significant (p < 0.001). For active coping, there was +0.33 change between baseline (M = 3.51, SD = 0.89) and eight weeks follow-up for intervention group (M = 3.78, SD = 0.76) and a -0.25 change for the control group (M = 3.76, SD = 0.65 vs. M = 3.51, SD = 0.31), which was statistically significant (p = 0.01). Moreover, for emotion-focused coping there was -0.23 change between baseline (M = 3.28, SD = 0.74) and eight weeks follow-up for intervention group (M = 3.07, SD = 0.85) and a -0.86 change for the control group (M = 3.17, SD = 0.79 vs. M = 2.32, SD = 0.46), which was also statistically significant (p = 0.001).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Garfield et al. (2016), US	RCT (pilot evaluation), neonatal intensive care unit (NICU)	Postpartum parents of very low-birth-weight infants	n = 90	App (NICU-2-Home)	Health education or promotion (via curated multimedia); Decision guideline (discharge checklist); Self-monitoring system (mood and daily activities)	Standard care	PSoC	No significant difference in the PSoC scores between intervention (M = 71.8, SD = 10.5) and control (M = 69.8, SD = 10.0) groups (p = 0.369). However, PSoC scores showed 7% improvement among intervention group compared to control group when accounting for actual mean app usage.
Globus et al. (2016), Israel	Quasi-experimental, tertiary NICU	Postpartum parents of infants hospitalized in NICU	n = 178	SMS	Electronic health records (daily update of preterm infant's health status via SMS)	Pre-SMS implementation (pre/post)	York Hospital NICU Discharge Survey	Anxiety scores improved after the intervention in two questions that measure anxiety: question 1) current anxiety: pre (M = 2.7, SD = 2.6) and post (M = 3.1, SD = 2.8); question 2) anxiety in anticipation of infant's discharge: pre (M = 3.1, SD = 2.8) and post (M = 2.5, SD = 2.5). However, both question 1 (p = 0.30) and question 2 (p = 0.15) were not statistically different.
Goetz et al. (2020), Germany	Quasi-experimental (pilot evaluation), hospital	Hospitalized, high-risk pregnant women between 24–34 weeks' gestation	n = 68	App (mindmom)	Psychoeducation or therapy (mindfulness-based program)	N/A	EPDS; STAI; Pregnancy-Related Anxiety Questionnaire abridged version (PRAQ-R)	No significant change in EPDS scores were reported between baseline (M = 8.41, SD = 4.77) and after completing the intervention (M = 8.62, SD = 4.13, p = 0.71). STAI-S (State scale) score were significantly lower compared to baseline (M = 46.65, SD = 11.35) and after intervention (M = 43.81, SD = 10.09, p = 0.03). No significant change in PRAQ-R scores were reported between baseline (M = 21.63, SD = 6.08) and after completing the intervention (M = 20.69, SD = 6.09, p = 0.20). However, participants who completed more than 50% of the program modules reported significantly lower PRAQ-R scores (M = 18.74, SD = 4.49) compared to participants who had low app engagement (M = 22.54, SD = 6.90, p < 0.05).
Hannan et al. (2016), US	RCT, hospital	Low-income first-time mothers and their infants	n = 129	SMS and voice calling	Communication and support (healthcare provider)	Standard care	Multidimensional Measure of Perceived Social Support (MSPSS); Perceived Stress Scale (PSS)	Mothers in the intervention group (M = 74.5, SD = 12.6) reported significantly higher perceived social support compared to the control group (M = 67.3, SD = 17.1, p < 0.05) . No significant difference in PSS scores between intervention (M = 10.0, SD = 6.1) and control groups (M = 11.9, SD = 7.9, p not reported) .

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Hantsoo et al. (2018), US	RCT, hospital	Pregnant women with depressive symptoms and low socioeconomic status, less than 32 weeks' gestation	n = 72	App	Self-monitoring system (mood); Communication and support (healthcare provider)	Standard care app	PHQ-9; GAD-7	As gestational age increased, women in the intervention group reported that they can manage their own health significantly higher than the control group (p = 0.007) after eight weeks of intervention. Women in the intervention group who received contact from providers reported significantly higher scores on PHQ-9 in Weeks 1-4 and GAD-7 in Weeks 3-4 (p < 0.05 for both comparisons).
Harrington et al. (2019), Kenya	Qualitative, hospitals serving a predominantly low-to-middle income rural population	Pregnant and postpartum women (up to 6 months); men who had a pregnant female partner	Women: n = 15 Men: n = 35	SMS (Mobile WACh platform)	Health education or promotion (via tailored SMS); Communication and support (healthcare provider)	N/A	FGD	Both female and male participants felt that receiving family planning-focused messages and including men would be beneficial and may stimulate good communication within couples.
Jallo et al. (2017), US	Quasi-experimental, hospital obstetrical antepartum high-risk unit	High-risk, pregnant women between 22–37 weeks' gestation	n = 15	App (Picture Wellness)	Psychoeducation or therapy (guided imagery stress coping program via audio files on app)	N/A	PSS; Visual Analog Stress Scale (VASS); Coping Self-Efficacy Scale 26-item (CSES)	For maternal stress, when comparing before and after listening to the app, the VASS scores significantly dropped by 22 points between pre (M = 44.13, SE = 4.90) and post (M = 22.04, SE = 4.92, p = 0.0001) intervention. However, there were no changes in PSS scores between pre (median = 22.0, range 17 to 28) and post (median = 22.0, range 16 to 26, p = 0.75) intervention. For stress coping, there was no significant change on the CSES scores between pre (median = 148.5, range 32 to 245) and post (median = 155, range 110 to 241, p = 0.875) intervention.
Jannati et al. (2020), Iran	RCT, healthcare centers	Postpartum women (up to 6 months) who scored 13 or higher on the EPDS scale	n = 75	App (Happy Mom)	Psychoeducation or therapy (cognitive-behavioral therapy based)	Standard care	EPDS	EPDS scores were significantly lower in the intervention group (M= 8.18, SD = 1.5) compared to the control group (M = 15.05, SD = 2.9) after the intervention (p = 0.001).
Jareethum et al. (2008), Thailand	RCT, hospital	Pregnant women less than 28 weeks' gestation	n = 68	SMS	Health education or promotion (via tailored text messages)	Standard care	Tested questionnaires using Visual Analog Scale (VAS) (specific scales used were not indicated)	For confidence level, higher levels of confidence were reported among intervention group (M = 8.91, SD = 0.86) than the control group (M = 7.79, SD = 1.45) during the antenatal period (p = 0.001). However, the difference was not significant during the perinatal period (M = 8.94, SD = 0.95 vs. M = 8.38, SD = 1.43, p = 0.074). For anxiety level, lower levels of anxiety were reported among intervention group (M = 2.78, SD = 2.06) than the control group (M = 4.93, SD = 2.89) during the antenatal period (p = 0.002). However, the difference was not significant during the perinatal period (M = 4.78, SD = 2.45 vs. M = 5.79, SD = 2.60, p = 0.122).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Kodama et al. (2021), Japan	RCT, clinics	Primigravida women less than 12 weeks' gestation	n = 39	SMS	Health education or promotion (via automated text messages)	Standard care	STAI	No significant differences were found in STAI scores between intervention and control group after the intervention. However, the STAI-S (State scale) was significantly lower after the intervention than at the baseline in the intervention group (p = 0.03).
Kubo et al. (2021), US	Quasi-experimental (single arm), clinics	Pregnant women less than 28 weeks' gestation and scored between 10 to 19 in PHQ-9 (moderate-to-moderately severe depressive symptoms)	n = 27	App (Headspace)	Psychoeducation or therapy (mindfulness-based program)	N/A	PHQ-8 (adapted from PHQ-9); PSS	PHQ-8 score improved significantly between baseline and 6-week follow-up (MD = -6.0, SD = 5.5, p < 0.001). PSS score improved significantly between baseline and 6-week follow-up (MD = -5.6, SD = 7.3, p = 0.0027).
Litterbach et al. (2017), Australia	Qualitative, general population	Pregnant women in 30+ weeks' gestation or parent/main carer of an infant aged under 3 months	n = 24	App and website (Growing Healthy Program)	Health education or promotion (via videos and automated personalized text messages); Communication and support	N/A	Semi-structured telephone interviews	Women who engaged in the program reported that it helped increase their confidence in feeding decisions. They also reported that the program provided nonjudgmental support.
Musiimenta et al. (2021), Uganda	Qualitative (drawn from a pilot RCT), hospital	Illiterate pregnant women initiating antenatal care	n = 30	App (MatHealth)	Health education or promotion (personalized information via video/audio); Reminders (appointment); Communication and support (healthcare provider)	N/A	Semi-structured face-to-face interviews	Participants reported that the app enhanced support and involvement from their spouses. This support included being escorted to the clinic for appointments, providing feeding support, purchasing essentials required for delivery, providing transportation means, and permission to the clinic for antenatal services and delivery.
Özkan Şat et al. (2018), Turkey	Descriptive, hospital	Pregnant women between 25–40 weeks' gestation	n = 230	App	N/A (general use of mHealth)	Pregnant women who did not use apps or blogs during pregnancy	Prenatal Self Evaluation Questionnaire (PSEQ)	For total PSEQ score, women who used apps (M = 129.75, SD = 21.77) had a better psychosocial adaptation to pregnancy than those who did not use apps (M = 135.94, SD = 26.40), but it was not statistically significant (p = 0.059). In the mean subscale score of PSEQ, women who used apps (M = 13.28, SD = 4.22) had a lower score in relationship with husband than those who did not (M = 15.69, SD = 5.41) which was statistically significant (p = 0.001). Women who used apps (M = 18.99, SD = 3.88 had a lower score in acceptance of pregnancy than those who did not (M = 20.86, SD = 6.12) which was also statistically significant (p = 0.005).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Rhodes et al. (2020), UK	Mixed methods, general population	Expectant and recent parents (under 24 weeks)	Qualitative: n = 13 pregnant women and n = 19 recent parents Quantitative: n = 436	App (Baby Buddy)	Health education or promotion (via personalized daily messages); Reminders (appointment); Decision guideline (list of questions to ask at appointment); Self-monitoring system (via diary)	N/A	Qualitative: telephone interviews Quantitative: web-based survey consisting of questions assessing the impact of COVID-19 on experiences, attitudes, and needs	Of the 436 web-based survey respondents, 88.5% (n = 386) reported that the pandemic increased their levels of anxiety around pregnancy, birth, and being a new parent. Pregnant (25%; 61/244) and postnatal (19.8%; 38/192) respondents reported using the app more during the pandemic. Both pregnant (79.1%; 193/244) and postnatal (87.0%; 167/192) respondents found that the app was helping in providing access to reliable information, mainly because the app provided information from the National Health Service (NHS). In the telephone interview, participants found the app to be valuable in the absence of support from health care professionals and baby groups due to the COVID-19 pandemic.
Seo et al. (2021), Korea	Mixed methods, general population	Mothers with a score of 9 or more on the EPDS	n = 4	App (Happy Mother)	Psychoeducation or therapy (cognitive-behavioral therapy based)	N/A	Qualitative: face-to-face interviews Quantitative: usability testing	In the interview, mothers with mild postpartum depression reported that the app had encouraged them to think positively and was helpful in their self-management of depression.
Seshu et al. (2021), India	Qualitative, rural community	Mothers who were screened to be positive for perinatal depression	n = 9	Interactive Voice Response System (IVRS)	Health education or promotion (via audio dramas)	N/A	IDIs and FGD	Participants reported that listening to the IVRS content had a soothing effect and helped them improve their mood.
Seyyedi et al. (2021), Iran	RCT, clinic	Mothers who intended to breast feed and had their firstborn child aged less than 3 months	n = 80	App	Health education or promotion (via breastfeeding education program)	Standard care	Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF)	BSES-SF scores increased more in the intervention group (MD = 26.85, SD = 7.13) than the control group (MD = 0.40, SD = 5.17) with significant difference between the two groups ($p < 0.001$).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Shorey et al. (2017), Singapore	RCT, tertiary teaching hospital	First-time parents	n = 250	App (Home-but-not Alone)	Psychoeducation or therapy; Communication and support (healthcare providers)	Standard care	Parenting self-efficacy scale, Perceived Social Support for Parenting Scale (PSSP), EPDS	For parenting self-efficacy, parents who received the intervention showed an improvement of self-efficacy at post-test (MD = 11.8, SD = 23.7) compared with baseline. The control group had a decrease in self-efficacy scores (MD = -11.9, SD = 21.9) over the same four-week intervention. There was a significant change in adjusted scores at post-test when comparing intervention and control group (MD = 23.20, 95% CI = 16.44 to 29.95, p < 0.001). For social support score, the scale measured social support from spouse and other sources. For social support from spouse, there was an improvement in post-test scores in the intervention group (MD = 0.31, SD = 23.3) from baseline. However, there was decrease in scores in the control group from baseline(MD = -27.4, SD = 22.3). This resulted in an overall significant difference between the intervention and control group in social support received from spouses (MD = 27.08, 95% CI = 20.94 to 34.8, p < 0.001). For social support from other sources, the results were similar. There was an improvement in post-test scores in the intervention group (MD = 4.3, SD = 29.3) but a decrease in the control group (MD = -22.0, SD = 22.5). This resulted in an overall difference between the intervention and control group in social support received from other sources (MD = 27.23, 95% CI = 19.06 to 35.40, p < 0.001). For EPDS scores, there was a MD of 7.0 (SD = 81.5) in the intervention group and 7.6 (SD = 76.1) in the control group at post-test compared with baseline. Among the intervention group, there was a smaller absolute change of EPDS scores which declined compared with the control group with a MD of -0.33 (95% CI = -1.21 to 0.53), however it was not statistically significant (p = 0.450).
Simpson et al. (2021), Zambia	Mixed methods, clinics in urban communities	Adolescent pregnant women between 24–34 weeks' gestation and living with HIV	n = 61	SMS (Insaka)	Communication and support (peer support groups)	N/A	Qualitative: FGD Quantitative: MSPSS; Rosenberg Self Esteem Scale (RSES) via interviews	MSPSS scores increased after the intervention compared to baseline (MD = 1.7, 95% CI = -10.8 to 14.1), however it was not statistically significant (p = 0.8). RSES scores decreased after the intervention compared to baseline (MD = -0.3, 95% CI = -9.0 to 8.3), however it was not statistically significant (p = 0.9).
Skar et al. (2018), Norway	Qualitative (interpretative phenomenological analysis), diabetes outpatient clinics	Women diagnosed with gestational diabetes mellitus (GDM)	n = 17	App (the Pregnant+)	Health education or promotion (via tailored information); Self-monitoring system (automatic transfer of blood glucose values from the measurement device to app)	N/A	Semi-structured interviews	Women who used the app reported an increase in their confidence of self-managing GDM and some reported that the app gave them a feeling of control.

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Song et al. (2013), US	Quasi-experimental, underserved communities	Low income pregnant women living in inner city of Milwaukee	n = 20	SMS (TuTalk)	Health education or promotion; Communication and support (via two-way automated text messaging system)	N/A	RAND Mental Health Inventory (MHI5), PSS, and CES-D	The text messaging system significantly reduced depressive symptoms ($t(19) = 2.991$, $p < 0.01$) and perceived stress ($t(19) = 2.226$, $p < 0.05$). Women also reported improvement in their overall mental well-being ($t(19) = -4.241$, $p < 0.001$). (Detailed results of statistical analyses were not provided)
Stonbraker et al. (2020), Dominican Republic	Mixed methods, clinic	Postpartum adolescent women (up to 6 months)	n = 58	Instant messaging service (WhatsApp Messenger)	Health education or promotion (via informational messages and associated images); Communication and support (intervention moderators)	N/A	Qualitative: IDI Quantitative: PROMIS	PROMIS scales Social Isolation, Instrumental Support, and Companionship increased after the intervention compared to baseline with an average increase of 1.3 points. Emotional Support and Informational Support scales decreased with an average decrease of 0.6 points. However, all changes were not statistically significant (p-value and details of scores were not reported).
Sun et al. (2021), China	RCT, clinics	Pregnant women between 12–20 weeks' gestation who were screened positive in depressive symptoms (EPDS score>9 or PHQ-9 score>4)	n = 168	App	Psychoeducation or therapy (mindfulness-based program)	Regular health consultation via instant messaging service (WeChat)	EPDS; GAD-7; PSS	Based on intention-to-treat analysis, EPDS scores (positive depressive symptoms) decreased in the intervention group compared to the control group (OR = 0.391, 95% CI = 0.164–0.930, p = 0.02). Moreover, intervention group showed a significant reduction on EPDS scores compared to the control group with OR ranging from 3.471 to 27.986. GAD-7 scores decreased at 4-week follow-up and continued to decrease at 8-week and 18-week follow-up among the intervention group. However, the scores increased at 8-week and 18-week follow-up among the control group. Medium between-group effect size was reported at the 18-week follow up (d = 0.46, 95% CI = 0.04–0.87). No significant difference was found on PSS scores.
Takeuchi et al. (2016), Japan	RCT, hospitals and clinics	Primigravida women between 30–33 weeks' gestation	n = 161	Smartphone website	Health education or promotion (perineal massage); Communication and support (peers and healthcare providers); Reminders	Paper-based leaflet	Childbirth Self Efficacy Scale	No significant difference of childbirth self-efficacy score between the intervention group (M = 93.4, SD = 13.81) and control group (M = 94.1, SD = 16.79) at 3-weeks follow- up (p = 0.587).

Study (year), country	Study design, setting	Study population	Sample size	mHealth service	mHealth intervention	Comparator	Evaluation	Reported psychosocial health outcomes
Trude et al. (2021), Brazil	Mixed methods, hospitals	Mothers with children between 12 to 18 months of age	n = 30	Instant message service (WhatsApp Messenger)	Communication and support (maternal support group)	N/A	Qualitative: IDI via video conference Quantitative: Social Support Questionnaire (SSQ); EPDS; Parental Self-Efficacy 17-item (specific scale not indicated)	13.3% point decrease was found in the prevalence of maternal depression symptoms between pre- and post-intervention (p = 0.045), Median score for maternal social support increased with a moderate effect (d = 0.28), however it was not statistically significant (p = 0.241). Moreover, no significant difference of self-efficacy was reported (p = 0.992).
Yee et al. (2020), US	Qualitative, hospital-based clinic providing care for low-income women	Women with publicly funded prenatal care and diagnosed with type 2 diabetes mellitus or gestational diabetes mellitus	n = 31	SMS (Texting for Diabetes Success)	Psychoeducation or therapy (messages based on Health Belief Model, Self-Efficacy Theory, Cognitive Load Theory); Reminders (appointment)	N/A	IDI	Participants reported: 1) Increase in connectedness with healthcare providers 2) Information provided helped them better manage their diabetes 3) Improvement in motivation