

Effect of Parenting Interventions on Perinatal Depression and Implications for Infant Developmental Outcomes: A Systematic Review and Meta-Analysis

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Abstract

Considering the significant impact of perinatal depression on both maternal wellbeing and infant development, it is important to examine the effectiveness of interventions designed to prevent or reduce these risks. This systematic review and meta-analysis synthesised evidence on parenting intervention in relation to how such programs affect symptoms of perinatal depression and infant outcomes within 12 months postpartum. We followed the Cochrane Collaboration guidelines on conducting systematic reviews and meta-analyses. A total of five electronic databases were searched for controlled trials that met pre-determined eligibility criteria. Outcomes of interest were maternal depressive symptoms and infants' language, motor and socioemotional development. Seventeen studies involving 1665 participants were included in the systematic review. Estimates from a random-effects model of 15 studies in the final meta-analysis revealed statistically significant reductions in maternal depressive symptoms at post-intervention for mothers allocated to receive parenting interventions (SMD = -0.34, 95%CI = -0.44, -0.24; $z = 6.48$, $p < 0.001$; $I^2 = 0\%$). Data on infant development outcomes from the included studies were scarce and therefore, infant outcomes were not analysed in this review. For individual study outcomes, the majority of studies reported a general trend for reductions in maternal depressive symptoms from pre- to post-intervention. Although parenting interventions are frequently considered preventive strategies that are designed to offer support to parents and impart skills that promote their physical and psychological wellbeing, our findings suggest that these interventions have a positive effect on perinatal depressive symptoms. Implications and recommendations for future research are addressed. The systematic review protocol was registered with PROSPERO 2020 CRD42020184491.

Keywords: parenting; parenting interventions; perinatal depression; infant outcomes; systematic review; meta-analysis

Introduction

The time preceding the birth of a baby and the 12 months postpartum is often considered a sensitive period for both mother and child. In this perinatal phase, the mental health of the mother is critical in influencing good outcomes for both her pregnancy and the baby's development. However, mental health conditions such as depression can disrupt the normal processes and adversely affect mothers' health and infants' development. Depression is common in pregnancy with 10–20% of women likely to develop depression during pregnancy or within the first-year postpartum (Bauer, Knapp, & Parsonage, 2016; Evans, Heron, Francomb, Oke, & Golding, 2001; The US Preventive Services Task Force, 2019). Perinatal depression can have significant effects on the mother-baby pair with the potential for long lasting negative consequences (Dimidjian; & Goodman, 2009) and may put women at increased risk of negative experiences like disillusionment, reduction in the quality of mother-child interaction, impairment in the mother-child relationship, and in some cases, thoughts of suicide or harming their infants (Cooper, De Pascalis, Woolgar, Romaniuk, & Murray, 2015; Donahue Jennings, Ross, Popper, & Elmore, 1999; Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010). Untreated depressive symptoms may also impact on the mother's ability to provide sensitive and responsive parenting since depression can inhibit displays of positive maternal behaviours that scaffold children's neurocognitive and physical development like praising and playing with the infant (Lovejoy, Graczyk, O'Hare, & Neuman, 2000; Mantis, Mercuri, Stack, & Field, 2019; Whittaker, Harden, See, Meisch, & Westbrook, 2011).

For infants, maternal perinatal depression may have multiple negative effects which can adversely influence short- and long-term health and developmental outcomes. For instance, infants born to depressed mothers are at increased risk of delayed cognitive and socio-emotional development, behaviour problems, and increased susceptibility to psychiatric

disorders in later life (Beck, 1998; Deave, Heron, Evans, & Emond, 2008; Goodman et al., 2011; Santos, Matijasevich, Barros, & Barros, 2014). In addition, infants born to depressed mothers are more likely to experience lower intensity of breastfeeding and/or early cessation of breastfeeding (Gaffney, Kitsantas, Brito, & Swamidoss, 2014; Wouk, Stuebe, & Meltzer-Brody, 2017) and receive fewer preventive health services like vaccinations (Minkovitz et al., 2005).

Existing research

Previous studies on interventions for maternal perinatal depressive symptoms have examined different treatment options including the use of medication (Appleby, Warner, Whitton, & Faragher, 1997; Yonkers, Lin, Howell, Heath, & Cohen, 2008). However, the uptake of pharmacological antidepressants during the perinatal period is low, and only 18% of women diagnosed with depression receive either psychological or psychiatric treatment (Marcus, 2009). Low uptake of antidepressants could be linked to concerns around the effects that medications may have on infant development. A systematic review by Suri and colleagues (Suri, Lin, Cohen, & Altshuler, 2014) found that the use of selective serotonin reuptake inhibitors (SSRI) in pregnancy could disrupt the child's motor and language development. Controversies around the use of antidepressants during the perinatal period (Ornoy & Koren, 2014) and evidence suggesting that the presence of antidepressants in breast milk could impact infants' development (Schoretsanitis et al., 2019; Wisner, Perel, & Findling, 1997) may partly explain why depressed mothers are reluctant to seek pharmacological treatment. However, as discussed by Casper (2015), the risks of antidepressant use in pregnancy are relatively low and the benefits frequently outweigh the risks of untreated depression, which may contribute to reduced antenatal care, poor feeding, suicidal ideation and substance use (Robinson, 2015).

Importantly, there is evidence supporting the use of interventions such as home-visits, peer support, family therapeutic interventions and psychotherapy in the prevention and treatment of perinatal depressive symptoms (Burger et al., 2020; Cluxton-Keller & Bruce, 2018; Dennis, 2014; Sharma & Sharma, 2012). In particular, evidence-based family behavioural interventions, which focus on parenting as a mechanism for improving maternal, child and family outcomes, have been found to be effective for perinatal depression in primiparous and multiparous women (Cluxton-Keller & Bruce, 2018). As noted in previous reviews and meta-analyses (Dennis & Dowswell, 2013; Wyatt Kaminski, Valle, Filene, & Boyle, 2008), interventions aimed at improving effective parenting also have the potential to reduce incidence of perinatal depression; however, it is unclear to what extent parenting interventions are effective in reducing perinatal depression as a main treatment outcome.

Earlier reviews and meta-analyses of psychotherapy involving parent-child outcomes have reported significant effects. For instance, Cuijpers, Weitz, Karyotaki, Garber, and Andersson (2015) conducted a meta-analysis on psychotherapy for maternal depression and mother-child interactions and found significant effects. Likewise, a review by Meaney (2018) observed that interventions which are effective for maternal depression may also improve child outcomes decreasing risk factors for impaired child development. This observation is supported by the meta-analytic findings of a previous review of a multi-level system of parenting support by Sanders, Kirby, Tellegen, and Day (2014) which reported significant short-term effects for children's social, emotional and behavioural outcomes ($d = 0.473$), and parental adjustment ($d = 0.340$). Also, a systematic review of group-based parent training programs for improving parental psychosocial health by Barlow, Smailagic, Huband, Roloff, and Bennett (2014) found significant results for short-term improvements in parental depression for mothers with children across all ages. Despite favourable findings from past reviews in support of parenting interventions and psychotherapy for parent-child outcomes in

the general population, it is still unclear whether parenting interventions have a significant effect on maternal depression and infant outcomes during the perinatal period.

A recent systematic review and meta-analysis involving six studies which examined the effect of parenting interventions on the parent-child relationship where depression was a risk factor did not find a significant effect (Rayce, Rasmussen, Væver, & Pontoppidan, 2020). While the non-significant findings of this review are not in contention, it is noteworthy that the study did not attempt to evaluate the effects of parenting intervention on depressive symptoms as an outcome, and this could be a limitation since the study targeted mothers with symptoms of postnatal depression. Another limitation is that the six studies included in the review were conducted in only four countries.

As a next step, reviews that aim to synthesise data and present evidence for parenting interventions targeting to improve maternal-infant outcomes and the impact of such outcomes on the bi-directional relationship between mothers and their infants in the perinatal period are crucial. Of importance should be the focus on how parenting mediates both risks and protective factors for infants born to depressed mothers, specifically the nexus between maternal depression, negative parenting, and infant developmental outcomes. A recent review on how problematic parenting mediates the association between mothers depression and children's adverse functioning (Goodman, Simon, Shamblaw, & Kim, 2020) found that maternal depression has a significant negative impact on child functioning even among infants aged 0-12 months through negative parenting. An earlier review (Goodman, Cullum, Dimidjian, River, & Kim, 2018), also found that prenatal depression is one of the mechanisms through which risk for infant's vulnerabilities to developmental psychopathology is transmitted. Taken together, these reviews (Goodman et al., 2018; Goodman et al., 2020) provide evidence for the need to design interventions that can prevent or reduce maternal depression in pregnancy and one year post-birth. These interventions

should also aim to simultaneously improve parenting outcomes. Targeting to treat or prevent maternal perinatal depression through evidence-based parenting interventions may be one of the approaches to ensure optimal child functioning with the twin benefit of reducing depressive symptoms and enhancing parenting competence as well as protecting infants against risks for developmental psychopathology. While these reviews are key in pointing out the connections between depression, parenting, and child functioning, additional reviews that include aspects of child developmental outcomes are worthwhile.

We found no reviews examining parenting interventions with perinatal depression and infant development milestones as key outcomes. Therefore, this review aims to synthesise findings from studies evaluating parenting interventions where maternal depression and/or infant developmental outcomes are assessed. Specifically, we aimed to examine the effects of parenting interventions with regard to symptoms of perinatal depression and infant outcomes in the three domains of language, motor and socioemotional development. In addition, we aimed to conduct subgroup analysis on study characteristics that may potentially have an impact on the intervention effect size, such as mothers' socioeconomic status, timing of intervention onset, delivery format and treatment intensity.

Methods

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline (Moher, Liberati, Tetzlaff, Altman, & Group, 2009). The systematic review protocol was prospectively registered with PROSPERO 2020 CRD42020184491.

Search strategy

We performed searches between June and July 2020 in five electronic databases; PsycINFO, CINAHL, PubMed, Cochrane Library, and Embase using titles and abstracts to identify published studies relevant to our systematic review question. The search terms were defined to match the requirements of each database. A snowball search strategy was used to identify any potentially relevant studies not found in the five key databases. A part from the English language, no restrictions or filters were put on our search strategy in terms of date and geographic location. The main search combined the following terms: “perinatal depression” OR “perinatal depressi* disorder” OR “prenatal depression” OR “postnatal depression” OR “maternal depression” OR “postpartum depression” OR “pregnancy depression” OR “antenatal depression” OR PND OR “maternal mood” OR PPD AND “parent* intervention” OR “parent* program*” OR “parent* training” OR “positive parenting” OR “parent* education” OR “mother* program*” OR “parent* psychoeducation*” OR “parent* psychol* intervention”.

Eligibility criteria and study selection

Publications from the electronic databases search results were screened for inclusion based on title and abstract. Study publications deemed relevant were retrieved for further scrutiny based on the full-text information. Potential papers were independently coded by JA and MM based on the eligibility criteria presented in Table 1.

Data extraction and risk of bias assessment

After completing full-text reviews, data were extracted on study characteristics of interest including (a) study setting, (b) study design, (c) participant characteristics, (d) intervention details, (e) timing of intervention onset, (f) outcomes assessed, and (g) outcome measures for maternal depression. Data extraction and information coding were conducted independently by JA and MM. Disagreements in reviews were resolved through discussion and consensus among the review authors. The primary outcome was change in maternal depressive symptoms and secondary outcomes were infant development outcomes in the three domains of language, motor and socioemotional development. The quality of each study was assessed independently by JA and AEM using the Cochrane Collaboration's Risk of Bias (RoB) tool for randomized trials (Higgins, Savović, Page, Elbers, & Sterne, 2019), and any disagreement about risk of bias was resolved by a third reviewer through discussion. A revised tool to assess risk of bias in randomised trials (RoB2) was used to generate the risk of bias graphs within and across studies (Sterne et al., 2019). Publication bias for the included studies was assessed using funnel plots since the review met the recommended minimum threshold of 10 studies (Sterne et al., 2011). With seventeen studies, the review had sufficient power to detect significant asymmetry in a meta-analysis.

Data analysis

We performed a meta-analysis using the Cochrane Collaboration's Review Manager Version 5.4 (2020). The standard mean differences for continuous data were computed; variability was assessed using the Cochrane Q statistic, and the random-effects model was used to estimate the overall intervention effect size from the heterogeneous data. We only analysed data for maternal depression outcomes since there was insufficient data for infant outcomes; although three studies (Cooper et al., 2009; Letourneau et al., 2011; Werner et al.,

2016) reported on infant outcomes they were not related to the infant development variables targeted in the current review.

Effect sizes are reported using standardised mean differences with 95% CI for continuous outcomes. We report random-effects inverse-variance-weighted mean effect sizes and 95% CIs using forest plots. Random effects models account for variability in population parameters of studies and also allow for the generalisation of meta-analytic results (Field & Gillett, 2010; Hunter & Schmidt, 2000). Studies were only considered for meta-analysis when the outcome measures and timing of assessment were comparable. In studies where multiple measures were used to assess for depressive symptoms and included the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, & Sagovsky, 1987), we selected EPDS data for meta-analysis since it is most suited for measuring symptoms of maternal perinatal depression. The meta-analytic data were drawn from those data collected at the post-intervention short-term assessment timepoints, which were collected no more than 6 months after the last intervention session. We could not conduct a meta-analysis on longer-term follow-up outcome data since the assessment timepoints were incomparable across studies.

Given the clinical and methodological diversity in studies, statistical heterogeneity is a common occurrence and is inevitable within a meta-analysis (Higgins, Thompson, Deeks, & Altman, 2003). Statistical heterogeneity between studies was assessed using the I^2 statistic. The corresponding values of the I^2 statistic normally represent low heterogeneity if less than 25%, and substantial or high heterogeneity if 50% or more (Shuster, 2011). We also conducted a sensitivity analysis to determine the source of heterogeneity in the meta-analysis results. The Tau^2 statistic was used to determine the amount of estimated variance of the true effect sizes of studies included in the meta-analyses. Since there were more than ten studies, we used the funnel plots method to assess for publication bias. Subsequently, a subgroup analysis was performed to explore potential moderators. Based on a previous a meta-analytic

review of interventions for preventing postnatal depression by (Dennis & Dowswell, 2013), which explored the moderating role of subgroups including intervention type, intervention format, intervention onset, intervention duration and risk factors on intervention outcomes, we aimed to perform similar moderation analyses in the current review. In addition, we explored whether baseline depressive symptom severity moderated the results of parenting intervention.

Results

Study selection

Figure 1 shows the selection process of studies included in the review. Initial combined electronic searches yielded 16,481 records, and one hand searched reference. After removing duplicates, 12,658 references were screened by title and abstract and 12,629 were excluded for not meeting the inclusion criteria. We reviewed 29 studies based on full-text and 12 were excluded with reasons as presented in Figure 1. Seventeen studies published between 2001 and 2020 met the eligibility criteria and were included in this review. All except one study (Sawyer et al., 2019) were randomised at the individual level. Eleven out of the 17 studies were from three countries, with seven from the United States (US), two from the United Kingdom (UK), and two from Australia. The other six were from South Africa, Sweden, Singapore, Taiwan, Canada and Scotland.

Participant characteristics

Table 2 presents the details of study characteristics. Eleven of the included studies started postnatally from between two weeks and six months postpartum. The remaining six studies enrolled mothers before the birth of the baby. Participants were included or assessed based on a pre-determined level of depressive symptoms, and the symptom outcomes were measured using a variety of validated instruments depending on the study. Eleven studies used the Edinburgh Postnatal Depression Scale (EPDS); the other six used the Patient Health

Questionnaire-PHQ-9 (Berkule et al., 2014; Werner et al., 2016), the Beck Depression Inventory-BDI-II (Boyd, Price, Mogul, Yates, & Guevara, 2019; Horowitz et al., 2001; Tsivos, Calam, Sanders, & Wittkowski, 2015), and the Depression Anxiety Stress Scales-DASS (Ericksen et al., 2018). The reported maternal mean age ranged from 25.9 to 32.8 years. All infants were under 12 months at the time of outcome assessment. Six studies focused on women of low socio-economic status, while the rest had middle and mixed economic status. Overall, the review included 1,665 participants from 17 studies with samples ranging from 17 to 449 participants.

Intervention characteristics

All the studies had parenting intervention components and were delivered to improve maternal outcomes including depression. Primarily, the interventions sought to support mother-infant interactions, attachment and relationships; and to improve parenting competency using diverse approaches, for example video interaction feedback, social media, coaching, peer support, play groups, mobile phone app, training, home visiting and telephone sessions. Two studies provided mindfulness sessions in addition to the aforementioned approaches (Lönnberg et al., 2020; Pan, Chang, Chen, & Gau, 2019). About 35% of the studies had prenatal intervention onset when participants were either in their second or third trimester of pregnancy. The interventions were delivered using different formats and intensity. For instance, participants in 10 out of 17 studies had individual sessions running from between 20 minutes to 180 minutes; the number of intervention sessions offered to participants varied from three to 16 sessions, which were delivered either in-person or online. All interventions were conducted on a weekly basis except in two studies (Horowitz et al., 2001; Munoz et al., 2007) where the intervals between sessions were weeks or months apart. Interventionists were from different backgrounds including psychology, psychiatric nursing, midwifery, coaching and lay community workers/peers. Control conditions included care as

usual ($k = 7$), waitlist ($k = 2$), no intervention ($k = 4$), and alternative treatment ($k = 4$). Care as usual included pharmacological treatment, psychological support, occasional interaction with health visitors, receiving information materials, and support group services. One study (Tsivos et al., 2015) reported that the majority of participants in both arms of the study continued to receive antidepressant treatment as usual, which could have confounded the intervention effect on the outcome measure. Overall, study baseline characteristics revealed that seven studies reported symptom severity mean scores in the range of moderate to severe levels, nine studies were in the less severe range, and one study had no data. The review found that two of the included studies had data published prior on their effectiveness to improve parenting. The rest of the studies were still being evaluated for their effectiveness in reducing depressive symptoms and improving parenting outcomes. We, however, noted that at post-intervention ten of the included studies had a significant effect on parenting outcomes among which six were equally effective for maternal depressive symptoms. Details on the effectiveness of the studies are presented in Table 3.

Outcome measures

All studies evaluated the effect of the intervention on maternal depressive symptoms. Measures applied to assess depressive symptoms were self-report questionnaires and only one study used an interview in addition to self-report (Cooper et al., 2009). All of the measures applied had adequate psychometric properties. Other parenting outcomes were also reported. Seven studies examined the mother-infant interaction/relationship, five reported parenting competence, two reported parental responsiveness and two reported parenting stress. All 17 studies included baseline and post-intervention assessments and only three studies (Goodman, Prager, Goldstein, & Freeman, 2015; O'Mahen et al., 2014; Tsivos et al.,

2015) explicitly reported later follow-up assessments. Although infant outcomes were part of the focus of this review, only three studies (Cooper et al., 2009; Letourneau et al., 2011; Werner et al., 2016) reported infant outcomes such as fussing and crying, attachment and security, feeding, and cortisol levels.

Risk of bias assessment

Figure 2 presents a summary of the risk of bias assessment for all included studies. An online risk of bias visualisation tool for randomised trials (robvis-RoB2) was used to generate the risk of bias graphs within and across studies (riskofbias.info). Risk of bias scores are summarised in five domains.

As depicted in Figure 2, all studies were judged to have low risk of bias in the three domains of bias arising from the randomisation process, bias due to deviations from intended interventions, and bias in measurement of the outcome. Two studies had outcomes where bias due to missing outcome data was classified as high risk. In one study (Letourneau et al., 2011), there was a large amount of missing data at post-test, and no comparison of baseline values for those with missing versus complete data was done. Another study (Werner et al., 2016) only had 65% of participants retained at endpoint assessment and post-hoc analysis revealed that there was differential attrition for the comparison group, which may have created an artificial appearance of improvement in the intervention group. Two studies (Pan et al., 2019; Tsivos et al., 2015) had no comparison between completers and non-completers making it hard to judge whether or not this influenced the outcome. On the basis of bias in selection of the reported results, two studies were judged as having some concerns. In one study (Puckering, McIntosh, Hickey, & Longford, 2010) there was neither a sample size calculation nor protocol registration reported, and in another study (Horowitz et al., 2013) there appeared to be some deviations from the planned analysis which changed from MANOVA to ANOVA and repeated-measures ANOVA. Despite this, all of the 17 studies

were included in the review; 64% were characterised as low risk, 24% had some concerns and 12% were high risk. A summary of the risk of bias for individual studies is presented in Figure 3.

Intervention effects

We conducted a meta-analysis comparing parenting interventions with control conditions. Due to the small number of studies and variability in the reporting timepoints for follow-up assessment, the meta-analysis was confined to post-intervention outcome data as short-term assessment of parenting intervention effects. To conduct the meta-analysis, the post-intervention depression means scores and standard deviations (SD) together with the corresponding sample sizes (n) were extracted for the intervention and comparison arms of each study as summarised in Table 4.

The meta-analytic findings for perinatal depressive symptoms are presented in Figure 4. Results show a statistically significant decrease in perinatal depressive symptoms from baseline to the post-intervention time point (SMD = -0.25, 95% CI = -0.45, -0.05; $z = 2.44$, $p = .01$; $I^2 = 71\%$).

There was a high degree of heterogeneity observed ($I^2 = 71\%$) and we conducted a sensitivity analysis to identify studies contributing to this. Two outlying studies (Horowitz et al., 2001; Letourneau et al., 2011) were identified, and upon filtering them out in a follow up analysis, the remaining 15 studies (1,497 participants) showed zero degree of heterogeneity ($I^2 = 0\%$) and statistically significant results in favour of the intervention (SMD = -0.34, 95%CI = -0.44, -0.24; $z = 6.48$, $p < .001$; $I^2 = 0\%$) as presented in Figure 5.

Comparing the two sets of meta-analytic results, the findings revealed that removal of the two outliers led to the intervention overall effect increasing significantly with a decrease in statistical heterogeneity (from $z = 2.4$, $p = .01$; $I^2 = 71\%$ to $z = 6.5$, $p < .001$; $I^2 = 0\%$). In

addition, there was an increase in the standardised mean difference (SMD) from 0.25 to 0.34 denoting better treatment effect. The corresponding 95% CI in the second meta-analysis was stable and ranged from a small to medium effect thus yielding more confidence in the interpretation of the estimated treatment effect of the 15 intervention studies included in this review. In particular, seven studies (Berkule et al., 2014; Cooper et al., 2009; Ericksen et al., 2018; Lönnberg et al., 2020; O'Mahen et al., 2014; Pan et al., 2019; Shorey et al., 2019) found statistically significant effects of parenting intervention on perinatal depressive symptoms.

The results of the random effects analysis in this review are deemed as good estimates of the intervention effect of parenting on perinatal depression in the real world given that bias of publication was symmetrically distributed as shown in Figure 6.

Four potential subgroups were explored to establish if they had a moderating effect on the intervention outcome. The subgroups explored were timing of the intervention onset, treatment intensity, participants' socioeconomic status, and intervention delivery format. Intervention onset was categorised as either prenatal or postnatal based on the point at which the intervention was initiated. A random effects model revealed a statistically significant result for both categories. However, studies initiated prenatally (SMD = -0.34, 95%CI = -0.48, -0.20; $z = 4.8, p < .001; I^2 = 0\%$) and those initiated postnatally (SMD = -0.33, 95%CI = -0.48, -0.18; $z = 4.3, p = .01; I^2 = 0\%$) had comparable effects on depressive symptoms.

Treatment intensity was measured by the number of intervention sessions offered to participants. The number of sessions across studies ranged from three to 16, with a median and modal value of eight sessions. Therefore, we categorised the interventions as either short (up to eight sessions) or long (more than eight sessions). A random effects model revealed statistically significant results with comparable outcomes for short interventions (SMD = -

0.35, 95%CI = -0.49, -0.20; $z = 4.72, p < .001; I^2 = 0\%$) and long interventions (SMD = -0.35, 95%CI = -0.52, -0.18; $z = 4.08, p < .01; I^2 = 14\%$).

Study participants from different socio-economic backgrounds were categorised and compared. One study (Puckering et al., 2010) did not report the participants' socio-economic status. Six studies had participants from low socioeconomic background while the remaining eight had participants with varied levels of income. Therefore, we dichotomised socio-economic status as 'low' and 'mixed', as was reported in the respective studies. A random effects model revealed statistically significant results, with similar estimated effects for participants of low income (SMD = -0.34, 95%CI = -0.48, -0.20; $z = 4.68, p < .001; I^2 = 6\%$) and those of mixed levels of income (SMD = -0.34, 95%CI = -0.50, -0.19; $z = 4.72, p < .001; I^2 = 0\%$).

Parenting interventions were delivered to participants individually or as a group. Seven studies used group formats to deliver the intervention and eight studies had individual sessions, which were delivered to participants either in person and/or online. A random effects model revealed significant results for both formats. Group sessions (SMD = -0.41, 95%CI = -0.60, -0.23; $z = 4.34, p < .001; I^2 = 0\%$) had a slightly higher standardised mean difference than individual sessions (SMD = -0.31, 95%CI = -0.43, -0.18; $z = 4.91, p < .001; I^2 = 0\%$) but the difference was not statistically significant.

We conducted a further subgroup analysis to determine if the baseline depressive symptom severity had a moderating role on the outcome of the intervention. Six studies had participants with moderate to severe symptoms and eight studies with a subclinical range of depressive symptoms at baseline as shown in Table 3. The results of a random effects model showed that parenting interventions had a significant medium effect on more severe symptoms (SMD = -0.54, 95% CI = -0.82, -0.25; $z = 3.70, p = .0002; I^2 = 0\%$) and small

effect size on less severe symptoms (SMD = -0.35, 95% CI = -0.47, -0.22; $z = 5.25$, $p = .00001$; $I^2 = 0\%$) at post-intervention.

DISCUSSION

The review aimed to synthesise data and present evidence on the effects of parenting interventions for perinatal depression and infant development outcomes. We searched five electronic databases and identified 17 studies that evaluated the effects of parenting interventions on perinatal depressive symptoms in mothers from nine different countries. Given the variations in assessment measures and study designs, it was only possible to conduct a meta-analytic review on perinatal depressive symptoms at post-intervention. Overall, we found statistically significant effects of parenting interventions on perinatal depressive symptoms with the majority of included studies (82%, $k = 14$) reporting a general trend of improvement in depressive symptoms from baseline to post-intervention in the treatment group.

In the meta-analytic findings, heterogeneity reduced significantly from $I^2 = 71\%$ to $I^2 = 0\%$ when results from two outlying studies were removed (Horowitz et al., 2001; Letourneau et al., 2011). The two studies found statistically significant results (SMD = 0.60, 95% CI = 0.04, 1.17) and (SMD = 0.85, 95% CI = 0.47, 1.23) in favour of the control group. We examined these two studies and established that in one study (Letourneau et al., 2011), the authors contend that the long three-year recruitment window might have prevented them from realising the baseline group differences during sample stratification, thus resulting in allocation of participants with more severe symptoms to the intervention arm relative to the control group. The study also reported adverse events and high attrition in the intervention arm, contributing to a rating of high risk of bias, which might have undermined the validity of the outcomes. In the second study (Horowitz et al., 2001), the authors opined that a few

persistent cases of depressive symptoms in the treatment group might have skewed the results; they also noted that the main aim of their study was to promote maternal-infant responsiveness and not to ameliorate depression. Despite this, the outcome data showed reductions in depressive symptoms in both arms of the study with small standard deviations (intervention SD = 0.99; control SD = 0.77) of the BDI-II scores at post-intervention. It was, however, unclear why the outcome favoured the control group.

Overall, the combined effect of parenting intervention on perinatal depressive symptoms at post-intervention was small but statistically significant. The estimated small effect could be attributed to the influence of a number of small studies that reported slight improvements in favour of the intervention groups. Given the small sample sizes of the majority of the included studies (10 out of 17 studies had fewer than 50 participants), there is a possibility that these studies were not sufficiently powered to detect significant effects. Despite the small effect, findings from 41% ($k = 7$) of the studies showed significant positive results in favour of the intervention group and this lends credence to the viability of parenting interventions as effective preventive interventions for perinatal depression. The findings from this meta-analysis concur with the results of a previous systematic review (Barlow et al., 2014) which found a statistically significant result for short-term improvements in parental depression resulting from participation in a parenting intervention, and extends this study by demonstrating that parenting interventions that specifically target women in the perinatal period may potentially have a significant effect on maternal depression. Our review included both group-based and individually delivered parenting interventions targeting depression as a main outcome and found a significant intervention effect, with a slightly higher standardised mean difference (SMD = 0.34) than the previous review (SMD = 0.17) by Barlow et al. (2014) in favour of parenting programs.

While parenting interventions primarily focus on improving parental competence, confidence, and sensitivity, among other skills, our findings indicate they also lead to reductions in depression for new mothers. This is important since maternal depression, in addition to socio-economic factors like poverty, has been linked to adverse child outcomes (Goodman et al., 2011; Smith-Nielsen et al., 2016) and positive intervention effects on maternal depression may flow on to infants (Stein et al., 2018), who may otherwise be at risk of poorer developmental outcomes. Even though we aimed to synthesise and present evidence on the effects of parenting intervention on infant development outcomes, none of the studies included in the meta-analysis reported on our target child development outcomes, hence we are unable to establish whether parenting intervention for mothers at risk of perinatal depression can impact or moderate infant outcomes. That notwithstanding, there is evidence from previous reviews that many behavioural parenting interventions which are effective for maternal depression may also improve child outcomes (Cuijpers et al., 2015; Lundahl, Risser, & Lovejoy, 2006).

Subgroup analyses indicated that mothers at risk of perinatal depression may benefit from parenting intervention either in pregnancy and/or postpartum no matter the timing of the intervention onset. Second, parenting intervention has the potential to prevent or reduce depressive symptoms irrespective of the intensity and duration of treatment. Third, participants exposed to individual or group intervention sessions are likely to benefit and experience similar outcomes without any disadvantage. Fourth, the positive outcomes of parenting interventions can be realised regardless of the participant's level of income or socio-economic status. A further subgroup analysis revealed that parenting interventions have a positive impact on even more severe depressive symptoms, which implies that these interventions may potentially confer benefits on perinatally depressed mothers especially in

settings where access to conventional mental healthcare services is a challenge due to impediments such as stigma, cost, and scarcity of clinicians.

Considering the diversity of studies included in this review, our observation is that parenting interventions developed and implemented across different settings and contexts including low-and-high income countries may yield comparable outcomes among participants. This presents a perspective worth exploring by researchers interested in adopting parenting interventions for perinatal depressive symptoms especially in settings where these have not been previously tested or disseminated.

Interpretation

This meta-analytic review is a synthesis of evidence illuminating the effects of parenting interventions as preventive and treatment strategies for depressive symptoms, and the findings must be interpreted within that context. Results of our moderator analysis suggest that parenting interventions can be equally effective whether it is delivered pre- or post-natally, and irrespective of symptom severity level. From a practical perspective, since most mothers attend at least some pre-natal care, this could be a good opportunity to engage expectant mothers in a preventive parenting intervention; likewise, it could be logistically easier to schedule and deliver intervention sessions pre-natally, since women may have fewer demands on their time and fewer barriers to participation such as caregiving responsibilities or post-birth complications.

In as much as the overall intervention effect was significant, there is a possibility that the estimated treatment effect size had some confounders which should be controlled for in future studies. For example, some studies had very small (< 25) sample sizes (Boyd et al., 2019; Puckering et al., 2010; Tsivos et al., 2015) and some had high attrition at post-intervention assessment (Letourneau et al., 2011); the overall effect on study outcomes and

the estimated treatment effect size is unknown. Therefore, adequately powered controlled trials of parenting interventions are needed for better estimates of the true effect size.

Most of the studies had behavioural orientations in their theoretical framework; however, there was substantial variation in the training and qualifications of the persons who delivered the interventions. It is unclear whether this might have affected the intervention outcomes in the current review. Interestingly, we noted that some interventions were delivered by lay persons/peers, e.g., Cooper et al. (2009) and Letourneau et al. (2011), and while this suggests that parenting interventions are easily adaptable and can be implemented with minimal level of training and great flexibility, one of the studies did not find significant effects on maternal depression. Nevertheless, we suggest that the influence of interventionists' qualifications and training on the delivery of parenting programs and resulting outcomes should be explored in future research.

Strengths and Limitations

As per protocol we only included RCTs and quasi-RCTs in our analysis. This was done to ensure a quality review that presents a realistic estimate of intervention effect size in addition to controlling for potential confounders, which is a strength of this review. Another strength of this review is the subgroup analyses of the potential moderators on the intervention outcome. Of interest is the finding that parenting interventions have a positive impact on more severe levels of depressive symptoms. This suggests that excluding mothers presenting with higher levels of depressive symptoms from participating in parenting interventions may be a disadvantage. However, there was a relatively small number of studies included, and most of the studies had small sample sizes thereby lacking sufficient power to detect intervention effects, which taken as a whole is a limitation of our review. Likewise, we were unable to conduct a meta-analytic review on long-term depression outcomes since the

majority of the studies did not report follow-up data. Therefore, it is impossible to determine if the interventions had long-term effects. An additional limitation is that included studies relied on self-report measures of perinatal depressive symptoms, which are acceptable but could be prone to bias. Despite not synthesising data on infant outcomes, a strength of our review is that it sheds light on the dearth of clinical trials at the intersection between parenting interventions targeting perinatal depression and infant development outcomes. As suggested in previous research (Goodman et al., 2015; Stein et al., 2014), one way to improve infant outcomes is by designing interventions targeting parenting as a mechanism through which reduction in maternal depression positively affects child development. In effect, with enhanced parenting ability, mothers can manage their depressive symptoms and as result protect the child from risks associated with perinatal depression.

Implications for practice

This review of 17 studies provides some evidence in support of parenting intervention for perinatal depressive symptoms at post-intervention; however, it is uncertain if this was sustained long-term. Also, bearing in mind that maternal depression contributes to adverse child outcomes, lack of studies exploring the consequences of parenting interventions for mothers at risk of perinatal depression on infant development within 12 months of birth points to the need for more research-generated data that would inform maternal-child interventions for practitioners. Furthermore, given that the majority of the studies were conducted in high-income countries, it will be important to establish whether parenting interventions can result in positive outcomes for mothers in low resource settings where the incidence of perinatal depression is as high and resources to manage maternal mental health difficulties are limited.

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Table 1: Inclusion and exclusion criteria

Inclusion	Exclusion
<p><i>Condition for inclusion:</i> studies needed to assess maternal depression to be eligible; infant outcomes were only assessed for those studies that also assessed depression.</p> <p><i>Outcomes assessed:</i> symptoms of perinatal depression and infant development.</p> <p><i>Designs:</i> randomised controlled trials, quasi-experimental designs, cluster randomised trials.</p> <p><i>Intervention delivery:</i> individual and/or group interventions delivered in-person or online irrespective of duration and intensity.</p> <p><i>Publications:</i> peer-reviewed journals.</p> <p><i>Data points:</i> pre- and post-intervention outcome data. Post-test done within 6 months after intervention delivery.</p> <p><i>Intervention onset:</i> during pregnancy and within 12 months postpartum.</p> <p><i>Strategies:</i> preventive or treatment.</p>	<p><i>Intervention:</i> Non-parenting intervention.</p> <p><i>Post-intervention assessment:</i> >12 months postpartum only.</p> <p><i>Publications:</i> No full texts available.</p> <p><i>Design:</i> Non-experimental studies, dissertations, study protocols, conference abstracts or posters.</p> <p><i>Delivery:</i> individual and/or group using methods/means other than in-person or online.</p> <p><i>Sample:</i> alcohol and substance use, pre-term births, and complicated pregnancies.</p>

Table 2: Characteristics of included studies

Study	Country, Study Design	Participants characteristics	Intervention Details	Intervention onset	Assessment points, Outcomes	Reported results for maternal depression
Berkule et al., 2014	USA 3-arm RCT	N=407 (Intervention = 126; Control = 134; Building Blocks=147) mothers age <i>M</i> =27.36 infant age <i>M</i> = 6.9 SES: low Race/ethnicity: Spanish-speaking immigrants	Name: Video Interaction Project Description: A 5- to 7-minute video of each mother-child dyad engaging in activities suggested and modelled by the interventionist. The interventionist reinforces positive interactions and provides suggestions regarding missed opportunities for interaction. No. of sessions: 4 Session length: 30 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 6 months post-treatment Maternal outcomes: depression (PHQ-9); parental responsiveness Infant outcomes: none Depressive symptoms baseline <i>M</i> = 3.11	Maternal depression reduced significantly in the intervention group relative to the control group at post- intervention.
Boyd et al., 2019	USA RCT	N=24 (Intervention = 12; Control = 12) mothers age <i>M</i> =26 infant age <i>M</i> = 2.7 SES: low Race/ethnicity: Mostly African American and recent immigrant families	Name: Parents Interacting with Infants (PIWI) Description: parenting intervention delivered via social media (Facebook) or in-person for mothers who screened positive for depression in paediatric clinics. No. of sessions: 8 Session length: not stated Delivery format: group	postnatal	Assessment timepoint: pre- and 8 weeks post- treatment Maternal outcomes: parenting sense of competence, depression (BDI-II) Infant outcomes: none Depressive symptoms baseline <i>M</i> = 26.45	Maternal depression reduced significantly in the intervention group but not for the control group at post- intervention.

Cooper et al., 2009	South Africa RCT	N=449 (Intervention = 220; Control = 229) mothers age <i>M</i> =25.85 infant age = not stated SES: low Race/ethnicity: African	Name: The Social Baby Description: The intervention was delivered from late pregnancy and for six months postpartum. Women were visited in their homes by untrained lay community workers who provided support and guidance in parenting. No. of sessions: 16 Session length: 60 minutes Delivery format: individual	prenatal	Assessment timepoint: pre- and 1-month post-treatment Maternal outcomes: quality of mother-infant interactions; maternal depression (EPDS) Infant outcome: infant attachment security Depressive symptoms baseline <i>M</i> = not stated	Maternal depression reduced significantly in the intervention group relative to the control group at post-intervention.
Ericksen et al., 2018	Australia RCT	N=31 (Intervention = 16; Control = 15) mothers age <i>M</i> =32.7 infant age <i>M</i> = 4.9 SES: middle Race/ethnicity: white Australian	Name: CHUGS Description: 10-session mother–infant therapeutic playgroup—Community HUGS (CHUGS)—which combines cognitive and experiential components through psychoeducation, play, music, and movement. No. of sessions: 10 Session length: 60 - 90 minutes Delivery format: group	postnatal	Assessment timepoint: pre- and 6 months post-treatment. Maternal outcomes: depression/anxiety (DASS); parenting stress; parenting competency; mother-infant attachment Infant outcomes: none Depressive symptoms baseline <i>M</i> = 15.96	Maternal depression reduced significantly in the intervention group relative to the control group at post-intervention.
Goodman et al., 2015	USA RCT	N=42 (Intervention = 21; Control = 21) mothers age <i>M</i> =30.69 infant age not stated SES: middle Race/ethnicity: mostly Hispanic	Name: Perinatal Dyadic Psychotherapy (PDP) Description: Dual-focused mother-infant intervention to prevent/decrease maternal postpartum depression and improve aspects of the mother-infant relationship related to child development, e.g., mother-infant interaction.	postnatal	Assessment timepoint: pre- and 8 weeks post-treatment; 3 months follow-up. Maternal outcomes: maternal depression (EPDS), anxiety, maternal self-esteem,	Maternal depression improved in the intervention group but not significantly different from the control group at post-intervention.

		American and white American	No. of sessions: 8 Session length: 60 minutes Delivery format: individual		parenting stress, and mother-infant interaction Infant outcomes: none Depressive symptoms baseline $M= 12.08$	
Horowitz et al., 2001	USA RCT	N=117 (Intervention = 60; Control = 57) mothers age $M=31$ infant age not stated SES: mixed levels Race/ethnicity: 68.9% European American or White, 7.4% African American or Black, 7.4% Latina or Hispanic, 7.4% mixed background, 4% other, 3.3% Asian or Pacific Islander, and 1.6% Native American.	Name: Interaction coaching for at-risk parents and their infants (ICAP) Description: Mother-infant interactions were videotaped and coded for responsiveness. All women received three home visits when their babies were 4-8 weeks (Time 1), 10-14 weeks (Time 2), and 14-18 weeks old (Time 3). The treatment group also received a coached behavioural intervention designed to promote maternal-infant responsiveness. No. of sessions: 3 Session length: 20 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 10-14 weeks post-treatment Maternal outcomes: depression (BDI-II); maternal-infant responsiveness Infant outcomes: none Depressive symptoms baseline $M= 14.37$	Maternal depression improved in the intervention group but not significantly different from the control group at post-intervention.
Horowitz et al., 2013	USA RCT	N=134 (Intervention = 62; Control = 63) mothers age $M=31$ infant age not stated SES: middle Race/ethnicity: African American 12%, Asian 8%, Caucasian 54%, Hispanic 22%, Others 5%	Name: Communicating and Relating Effectively (CARE) Description: A relationship-focused behavioural nursing intervention designed to promote responsive interaction over time between depressed mothers and their infants by coaching mothers to interpret infants' behavioural cues and to respond sensitively and contingently. No. of sessions: 5 Session length: 60 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 3 months post-treatment Maternal outcomes: depression (EPDS); quality of mother/infant interaction Infant outcomes: none	There was no significant reduction in maternal depression for both the intervention and control groups at post-intervention.

					Depressive symptoms baseline $M= 12.34$	
Letourneau et al., 2011	Canada RCT	N=60 (Intervention = 27; Control = 33) mothers age not stated infant age $M= 5.12$ SES: mixed Race/ethnicity: not stated	Name: Home based peer support Description: Mothers received 12 weeks of home-based peer support that included maternal–infant interaction teaching; peers were mothers who had recovered from postpartum depression and were trained to provide support. No. of sessions: 12 Session length: 20 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 12 weeks post-treatment Maternal outcomes: depression (EPDS); social support; maternal-infant interactions Infant outcomes: feeding, cortisol levels Depressive symptoms baseline $M= 17.15$	Maternal depression reduced significantly in the control group relative to the intervention group at post-intervention.
Lonnberg et al., 2020	Sweden RCT	N=193 (Intervention = 96; Control = 97) mothers age $M=32$ infant age not stated SES: mixed Race/ethnicity: mostly Swedish and European	Name: Mindfulness-Based Childbirth and Parenting Program (MBCP) Description: the MBCP curriculum were the practices of interpersonal mindful speaking and listening inquiry, methods to increase awareness of the baby and to cope with pain during labour. The content addressed needs of a newborn, breastfeeding, partner support, secure attachment and child development. No. of sessions: 8 Session length: 135 minutes Delivery format: group	prenatal	Assessment timepoint: pre- and 12 weeks post-treatment. Maternal outcomes: stress, depressive symptoms (EPDS), positive states of mind, and five facets of mindfulness. Infant outcomes: none Depressive symptoms baseline $M= 10.01$	Maternal depression reduced significantly in the intervention group relative to the control group at post-intervention.

Munoz et al., 2007	USA RCT	N=41 (Intervention = 21; Control = 20) mothers age <i>M</i> =26.75 infant age not stated SES: low Race/ethnicity: mainly Spanish- speaking Latina immigrants	Name: Mamás y Bebés/Mothers and Babies Course Description: Teaches participants to recognize which thoughts, behaviours, and social contacts influence their mood, the effect of mood on health, and the benefits of strengthening maternal-infant bonding. No. of sessions: 16 Session length: not stated Delivery format: group	prenatal	Assessment timepoint: pre- and 3 months post-treatment Maternal outcomes: depression (CES-D) Infant outcomes: none Depressive symptoms baseline <i>M</i> = 16.4	There was no significant reduction in maternal depression for either the intervention or control group at post-intervention.
O'Mahen et al., 2013	UK RCT	N=83 (Intervention = 41; Control = 42) mothers age not stated infant age not stated SES: low Race/ethnicity: Mostly white/British, 2.4% Asian and 4.8% other	Name: Netmums Description: a 12-session, modular, guided internet behavioural activation (BA) treatment modified to address postnatal-specific concerns e.g., infant feeding, attachment and bonding, understanding depression. No. of sessions: 12 Session length: 20- 30 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 17 weeks post-treatment; 6 months follow-up. Maternal outcomes: depression (EPDS), work, social impairment, anxiety, postnatal bonding and perceived social support Infant outcomes: none Depressive symptoms baseline <i>M</i> = 20.71	Maternal depression reduced significantly in the intervention group relative to the control group at post-intervention.

Pan et al., 2019	Taiwan RCT	N=74 (Intervention = 39; Control = 35) mothers age $M=32.8$ infant age not stated SES: mixed Race/ethnicity: Chinese	Name: MBCP Intervention Description: session involved teaching participants how to monitor their sensory and emotional states and cognitive processes, deepen their sensory self-awareness, and become more mindful of the process of labour and parenting. No. of sessions: 8 Session length: 180 minutes Delivery format: group	prenatal	Assessment timepoint: pre- and 3 months post-treatment. Maternal outcomes: depression (EPDS); five facets of mindfulness Infant outcomes: none Depressive symptoms baseline $M= 9.15$	Maternal depression reduced significantly in the intervention group relative to the control group at post- intervention.
Puckering et al., 2010	Scotland Quasi- Exp	N=17 (Intervention = 11; Control = 6) mothers age not stated infant age not stated SES: not stated Race/ethnicity: Scottish	Name: Mellow Babies group intervention Description: Mellow Babies aims to promote both mother-infant interaction and maternal well-being. No. of sessions: 14 Session length: 5 hours Delivery format: group	postnatal	Assessment timepoint: pre- and 4 months post-treatment Maternal outcomes: depression (EPDS); mother-infant interaction Infant outcomes: none Depressive symptoms baseline $M= 18.8$	Maternal depression reduced significantly in the intervention group relative to the control group at post- intervention.
Sawyer et al., 2019	Australia Block RCT	N=118 (Intervention = 60; Control = 58) mothers age $M=31.1$ infant age $M= 4$ months SES: mixed Race/ethnicity: white Australian	Name: eMums plus Description: Mothers were assigned to a nurse-led, online group consisting of approximately 20 mothers of similarly aged infants. The 4-month intervention was delivered when infants were aged approximately 2 to 6 months and was accessed by mothers via a mobile phone app. The curriculum consists of information provided to support mothers with parenting	postnatal	Assessment timepoint: pre- and 2 months post-treatment Maternal outcomes: depression (EPDS); parenting competence; quality of maternal caregiving Infant outcomes: none	There was no significant reduction in maternal depression for either the intervention or control group at post-intervention.

			<p>problems and a modularised program designed to reduce symptoms of depression.</p> <p>No. of sessions: 11 Session length: not stated Delivery format: group</p>		<p>Depressive symptoms baseline $M= 9.15$</p>	
Shorey et al., 2019	Singapore RCT	<p>N=118 (Intervention = 59; Control = 59) mothers age $M=30.9$ infant age not stated SES: low Race/ethnicity: Chinese 46.2%, Malay 23.7%, Indian 18.6%</p>	<p>Name: SEPP Description: SEPP is based on Bandura's self-efficacy theory and Bowlby's theory of attachment. Components of the intervention include 2 telephone-based educational sessions (1 antenatal and 1 immediately postnatal) and a mobile health app follow-up for 1 month. The app content addressed issues around breastfeeding, maternal self-care, newborn care tasks, dealing with emotional challenges, and enhancing parental efficacy and bonding. No. of sessions: 15 Session length: 60 minutes Delivery format: individual</p>	<p>prenatal</p>	<p>Assessment timepoint: pre- and 2 months post-treatment</p> <p>Maternal outcomes: parenting self-efficacy; parental bonding; perceived social support; parenting satisfaction; postnatal depression (EPDS); and anxiety</p> <p>Infant outcomes: none</p> <p>Depressive symptoms baseline $M= 6.2$</p>	<p>Maternal depression reduced significantly in the intervention group relative to the control group at post-intervention.</p>

Tsivos et al., 2015	UK RCT	N=27 (Intervention. = 14; Control = 13) mothers age M=28.4 infant age M= 6.2 SES: mixed levels Race/ethnicity: British	Name: Baby Triple P Description: Baby Triple is a strengths-based intervention which aims to (1) promote healthy infant development, (2) reduce family risk factors and (3) reduce parental psychopathology. No. of sessions: 8 Session length: 40-90 minutes Delivery format: individual	postnatal	Assessment timepoint: pre- and 8 weeks post-treatment; 3 months follow-up Maternal outcomes: mood/depression (BDI-II); parenting competence; mother-infant relationship Infant outcomes: none Depressive symptoms baseline M= 19.1	Maternal depression improved in the intervention group but not significantly different from the control group at post-intervention.
Werner et al., 2016	USA RCT	N=54 (Intervention = 27; Control = 27) mothers age M=30.24 infant age not stated SES: mixed Race/ethnicity: Asian 7.70 %, Black/African American 15.40 %, White/Caucasian 15.40 %, Biracial 3.80 %, Hispanic 57.70 %	Name: Practical Resources for Effective Postpartum Parenting (PREPP) Description: A PPD prevention protocol that aims to treat women at risk for PPD by promoting maternally mediated behavioural changes in their infants, e.g., fussing and crying, while also including mother-focused skills. No. of sessions: 4 Session length: not stated Delivery format: individual	prenatal	Assessment timepoint: pre- and 6 weeks post-treatment Maternal outcomes: depression (HSRD); anxiety Infant outcomes: fussing and crying Depressive symptoms baseline M= 18.48	Maternal depression reduced significantly in the intervention group but not in the control group at post-intervention.

Note. RCT, randomised controlled trial; N, sample size; M, mean (years for mothers and months for infants); SES, socio-economic status; PHQ-9, Patient Health Questionnaire; BDI, Beck Depression Inventory; EPDS, Edinburgh Postnatal Depression Scale, DASS, Depression, Anxiety, Stress Scales; CES-D, Centre for Epidemiologic Studies Depression Scale; HRSR, Hamilton Rating Scale for Depression

Table 3: Intervention effectiveness on parenting and depressive symptoms

Study	Intervention's effectiveness on parenting published prior	Significantly improved parenting at post-test	Baseline symptom severity	Significantly reduced depressive symptoms at post-test
	<i>Yes/No</i>	<i>Yes/No/Not reported</i>	<i>Mild, Moderate, Severe</i>	<i>Yes/No</i>
Berkule et al., 2014	Yes	Yes	Mild	Yes
Boyd et al., 2019	No	Yes	Moderate	No
Cooper et al., 2009	Yes	Yes	Not reported	Yes
Ericksen et al., 2018	No	Yes	Moderate	Yes
Goodman et al., 2015	No	No	Mild	No
Horowitz et al., 2001	No	Yes	Mild	No
Horowitz et al., 2013	No	Yes	Mild	No
Letourneau et al., 2011	No	No	Moderate	No
Lonnberg et al., 2020	No	Yes	Mild	Yes
Munoz et al., 2007	No	Not reported	Moderate	No
O'Mahen et al., 2013	No	No	Severe	Yes
Pan et al., 2019	No	Yes	Mild	Yes
Puckering et al., 2010	No	Yes	Moderate	No
Sawyer et al., 2019	No	No	Mild	No
Shorey et al., 2019	No	Yes	Mild	Yes
Tsivos et al., 2015	No	No	Moderate	No
Werner et al., 2016	No	Not reported	Mild	No

Table 4: Post-intervention data of studies included in meta-analyses

Author	Depression assessment	Intervention			Comparison		
		<i>Mean</i>	<i>SD</i>	<i>n</i>	<i>Mean</i>	<i>SD</i>	<i>n</i>
Berkule et al., 2014	PHQ-9	2.47	3.59	126	3.79	4.07	134
Boyd et al., 2019	BDI-II	20.2	2.2	12	23.3	4.9	8
Cooper et al., 2009	EPDS	2.78	4.54	170	3.91	5.8	184
Ericksen et al., 2018	DASS	7.69	6.77	16	15.23	11.03	15
Goodman et al., 2015	EPDS	6.19	3.64	21	6.35	5.45	21
Horowitz et al., 2001	BDI-II	10.27	0.99	60	9.51	0.77	57
Horowitz et al., 2013	EPDS	9.16	4.4	62	9.95	5.8	65
Letourneau et al., 2011	EPDS	11.8	4.68	23	8.68	5.44	28
Lonnberg et al., 2020	EPDS	6.31	4.1	75	8.33	5.48	89
Munoz et al., 2007	CES-D	15.09	12.31	21	16.43	8.5	20
O'Mahen et al., 2013	EPDS	11.05	4.71	37	14.26	5.11	34
Pan et al., 2019	EPDS	6.51	4.51	39	8.77	3.41	35
Puckering et al., 2010	EPDS	11.9	5.6	11	17.4	8	6
Sawyer et al., 2019	EPDS	7.8	4.4	54	8.8	4.9	57
Shorey et al., 2019	EPDS	5.41	4.04	59	8.05	6.12	59
Tsivos et al., 2015	BDI-II	9.39	8.34	12	11.23	9.79	10
Werner et al., 2016	HRSD	12.09	7.31	22	17.17	9.81	23

Note. PHQ-9, Patient Health Questionnaire; BDI, Beck Depression Inventory; EPDS, Edinburgh Postnatal Depression Scale, DASS, Depression, Anxiety, Stress Scales; CES-D, Centre for Epidemiologic Studies Depression Scale; HRSD, Hamilton Rating Scale for Depression

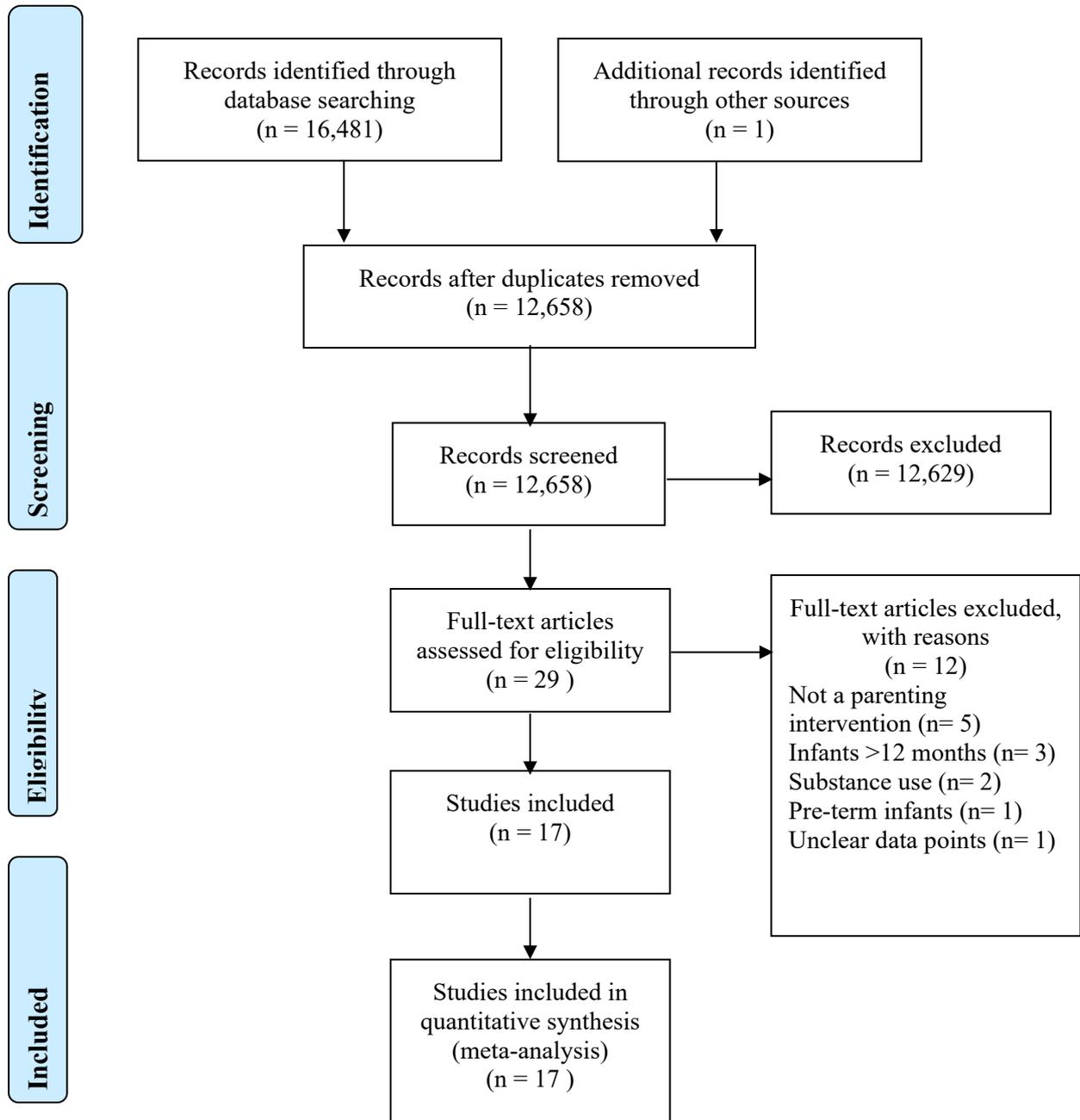


Figure 1: Flow diagram for study selection process

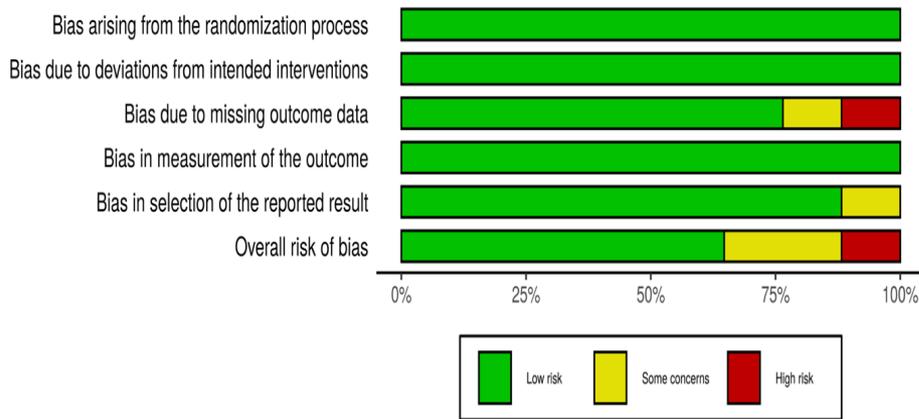


Figure 2. Risk of bias visualization for included studies

Study	Risk of bias domains					Overall
	D1	D2	D3	D4	D5	
Berkule et al., 2014	+	+	+	+	+	+
Boyd et al 2019	+	+	+	+	+	+
Cooper et al., 2009	+	+	+	+	+	+
Ericksen et al., 2018	+	+	+	+	+	+
Goodman et al., 2015	+	+	+	+	+	+
Horowitz et al., 2001	+	+	+	+	+	+
Horowitz et al., 2013	+	+	+	+	-	-
Letourneau et al., 2011	+	+	X	+	+	X
Lonnberg et al., 2020	+	+	+	+	+	+
Munoz et al., 2007	+	+	+	+	+	+
O'Mahen et al., 2013	+	+	+	+	+	+
Pan et al., 2019	+	+	-	+	+	-
Puckering et al., 2010	+	+	+	+	-	-
Sawyer et al., 2019	+	+	+	+	+	+
Shorrey et al., 2019	+	+	+	+	+	+
Tsivos et al., 2015	+	+	-	+	+	-
Werner et al., 2016	+	+	X	+	+	X

Domains:
D1: Bias arising from the randomization process
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
● High
● Some concerns
● Low

Figure 3. Risk of bias assessment for individual studies

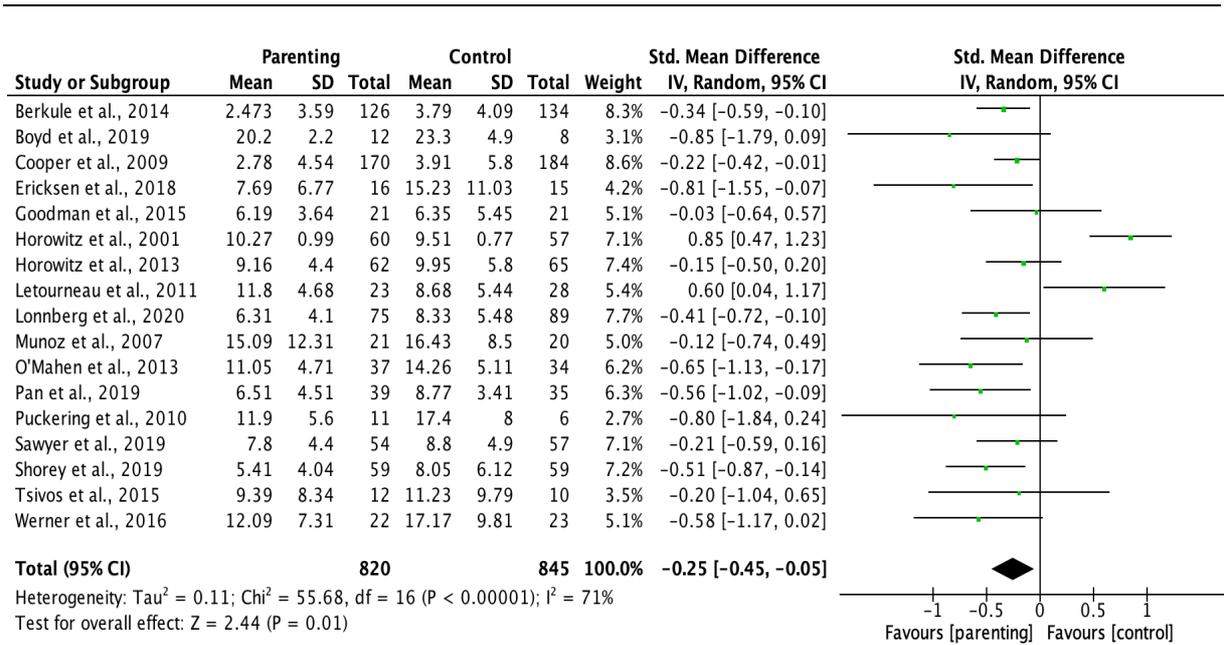


Figure 4. Summary of findings for perinatal depressive symptoms at post-intervention

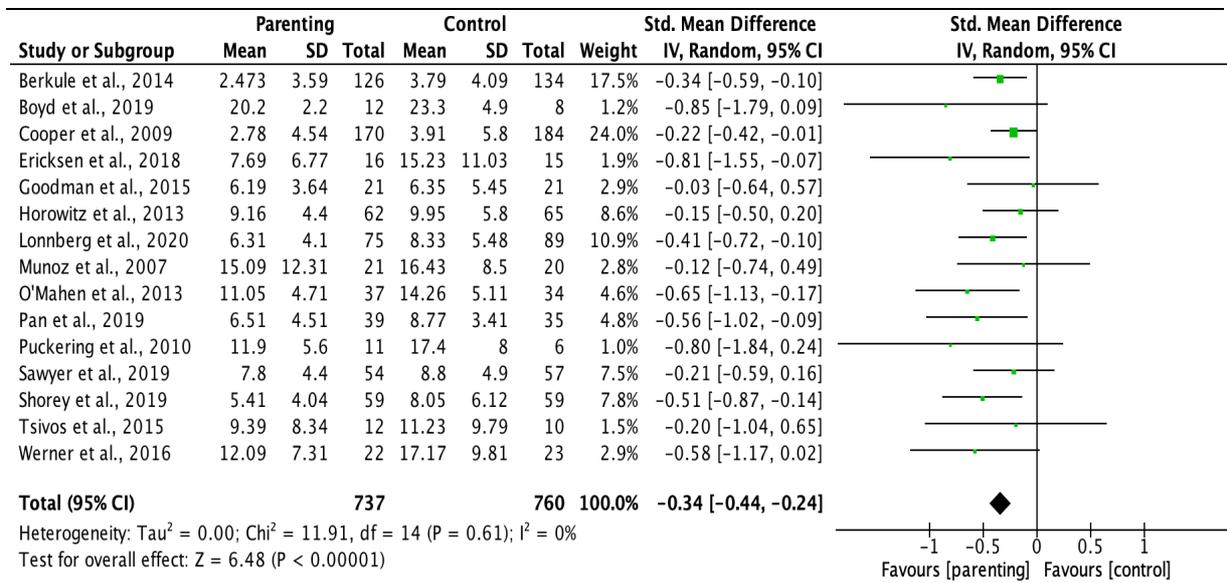


Figure 5: Summary of findings for perinatal depressive symptoms excluding outliers at post-test

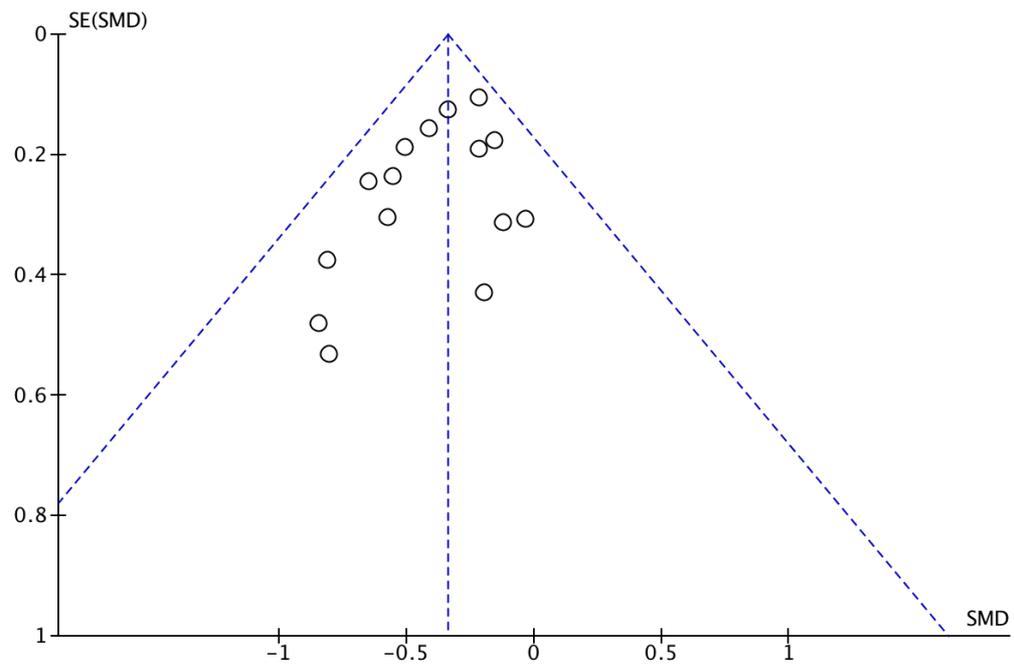


Figure 6: Bias due to publication of parenting studies