



Review article

The effectiveness of telemedicine interventions, delivered exclusively during the postnatal period, on postpartum depression in mothers without history or existing mental disorders: A systematic review and meta-analysis

Nivine Hanach^{a,*}, Nanne de Vries^a, Hadia Radwan^b, Nour Bissani^c

^a CAPHRI, Faculty of Health, Medicine, and Life Sciences, Maastricht University, Maastricht, Netherlands

^b Department of Clinical Nutrition and Dietetics, College of Health Sciences, Research Institute of Medical and Health Sciences (RIMHS), University of Sharjah, Sharjah, United Arab Emirates

^c Department of Nutrition and Food Science, Faculty of Agricultural and Food Sciences, American University of Beirut, Beirut, Lebanon

ARTICLE INFO

Keywords:

Postpartum depression
Postnatal care
Telemedicine
Telehealth
Systematic review
Meta-analysis

ABSTRACT

Background: Postpartum depression, one of the most common forms of depression, is highly prevalent worldwide among women during childbirth. Despite available treatments for postpartum depression, numerous barriers hinder women to access care including time, financial constraints, and childcare concerns. Telemedicine interventions are suggested to be feasible to prevent and improve postpartum depression.

Objective: To examine the effectiveness of telemedicine interventions – delivered exclusively during the postnatal period, on postpartum depression symptomatology in women with no history of mental disorders.

Design: A systematic review and meta-analysis of randomized controlled trials.

Methods: PubMed, Web of Science, Cochrane Library, and ProQuest Dissertations & Theses databases were used to identify relevant randomized controlled trials, until 7 January 2020. Studies were quality assessed using the Cochrane Library Risk of Bias Tool. The results of postpartum depression scores were pooled using a random-effects model. Intervention completion rate and participants' satisfaction were reported in a narrative form, as secondary outcomes.

Results: Ten trials including a total of 2366 participants, contributed data to the review. Seven studies were included in the quantitative synthesis. Women who received technology-based interventions, regardless of the type (web-based versus telephone-based), had a statistically significant improvement in postpartum depression (mean difference: -1.81, 95% CI: -2.68 to -0.93; $P < .0001$). The completion rate was 80% in the intervention groups compared to 76% in the control groups. Three studies reporting participants' satisfaction revealed that the participants were highly satisfied with the technology-based interventions.

Conclusion: Overall, telemedicine interventions appear to be promising in preventing and improving postpartum depression. Further larger-scale high-quality research is required to establish an evidence-based telemedicine approach, in terms of structure, content, and providers. Future economic evaluation is also vital to evaluate the long-term use of telemedicine in improving postpartum depression.

Introduction

Depression is recognized as the largest cause of disability worldwide and a major contributor to the overall global burden of disease (World Health Organization (WHO), 2020). The likelihood of experiencing major depressive episodes is about twice as likely to occur

in women during their lifetime compared with men (Kuehner, 2017; Brody et al., 2018) Kessler et al., 1994; Andrade et al., 2003). This difference is suggested to be correlated with hormonal fluctuations in women such as before menstruation, during pregnancy, postpartum, and at perimenopause (Albert, 2015).

Abbreviations: PPD, postpartum depression; CBT, cognitive-behavior therapy; EPDS, Edinburgh Postnatal Depression Scale; BDI-II, Beck Depression Inventory (BDI-II); IG, intervention group; CG, control group.

* Corresponding author.

E-mail address: n.hanach@maastrichtuniversity.nl (N. Hanach).

<https://doi.org/10.1016/j.midw.2020.102906>

Received 17 August 2020; Received in revised form 7 December 2020; Accepted 12 December 2020

0266-6138/© 2020 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

Maternal postpartum depression (PPD) is one of the most common forms of depression, affecting approximately one in nine women (Ko et al., 2017). PPD is defined as clinical depression that occurs within 4 weeks to 12 months following childbirth (Dennis and Dowswell 2013; Stewart and Vigod, 2016). In a recent systematic review of 58 studies ($n = 37,294$), Shorey et al. (2018) reported a 12% [95% CI 0.04 – 0.20] incidence of PPD and a 17% [95% CI 0.15 – 0.20] overall prevalence of PPD among healthy women without a prior history of depression. A statistical difference in the prevalence between different geographical regions was shown, with the Middle East having the highest prevalence (26%, [95% CI 0.13–0.39]). No specific underlying cause for the development of PPD has been isolated. Conversely, the etiology has been suggested to be multifactorial. Poor social support, a history of mood or anxiety disorder, stressful life events, persistent infant health problems, and marital difficulties were found to be predictors of PPD (Stewart and Vigod, 2016). If left untreated, PPD can develop into long-lasting depression resulting in significant ongoing problems for mother, child, and family (Stewart and Vigod, 2016). Mothers might engage in harmful behaviours such as self-harm and substance abuse, they may neglect their child's physical health by not attending well-child visits, not breastfeeding, and not completing infant immunization (Slomian et al., 2019).

A wide array of effective therapies has been broadly concluded to prevent or treat PPD. This includes person-centered approaches, cognitive-behavioural therapy (CBT), interpersonal psychotherapy, peer support, and educational interventions (Morrell et al., 2016). However, several barriers were reported to hinder women with PPD to receive the appropriate care. This includes time, financial constraints, transportation, childcare concerns, and stigma (Goodman, 2009). Therefore, to prevent PPD and to facilitate the accessibility to treatment, an increased interest in establishing technology-based interventions (e.g. telephone-based, web-based, mobile application, etc.) has been remarked over the past few years. In a recent meta-analysis of 20 randomised controlled trials ($n = 3623$), Huang et al. (2018) concluded that the telephone-based CBT exhibited a significant decrease in maternal postpartum depression ($P < .05$). Additionally, the findings in Barrera et al. (2015) ($n = 111$) and Chan et al. (2019) ($n = 660$) showed that participants receiving internet-based sessions during the antenatal period had a significant reduction of postpartum depression symptoms ($P < .05$). However, results of a qualitative study carried out by Bilszta et al. (2010) showed that when PPD was discussed during antenatal educational sessions, women acknowledged that they lost interest as they believed that they will unlikely have PPD.

Although previous research has examined the overall plausible effect of telemedicine interventions on PPD, to our knowledge, there is limited literature on the effectiveness of various types of telemedicine on PPD – delivered exclusively during the postnatal period. Therefore, this systematic review and meta-analysis aim to evaluate the impact of different types of telemedicine interventions offered during the postnatal period, on maternal postpartum depression. We hypothesize that telemedicine is an efficient approach to mitigating the symptoms of postpartum depression.

Methods

This review was conducted and revised according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). The review was registered on the International Prospective Register of Systematic Reviews (PROSPERO) as CRD42020151454.

Eligibility criteria

The selection of the studies was restricted to full-text and English language published articles.

The following criteria had to be met for studies to be eligible for inclusion in the review:

Types of participants: Women who were 0 to 12-months postpartum, aged 18 years old or more, with a healthy pregnancy, and full-term birth. There was no restriction on the participant's baseline postnatal depression score.

Types of studies: Randomised controlled trials in which the recruited participants were randomly assigned to ≥ 1 intervention group compared to one control group.

Types of interventions: The intervention group receives intervention via any type of telemedicine technology strictly during the postpartum period. This could comprise either telephone (e.g. telephone calls, text messages) or internet-based therapy (e.g. online psychoeducational sessions or CBT, mobile application, emails, video conference, social media platforms, and online chat). The duration of the intervention was not of a concern in the current review.

Types of outcome measures: The primary outcome is the mean maternal postpartum depression score measured post-intervention using Edinburgh Postnatal Depression Scale (EPDS) (Cox et al., 1987a) and or Beck Depression Inventory (BDI-II) (Beck and Gable, 2001a). The validity and reliability of both scales have been well demonstrated across different cultural contexts and in a wide variety of languages (Dennis, 2003; Wang and Gorenstein, 2013).

Intervention completion rate and participants' satisfaction are reported as secondary outcomes.

Exclusion criteria are illustrated in Table (1)Table 1.

Search strategy

Electronic databases including PubMed, Web of Science, Cochrane Library, and ProQuest Dissertations & Theses Database were systematically searched to identify relevant studies for inclusion, with the last search on January 7, 2020. The reference lists of all retrieved articles and existing systematic reviews and meta-analyses were also hand-searched. To identify unpublished trials, study authors were contacted by e-mail and Clinicaltrials.gov was searched. No publication date or publication type restrictions were applied in this review. The following search algorithm was used: (Postpartum depression OR postnatal depression OR maternal depression) AND (telemedicine OR telehealth OR telecommunication OR e-health OR online OR internet OR web-based OR telephone OR mobile OR cell phone OR social media OR mobile application) AND (Postpartum women OR postnatal women OR mothers).

Data extraction

The first selection of studies was done on the title, after which the abstract was inspected, then a full-text read was performed. The following data were extracted and tabulated in an excel spreadsheet: Author (s), publication country, publication year, participants' characteristics (e.g. sociodemographic information, inclusions, and sample size), description of the intervention group and control group (e.g. duration, type of therapy and number of participants), outcome measure and pre- and post-intervention results. Both study selection and data extraction were primarily performed by NH with oversight by two review authors (NdV and HR). All discrepancies were resolved by consensus. In case of missing or unclear key data, the corresponding authors of included studies were contacted to provide further details.

Quality assessment

The quality of randomised controlled trials was evaluated using the risk of bias criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2019). The Cochrane risk of bias tool assesses six specific domains: random sequence generation, allocation sequence concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, and selective outcome reporting (Higgins et al., 2019). A scoring system is not used in this tool, instead, the judgment for each domain is rated as 'low', 'high'

Table 1
Exclusion criteria.

Participants	<ul style="list-style-type: none"> • Pregnant women with more than one child • Women with a preterm birth • Women with existing or a history of psychotic mental illness or any physical, chronic disease • Women who had a complicated pregnancy • Women with existing or a history of substance abuse
Studies	<ul style="list-style-type: none"> • Observational studies • Non-English language papers
Intervention	<ul style="list-style-type: none"> • Mothers who received a telemedicine intervention during preconception and/or antenatal period

or ‘unclear’ risk of bias. The reason for that is to explicitly separate the assessment of internal and external validity (Higgins et al., 2019). Two review authors (NH and NB) independently assessed the quality of retrieved studies, any uncertainties were resolved by consensus. Data were added to the excel file.

Statistical analysis

The meta-analysis was performed using RevMan software (Review Manager, version 5.3.5; The Nordic Cochrane centre, The Cochrane Collaboration, 2014; <http://community.cochrane.org/tools/review-production-tools/revman-5/revman-5-download>). The outcome was analyzed as the post-intervention mean value of postpartum depression (mean \pm SD). When the standard deviation (SD) was not reported, it was computed from the confidence interval using the Cochrane Handbook proposed equation (Higgins et al., 2019), as follows:

$$SD = \sqrt{N \times (\text{upper limit} - \text{lower limit}) / 3.92}$$

The combination approach was used when a study with multiple intervention groups was included in the meta-analysis – all relevant control intervention groups were combined into one single control group as recommended by the Cochrane Handbook (Higgins et al., 2019). For the continuous outcomes, the effect sizes are presented as mean differences (95% CIs). Statistical heterogeneity between the studies was assessed using I^2 . I^2 indicates the percentage of the variability in effect estimates across studies due to heterogeneity rather than sampling error. Substantial heterogeneity was regarded when I^2 was greater than 50%. When no heterogeneity was identified, the results were pooled using a fixed-effects model. A P value <0.05 was considered to be statistically significant.

To investigate whether the changes in the primary outcome were affected by the type of telemonitoring intervention, a subgroup analysis was conducted adjusting for the received mode of therapy (telephone-based vs web-based). Additionally, a sensitivity analysis was undertaken by excluding a single study at a time, to examine the robustness of the overall findings to potentially influential decisions made during the review process (cf. Higgins et al., 2019).

Results

Fig. 1 illustrates the flow of study selection throughout the review process. A total of 375 articles were identified after the electronic search. Abstracts and titles screening lead to the exclusion of 361 articles. Out of which 3 studies recruited pregnant women, 2 studies were not randomised controlled trials, 1 study evaluated a different primary outcome measure, and the remaining contained irrelevant content. A further full-text screening resulted in the exclusion of 6 studies due to the inclusion of participants with a history of depression or with the existing use of psychiatric medications. Besides, after the manual search of references of key articles and existing reviews 2 articles were retrieved. Therefore, a total of 10 studies published between 2013 and 2019 were included in this systematic review; out of these, seven were included in the meta-analysis. Two studies were conducted in Iran, the UK, and Singapore, while one study was carried out in Canada, China, USA, and Australia.

Study characteristics

Table 2 presents a summary of the characteristics of the included studies. A total of 2366 participants from 10 studies with a mean age \pm SD between 26.5 ± 5.5 and 32.25 ± 5.2 years were included in this review. On average, 54% of mothers had an undergraduate degree (all trials), 45% were employed (Mohammad-Alizadeh-Charandabi et al., 2013; O'mahen et al., 2013a, 2013b; Ngai et al., 2015; Sawyer et al., 2019), 84% were married (O'mahen et al. 2013a; O'mahen et al., 2013b; Wozney et al., 2017; Boyd et al., 2018; Shorey et al., 2019; Sawyer et al., 2019; Jiao et al., 2019) and 57% had vaginal childbirth (Mohammad-Alizadeh-Charandabi et al., 2013; Milani et al., 2015; Ngai et al., 2015; Sawyer et al., 2019; Jio et al., 2019). No significant differences in sociodemographic variables have been reported between groups at baseline, except for employment status in O'mahen et al. (2013a) and Sawyer et al. (2019). In 6 trials, the recruitment of participants was restricted to baseline postpartum depression severity level as well as EPDS score (O'mahen et al., 2013a, 2013b; Ngai et al., 2015; Boyd et al., 2018; Sawyer et al., 2019; Shorey et al., 2019). Whereas in the remaining 4 studies, women's enrollment was not limited to baseline EPDS score.

Intervention

All trials had one intervention and one control study arm except in Jiao et al. (2019) where a co-intervention group received a home-based psychoeducational intervention. The duration of the intervention ranged from 4 weeks to 17 weeks among studies. The types of interventions of interest can be sub-grouped into four main categories: (1) telephone support (2) mobile application (3) social media (4) websites. In O'mahen et al. (2013b) the intervention group received telephone calls besides the web-based primary intervention. Interventions were carried by trained nurses (Mohammad-Alizadeh-Charandabi et al., 2013; Milani et al., 2015; Ngai et al., 2015; Sawyer et al., 2019), peer volunteers (Shorey et al., 2019), trained facilitators (Boyd et al., 2018), research assistants (Jiao et al., 2019), and specialist health visitors along with service users (O'mahen et al., 2013a, 2013b). Psychological therapy approaches such as CBT and psychoeducation were mainly used among the selected studies ($n = 7$). Additionally, in most of the trials, routine or standard care was accessible to participants in the intervention group.

Comparison

In all trials, the control group received routine or standard postpartum care either at the hospital or by a home visit nurse, except in Boyd et al. (2018) where the comparison group received an in-person psychoeducation intervention. In Wozney et al. (2017), the control group received additional two 'Ask Dr. Pat' columns specific to depression and PPD ('Ask Dr. Pat' is an evidence-based weekly column that appears in a local newspaper) as well as an informative brochure on PPD, its causes, and its treatment options.

Quality assessment

Figs. 2 and 3 show the risk of bias graph and summary, respectively. In this systematic review, the high risk of bias was attributed

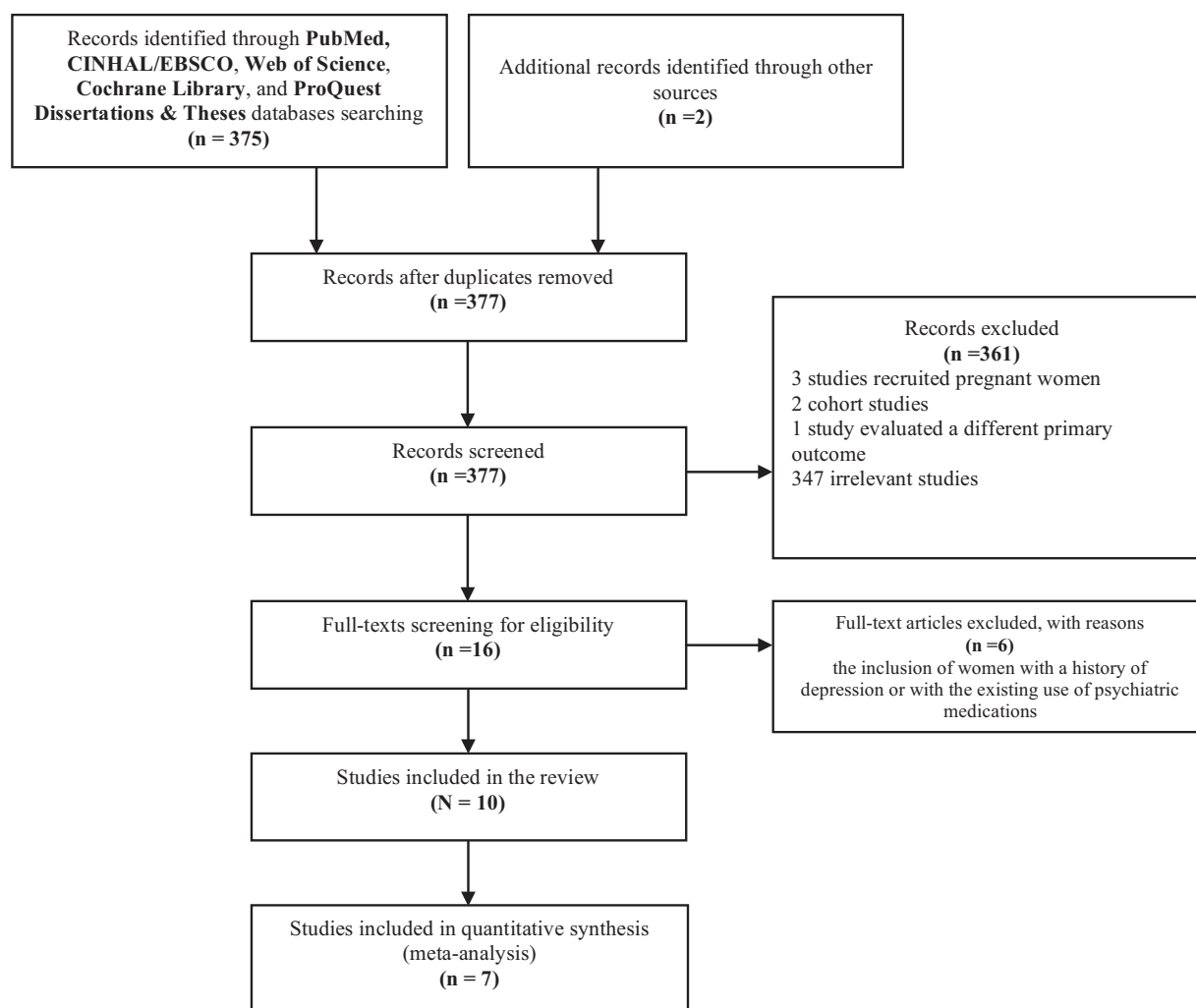


Fig. 1. PRISMA Flow Diagram.

Table 2

Characteristics of the included randomised controlled trials.

Author (s) (Publication date)	Region	Total number of participants	Mean age ± standard deviation	Intervention Group	Duration of intervention	Control Group	Outcome measuring tool
(Mohammad-Alizadeh-Charandabi et al., 2013)	Iran	403	26.5 ± 5.5	Telephone calls + usual care	6-week	Usual care	EPDS
O'mahen et al. (2013a)	United Kingdom	299	32.25 ± 5.2	Web-based	15-week	Usual care	EPDS
O'mahen et al. (2013b)	United Kingdom	71	> 18 y (not specified)	Web-based program + telephone calls	17-week	Usual care	EPDS
(Milani et al., 2015)	Iran	54	27.98 ± 6.08	Web-based	6-week	Usual care	EPDS
Ngai et al. (2015)	China	397	30.8 ± 4.1	Telephone calls + usual care	6-week	Usual care	EPDS
(Boyd et al., 2018)	USA	24	26.35 ± 1.85	Facebook group	8-week	Similar to intervention but delivered in-person	BDI-II
Wozney et al. (2017)	Canada	62	28.95 ± 4.75	Telephone calls + educational handbook and videos	12-week	'Ask Dr. Pat' 2 weekly columns + Informative brochure + encouraged for usual care	BDI-II
Sawyer et al. (2019)	Australia	111	31.65 ± 4.5	Mobile application	16-week	Usual care	EPDS
Shorey et al. (2019)	Singapore	64	32.05 ± 4.35	Telephone calls/ emails/ WhatsApp	4-week	Usual care	EPDS
Jiao et al. (2019)	Singapore	127	30.6 ± 3.8	Web-based + routine care	4-week	Usual care	EPDS

Abbreviations: EPDS, Edinburgh Postnatal depression scale; BDI-II, Beck Depression Inventory-II.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)
Boyd et al. 2018	+	+	+	-	+	+
Charandabi et al. 2013	?	-	+	-	-	+
Jiao et al., 2019	+	+	+	+	+	+
Milani et al., 2015	+	+	+	+	?	+
Ngai et al., 2015	+	+	+	+	+	+
O'mahen et al., 2013a	+	+	+	+	+	+
O'mahen et al., 2013b	+	+	+	+	+	+
Sawyer et al., 2019	+	?	+	-	+	+
Shorey et al., 2019	+	+	+	+	+	+
Wozney et al. 2017	+	+	+	+	+	+

Fig. 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study. Green (+): Low risk of bias; Yellow (?): Unclear risk of bias; Red (-): High risk of bias.

to the lack of allocation concealment, attrition bias (Mohammad-Alizadeh-Charandabi et al., 2013), and lack of outcome assessors blinding (Mohammad-Alizadeh-Charandabi et al., 2013; Boyd et al., 2018; Sawyer et al., 2019). The insufficient description of the used random sequence generation (Mohammad-Alizadeh-Charandabi et al., 2013) and allocation concealment methods (Sawyer et al., 2019), as well as not reporting the reasons of missing data across groups (Milani et al., 2015), resulted in an unclear risk of bias judgment. Due to the nature of interventions in all the trials, blinding of participants was not feasible, and thus a low risk of bias was stated.

Primary outcome

Postpartum Depression

The meta-analysis of the mean difference in mean post-intervention values of postpartum depression score included 7 studies with 521 participants in intervention group and 585 participants in control group (Fig. 4). The remaining studies were not included due to differences in data reporting. Findings showed a significant decrease in postpartum depression score post-intervention – measured using EPDS, with a mean difference of -1.81, 95% CI: -2.68 to -0.93 (P<.0001) and a moderate heterogeneity between the studies (I²=52%). When a sensitivity analysis was conducted, the elimination of O'mahen et al. (2013a) led to I = 0% without altering the overall effect (mean difference: -1.26, 95% CI: -1.82 to 0.70; P<.0001). Therefore, results should be interpreted with caution. In Boyd et al. (2018), the obtained results showed that the mean total depression score on the BDI-II has significantly decreased from baseline to post-intervention in the social media group (29.5 ± 2.3 to 20.2 ± 2.2, respectively, P<.01) compared to the in-person group. Conversely, the telephone-based intervention in Wozney et al. (2017), showed no significant in-between groups difference in the EPDS and BDI-II scores after 12 weeks. Ngai et al. (2015) reported statistically significant differences in mean EPDS scores at 6-week post-intervention between the intervention group and control group (P=.028). Differences between groups remained statistically significant when a subgroup analysis of mothers with minor and major depression was conducted (mean difference for EPDS score: 1.90, 95% CI: 0.72 to 3.08; P = 0.002 and 5, 95% CI:3.12 to 6.88; p < .001, respectively).

Subgroup analysis

The results of the subgroup analysis (Fig. 4.) stratified by the type of intervention showed a statistically significant overall effect of both telephone-based and web-based interventions on postpartum depression scores, however, the effect of telephone-based interventions was

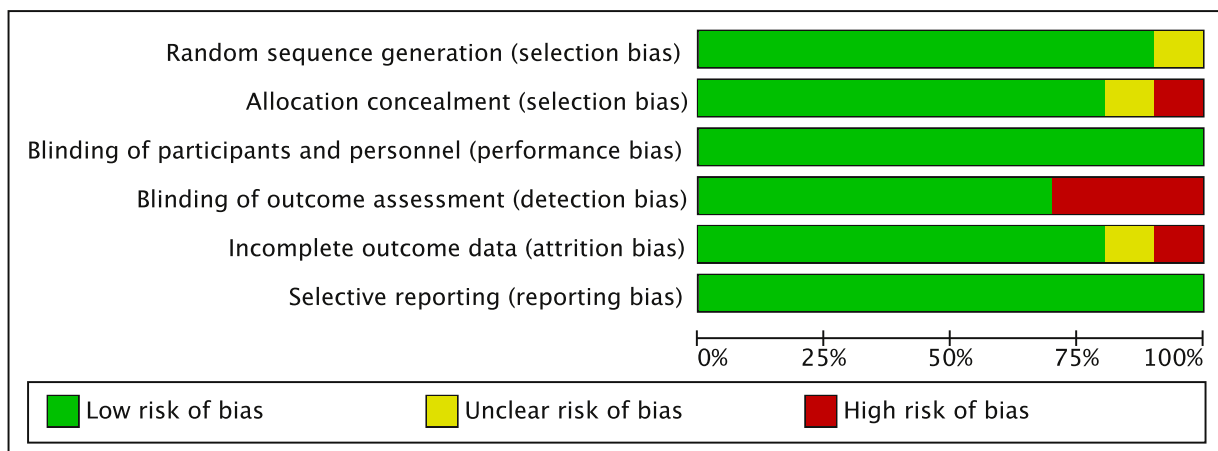


Fig. 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

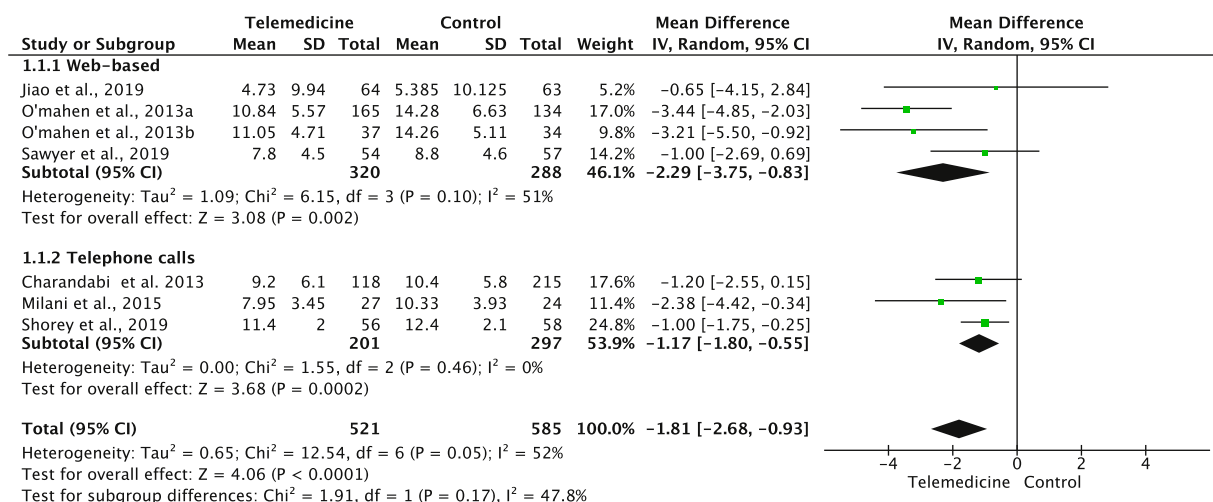


Fig. 4. Forest plot showing results of the subgroups analysis of the mean difference in mean post-intervention values of postpartum depression score according to the type of telemedicine intervention.

larger than the web-based interventions (mean difference: -2.26, 95% CI: -3.76 to -0.77; P=.003 and -1.17, 95%: -1.80 to -0.55; P=.0002, respectively).

Follow-up

A follow-up assessment has been performed in 6 studies. O'mahen et al. (2013b) reported a large effect size on EPDS (-0.678, 95% CI: -1.121 to -0.236) favoring the intervention group over the control group at 6-month post-intervention (mean difference: -2.28, 95% CI: -5.41 to 0.84). Ngai et al. (2015) revealed that EPDS remained significantly lower in the control group with minor depression group (P=.034) as compared with the major depression group (P=.064), at 6-months postpartum. In Shorey et al. (2019), changes in EPDS at 3-month post-intervention became statistically significant in the intervention group compared to the control group, after adjusting for covariates (P=.03). Similar results were observed in Jiao et al. (2019) at 3-month in the intervention group (P=.017), however, EPDS appeared to increase at 6-month post-intervention in the intervention group and thus no statistically significant changes have been reported. While Sawyer et al. (2019) reported that the statistically significant difference in EPDS between groups remained at 12-month (P=.001). On the other hand, Wozney et al. (2017) uncovered no significant changes in the intervention group for EPDS and BDI-II at 6 and 12-month.

Secondary outcomes

Completion rate and satisfaction

All trials reported the completion rate of the post-intervention assessment. Only 3 studies evaluated participants' satisfaction. Participants reported satisfaction with the intervention they received in Wozney et al. (2017), Boyd et al. (2018), and Jiao et al. (2019). The completion rate of post-intervention assessment varied between studies from 39% to 96% (Average: 80%) in the intervention group compared to 3% to 99% (Average: 76%) in the control groups. The participants also claimed usefulness of the intervention in increasing their knowledge about infant's development, parental and emotional information, as well as engaging and receiving support from coaches/ nurses and other members/ mothers (Wozney et al., 2017 and Sawyer et al., 2019).

Discussion

This review aims to systematically evaluate the efficacy of telemedicine interventions – delivered exclusively during the postna-

tal period – for improving maternal postpartum depression. Findings of the meta-analysis highlighted the significantly favourable effects of telemedicine interventions on maternal postpartum depression. Overall, compliance rates and participants' satisfaction appeared to be promising and positive across studies. In the subgroup analysis, no significant difference was found between the telephone-based and web-based groups for improving PPD symptoms.

Several studies have examined the perception of technology-based interventions by mothers in the postnatal period and potential variables mediating its effectiveness on PPD. In a recent qualitative study carried by Shorey and Ng (2019), results showed that the provision of a telephone-based peer-support intervention program was successfully perceived by mothers at risk of PPD. The majority of participants affirmed to have reduced negative feelings and to receive fulfilling emotional support (Shorey and Ng, 2019). In (Loughnan et al., 2019), the delivery of a web-based CBT therapy to women during the postpartum period has demonstrated a large improvement in PPD symptoms as well as a significant increase in parenting confidence and psychological quality of life (p < .001). Similarly, Ngai et al. (2017) found that women who received telephone-based CBT experienced significant improvement in both mental (p = 0.03) and physical health-related quality of life (p < .01). An increase in maternal (Jiao et al., 2019) and parental self-efficacy (Shorey et al., 2017) has also been reported in participants receiving internet theory-based psychoeducational intervention and mobile-health educational programs, respectively. Therefore, a possible explanation for the current meta-analysis findings is that telemedicine interventions have lowered postpartum depression symptomatology by enhancing maternal emotional wellbeing, parenting confidence, maternal and parental self-efficacy, and quality of life. Further research is needed to define and confirm the underlying mediators.

Although results of the subgroup analysis showed no significant difference between the different types of telemedicine interventions, it is important to note that in O'mahen et al. (2013b) the web-based intervention was also supported by telephone calls from certified mental health workers. When a sensitivity analysis was performed, the exclusion of O'mahen et al. (2013b) led to the absence of a statistically significant effect of a web-based group on PPD (p = .05) compared to the telephone-based one, without affecting the overall results (p < .001). Perhaps, this has created an overestimation of the positive effect of the web-based interventions and thus, could limit the accuracy of the findings. Additionally, O'mahen et al. (2013b) revealed that the provision of telephone guidance in the internet-based intervention group was associated with considerably less attrition. This is consistent with the results

of a pragmatic randomised controlled trial that illustrated an increase of use of computerized CBT by a factor of 1.5 to 2-fold with telephone facilitation compared to minimally supported CBT, besides significantly decreasing depression severity in individuals with depression ($p < .05$) (Gilbody et al., 2017). Consequently, this suggests further investigations to help explicate the effective component of the intervention, whether it is web-based or telephone-supported or the combination of both.

There was a noticeable discrepancy in the PPD scores at different follow-up points between studies. This could be attributed to the intervention duration, as studies with longer therapy duration and higher intensity (O'mahen et al., 2013b and Sawyer et al., 2019) (Table 2) tended to maintain a statistically significant impact on PPD for up to 6 and 12 months. Another contributing factor could be the severity level of postpartum depression as findings of Ngai et al. (2015) showed that the intervention effect was no longer statistically significant at 6-month for women with major depression (EPDS>13). Wozney et al. (2017) argued that the effective response to treatment at 3 and 6-month follow-up was dose-dependent as participants had a 1.4 times greater chance of showing improvement in postpartum depression with every additional session of treatment. Thus, designing trials to provide an in-depth analysis of the appropriate intervention duration, intensity, and period of follow-up is crucial for PPD prevention.

In terms of feasibility and acceptability of the technology-based interventions for postpartum depression, our findings are consistent with the available evidence. Postmontier et al. (2016) affirmed the effectiveness and feasibility of telephone-administered interpersonal psychotherapy in women with postpartum depression. Similarly, in a systematic review of a total of 178 quantitative and qualitative studies, Morrell et al. (2016) found that the delivery of intervention sessions over the phone for postnatal depression increases the feasibility and acceptability of the intervention as well as adherence. Web-based peer-support (Baumel et al., 2018) and psychoeducational (Haga et al., 2013) interventions were also confirmed to have high usability and acceptance among participants.

Several factors must be considered when interpreting the findings of the meta-analysis. None of the included studies has adjusted the results for the correlates of postpartum depression. (Sylvén et al., 2016) identified that delivery mode, anxiety proneness before and during pregnancy, and subjective problems with the baby as predicting factors of postpartum depressive symptoms in women with no previous psychiatric contact. Only five studies (O'mahen et al., 2013a, 2013b; Boyd et al., 2018; Jiao et al., 2019; Sawyer et al., 2019) have adjusted for the baseline outcome scores. This might have influenced the precision of the findings and created potential bias. In Wozney et al. (2017) and Sawyer et al. (2019), participants were offered "Thank you" gifts and reimbursement up to \$100, respectively, after completing each of the study follow-up assessments. As a result, a participation bias could have occurred and affected the interventions' adherence and completion rate. Six studies (O'mahen et al., 2013a; Milani et al., 2015; Ngai et al., 2015; Boyd et al., 2018; Shorey et al., 2019; Sawyer et al., 2019) have restricted the participants' recruitment based on the baseline depression scores, this limits the findings to be generalized to the entire population of interest (i.e. mothers during the postnatal period). In Wozney et al. (2017) and Jiao et al. (2019), postpartum depression outcome measures were not identified as primary outcomes, and thus these studies might have not been adequately powered to detect statistically significant changes in depression scores.

Strengths and limitations

This review has several limitations that could influence the external validity of the findings. The number of selected studies in the meta-analysis was relatively small. Trial authors also commented on small sample sizes. Duration of interventions in half of the studies was generally short. Only a few studies have performed follow-up assessments to evaluate the long-term impact of the interventions. There was a method-

ological heterogeneity between the studies in terms of type, content, and providers of the interventions. Despite the limitations, this systematic review and meta-analysis have multiple strengths. To the best of our knowledge, this is the first review to highlight the plausible impact of telemedicine interventions delivered exclusively during the postnatal period on postpartum depression, in women with no previous history of mental health disorders. It was conducted according to the PRISMA statement (Moher et al., 2009). The measuring tools used to identify PPD are valid and reliable and could be applied in clinical and research settings. More than half of the included studies were of high quality. The selected trials were geographically and ethnically diverse. The meta-analysis was stratified by the type of intervention. Finally, the authors showed full transparency in each phase of the synthesis process to allow the reader to recognize the critical appraisal of the compiled information.

Conclusion

Compared with standard care, telemedicine interventions significantly decreased postpartum depression symptoms and demonstrated feasibility and acceptability among mothers in the postnatal period. However, the findings of this review highlight the need for larger-scale high-quality randomised controlled trials to evaluate the impact of technology-based interventions on postpartum depression in the short and long-term. To investigate and establish the appropriate telemedicine approach, whether to combine telephone and web-based interventions or not, as well as to standardize and structure the content of the interventions. Another factor to explore is the accountable intervention providers, to determine whether peer volunteers, nurses or mental health workers should deliver the interventions. Future studies should also consider identifying the effectiveness of telemedicine interventions on other potential outcomes that are relevant in the context of postpartum depression such as maternal self-efficacy, infant development, and relationship with partner (Slomian et al., 2019). Future economic evaluation involving cost-utility and cost-effectiveness analyses is imperative to estimate the long-term benefits of telemedicine on the prevention of postpartum depression.

Ethical approval

Not applicable.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

None declared.

Acknowledgements

All authors have read and approved the final manuscript.

References

- Albert, P., 2015. Why is depression more prevalent in women? *J. Psychiatry Neurosci.* 40, 219–221. doi:10.1503/jpn.150205.
- Barrera, A., Wickham, R., Muñoz, R., 2015. Online prevention of postpartum depression for Spanish- and English-speaking pregnant women: a pilot randomized controlled trial. *Internet Interv.* 2, 257–265. doi:10.1016/j.invent.2015.06.002.
- Baumel, A., Tinkelman, A., Mathur, N., Kane, J., 2018. Digital peer-support platform (7Cups) as an adjunct treatment for women with postpartum depression: feasibility, acceptability, and preliminary efficacy study. *JMIR mHealth and uHealth* 6, e38. doi:10.2196/mhealth.9482.
- Beck, C., Gable, R., 2001. Comparative analysis of the performance of the postpartum depression screening scale with two other depression instruments. *Nurs. Res.* 50, 242–250. doi:10.1097/00006199-200107000-00008.

- Bilszta, J., Ericksen, J., Buist, A., Milgrom, J., 2010. Women's experience of postnatal depression-beliefs and attitudes as barriers to care. *Aust. J. Adv. Nurs.* 27 (3), 44 The.
- Boyd, R., Price, J., Mogul, M., Yates, T., Guevara, J., 2018. Pilot RCT of a social media parenting intervention for postpartum mothers with depression symptoms. *J. Reprod. Infant. Psychol.* 37, 290–301. doi:10.1080/02646838.2018.1556788.
- Brody, D.J., Pratt, L.A., Hughes, J.P., 2018. Prevalence of depression among adults aged 20 and over: united States, 2013–2016. In: US Department of Health and Human Services, Centers for Disease Control and Prevention. National Center for Health Statistics, pp. 1–8.
- Mohammad-Alizadeh-Charandabi, S., Malakoti, J., Sohrabi, F., Shokranian, N., 2013. The Effect of telephone support on postpartum depression: a randomized controlled trial. *J. Caring Sci* 2 (2), 147. doi:10.5681/jcs.2013.018.
- Cox, J., Holden, J., Sagovsky, R., 1987. Detection of Postnatal Depression. *Br. J. Psychiatry* 150, 782–786. doi:10.1192/bjp.150.6.782.
- Dennis, C.-L., 2003. In: Stewart, D.E., Robertson, E., Dennis, C.-L., Grace, S.L., Wallington, T. (Eds.). *Postpartum depression: Literature review of risk factors and interventions*.
- Dennis, C., Dowswell, T., 2013. Psychosocial and psychological interventions for preventing postpartum depression. *Cochrane Datab. System. Rev.* doi:10.1002/14651858.cd001134.pub3.
- Gilbody, S., Brabyn, S., Lovell, K., Kessler, D., Devlin, T., Smith, L., Araya, R., Barkham, M., Bower, P., Cooper, C., Knowles, S., 2017. Telephone-supported computerised cognitive-behavioural therapy: REEACT-2 large-scale pragmatic randomised controlled trial. *Br J Psychiatry* 210 (5), 362–367. doi:10.1192/bjp.bp.116.192435.
- Goodman, J., 2009. Women's attitudes, preferences, and perceived barriers to treatment for perinatal depression. *Birth* 36, 60–69. doi:10.1111/j.1523-536x.2008.00296.x.
- Haga, S., Drozd, F., Brendryen, H., Slinning, K., 2013. Mamma mia: a feasibility study of a web-based intervention to reduce the risk of postpartum depression and enhance subjective well-being. *JMIR Res. Protoc.* 2, e29. doi:10.2196/resprot.2659.
- Higgins, J.P., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M.J., 2019. In: Welch, V.A. (Ed.), eds. *John Wiley & Sons*.
- Huang, L., Zhao, Y., Qiang, C., Fan, B., 2018. Is cognitive behavioral therapy a better choice for women with postnatal depression? a systematic review and meta-analysis. *PLoS ONE* 13, e0205243. doi:10.1371/journal.pone.0205243.
- Jiao, N., Zhu, L., Chong, Y., Chan, W., Luo, N., Wang, W., Hu, R., Chan, Y., He, H., 2019. Web-based versus home-based postnatal psychoeducational interventions for first-time mothers: a randomised controlled trial. *Int. J. Nurs. Stud.* 99, 103385. doi:10.1016/j.ijnurstu.2019.07.002.
- Ko, J., Rockhill, K., Tong, V., Morrow, B., Farr, S., 2017. Trends in postpartum depressive symptoms — 27 States, 2004, 2008, and 2012. *MMWR. Morbid. Mortal. Weekly Rep.* 66, 153–158. doi:10.15585/mmwr.mm6606a1.
- Kuehner, C., 2017. Why is depression more common among women than among men? *The Lancet Psychiatry* 4 (2), 146–158. doi:10.1016/S2215-0366(16)30263-2.
- Loughnan, S.A., Butler, C., Sie, A.A., Grierson, A.B., Chen, A.Z., Hobbs, M.J., Joubert, A.E., Haskelberg, H., Mahoney, A., Holt, C., Gemmill, A.W., 2019. A randomised controlled trial of 'MUMentum postnatal': internet-delivered cognitive behavioural therapy for anxiety and depression in postpartum women. *Behave Res Ther* doi:10.1016/j.brat.2019.03.001.
- Milani, H.S., Azargashb, E., Beyraghi, N., Defaie, S., Asbaghi, T., 2015. Effect of telephone-based support on postpartum depression: a randomized controlled trial. *Int. j. fertil. steril.* 9 (2), 247. doi:10.22074/ijfs.2015.4246.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., The Prisma Group, 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS med* 6 (7). doi:10.1371/journal.pmed.1000097. p. e1000097.
- Morrell, C., Sutcliffe, P., Booth, A., Stevens, J., Scope, A., Stevenson, M., Harvey, R., Bessey, A., Cantrell, A., Dennis, C., Ren, S., Ragonesi, M., Barkham, M., Churchill, D., Henshaw, C., Newstead, J., Slade, P., Spiby, H., Stewart-Brown, S., 2016. A systematic review, evidence synthesis and meta-analysis of quantitative and qualitative studies evaluating the clinical effectiveness, the cost-effectiveness, safety and acceptability of interventions to prevent postnatal depression. *Health Technol. Assess. (Rockv)* 20, 1–414. doi:10.3310/hta20370.
- Ngai, F., Wong, P., Leung, K., Chau, P., Chung, K., 2015. The effect of telephone-based cognitive-behavioral therapy on postnatal depression: a randomized controlled trial. *Psychother. Psychosom.* 84, 294–303. doi:10.1159/000430449.
- Ngai, F., Wong, P., Chung, K., Leung, K., 2017. The effect of a telephone-based cognitive behavioral therapy on quality of life: a randomized controlled trial. *Archives of Women's Mental Health* 20, 421–426. doi:10.1007/s00737-017-0722-0.
- O'Mahen, H., Richards, D., Woodford, J., Wilkinson, E., McGinley, J., Taylor, R., Warren, F., 2013a. Netmums: a phase II randomized controlled trial of a guided Internet behavioural activation treatment for postpartum depression. *Psychol. Med.* 44, 1675–1689. doi:10.1017/s0033291713002092.
- O'Mahen, H., Woodford, J., McGinley, J., Warren, F., Richards, D., Lynch, T., Taylor, R., 2013b. Internet-based behavioral activation—Treatment for postnatal depression (Netmums): a randomized controlled trial. *J. Affect. Disord.* 150, 814–822. doi:10.1016/j.jad.2013.03.005.
- Posmontier, B., Neugebauer, R., Stuart, S., Chittams, J., Shaughnessy, R., 2016. Telephone-Administered Interpersonal Psychotherapy by Nurse-Midwives for Postpartum Depression. *J. Midwifery Womens Health* 61, 456–466. doi:10.1111/jmwh.12411.
- Sawyer, A., Kaim, A., Le, H., McDonald, D., Mittinty, M., Lynch, J., Sawyer, M., 2019. The Effectiveness of an app-based nurse-moderated program for new mothers with depression and parenting problems (eMums Plus): pragmatic randomized controlled trial. *J. Med. Internet Res.* 21, e13689. doi:10.2196/13689.
- Shorey, S., Chee, C., Ng, E., Chan, Y., Tam, W., Chong, Y., 2018. Prevalence and incidence of postpartum depression among healthy mothers: a systematic review and meta-analysis. *J. Psychiatr Res.* 104, 235–248. doi:10.1016/j.jpsychires.2018.08.001.
- Shorey, S., Ng, E., 2019. Evaluation of a technology-based peer-support intervention program for preventing postnatal depression (part 2): qualitative study. *J. Med. Internet Res.* 21, e12915. doi:10.2196/12915.
- Shorey, S., Chee, C., Ng, E., Lau, Y., Dennis, C., Chan, Y., 2019. Evaluation of a Technology-Based Peer-Support Intervention Program for Preventing Postnatal Depression (Part 1): randomized Controlled Trial. *J. Med. Internet Res.* 21, e12410. doi:10.2196/12410.
- Slomian, J., Honvo, G., Emonts, P., Reginster, J., Bruyère, O., 2019. Consequences of maternal postpartum depression: a systematic review of maternal and infant outcomes. *Women's Health* 15, 174550651984404. doi:10.1177/1745506519844044.
- Stewart, D., Vigod, S., 2016. Postpartum depression. *N. Engl. J. Med.* 375, 2177–2186. doi:10.1056/nejmcp1607649.
- Sylvén, S., Thomopoulos, T., Kollia, N., Jonsson, M., Skalkidou, A., 2016. Correlates of postpartum depression in first time mothers without previous psychiatric contact. *Eur. Psychiatry* 40, 4–12. doi:10.1016/j.eurpsy.2016.07.003.
- Wang, Y., Gorenstein, C., 2013. Psychometric properties of the Beck Depression Inventory-II: a comprehensive review. *Revista Brasileira de Psiquiatria* 35, 416–431. doi:10.1590/1516-4446-2012-1048.
- World Health Organization (WHO) (2020) Depression [Online]. Available at: <https://www.who.int/news-room/fact-sheets/detail/depression> [Accessed Jan 5 2020].
- Wozney, L., Olthuis, J., Lingley-Pottie, P., McGrath, P., Chaplin, W., Elgar, F., Cheney, B., Huguet, A., Turner, K., Kennedy, J., 2017. Strongest Families™ Managing Our Mood (MOM): a randomized controlled trial of a distance intervention for women with postpartum depression. *Arch. Womens Ment. Health* 20, 525–537. doi:10.1007/s00737-017-0732-y.