Archives of Women's Mental Health (2019) 22:737–750
https://doi.org/10.1007/s00737-019-00961-9

REVIEW ARTICLE

Internet-delivered psychological interventions for clinical anxiety and depression in perinatal women: a systematic review and meta-analysis

Siobhan A. Loughnan[1,2] · Amy E. Joubert[1,3] · Ashlee Grierson[1,2] · Gavin Andrews[1,2] · Jill M. Newby[1,3]

Received: 11 June 2018 / Accepted: 18 March 2019 / Published online: 17 May 2019

Abstract
Perinatal anxiety and depression are common and associated with negative outcomes if left untreated. Internet-delivered treatments can improve treatment accessibility and have demonstrated effectiveness in treating anxiety and depression in the general adult population. However, little is known about how effective and acceptable these interventions are for perinatal women. This paper describes a systematic review and preliminary meta-analysis of internet-delivered psychological interventions for the treatment of clinical anxiety and depression in perinatal women. A systematic search was carried out of seven electronic databases. Seven studies evaluating six distinct internet-delivered psychological interventions were identified. Of the seven studies included, two were open trials and five were randomized controlled trials with a total of 595 participants. Preliminary findings indicate large improvements in depression (Hedges $g = 1.67$; 95% CI 1.38–1.96) and anxiety (Hedges $g = 1.08$; 95% CI 0.80–1.36) from pre- to post-treatment. However, between-group differences between interventions and control conditions were only moderate for depression (Hedges $g = 0.60$; 95% CI 0.43–0.78) and anxiety (Hedges $g = 0.54$; 95% CI 0.24–0.85). While our preliminary findings are promising, this review identifies an area of research still in its early stages with significant gaps in the literature that need to be addressed. Further research is needed to establish the efficacy and acceptability of these interventions in this population, especially for antenatal depression and anxiety disorders.

Keywords Pregnancy · Postpartum · Anxiety · Depression · Internet

Introduction

Anxiety and depression are common during the perinatal period, defined as pregnancy through 12 months postpartum, with approximately 15% of women meeting diagnostic criteria for an anxiety or depressive disorder (Dennis et al. 2017; Woody et al. 2017). Untreated maternal anxiety and depression are associated with short- and long-term adverse outcomes, such as the recurring course of maternal symptoms and increased risk of negative birth outcomes (Stein et al. 2014). Despite effective psychological treatments being available, fewer than half of these women seek help due to a range of barriers, including perceived stigma and logistical issues in attending appointments, which limit their engagement with existing treatment services (Dennis and Chung-Lee 2006; Goodman 2009; Woolhouse et al. 2009).

Internet-delivered psychological treatment is one approach that can improve treatment uptake in this population and has many advantages over traditional face-to-face therapy such as reduced out-of-pocket cost and increased convenience and privacy. Specifically, internet-delivered cognitive behavioral therapy (iCBT) has been proven to be an acceptable and effective psychological treatment for depression and anxiety in the general adult population (Hedman et al. 2014), and has been shown to be as effective in reducing depressive and anxious symptomology as the face-to-face CBT (Carlbring et al. 2018).

✉ Siobhan A. Loughnan
Siobhan.Loughnan@svha.org.au

[1] Clinical Research Unit for Anxiety and Depression (CRUfAD), UNSW School of Psychiatry, Level 4, O'Brien Centre, St Vincent's Hospital, 394 Victoria Street, Sydney, New South Wales 2010, Australia

[2] School of Psychiatry, University of New South Wales, Sydney, Australia

[3] School of Psychology, University of New South Wales, Sydney, Australia

To date, two reviews have synthesized the literature on computer- or web-based interventions for the prevention or treatment of perinatal mental health issues (e.g., stress management, complicated grief after pregnancy loss; Ashford et al. 2016; Lee et al. 2016), and one meta-analysis has examined iCBT for postpartum depression, anxiety, and stress. Overall, preliminary findings suggest that postpartum depression symptoms improve after treatment, with moderate effect size improvements for iCBT compared with that for control conditions (Cohen's $d = -0.63$; Lau et al. 2017). Anxiety outcomes appear to be mixed, with only small improvements in postpartum anxiety symptoms ($d = -0.36$) for iCBT compared with that for control conditions (Lau et al. 2017).

However, while these findings are promising, there are significant limitations that need to be addressed. First, it is difficult to determine how efficacious and acceptable these interventions are for the treatment of clinical anxiety and depression given the broad range of studies included. This is problematic as anxiety and depression outcomes associated with discrete mental health conditions, such as complicated grief and posttraumatic stress, are difficult to generalize to women who have not experienced such trauma. It is also problematic to synthesize and compare findings from preventative interventions evaluated in subclinical samples, studies evaluated in women outside the defined "perinatal" period (i.e., greater than 12 months postpartum), and studies evaluated in mothers *and partners.*

Second, no studies included in the previous reviews targeted anxiety disorders. Studying anxiety outcomes in this population is important given that up to 23% of perinatal women will experience clinical levels of anxiety (Dennis et al. 2017) and the available internet-delivered interventions, not tailored to anxiety, having only a small impact on symptom improvements (Lau et al. 2017). Third, it is difficult to determine how efficacious these interventions are in reducing antenatal symptoms (i.e., during pregnancy). Only one study has evaluated a general depression program in pregnant women (Kim et al. 2014). Given that antenatal anxiety and depression are strong predictors of postpartum anxiety and depression, it is important to determine not only if these interventions are efficacious but also whether delivering the treatment during pregnancy offers any long-term postpartum benefits.

Improving treatment accessibility via the internet is a rapidly developing area of research. Given the gaps in the current literature and serious negative consequences associated with untreated anxiety and depression, an updated and more focused review is required to inform treatment for clinical anxiety and depression in perinatal women. The present meta-analytic review was therefore restricted to internet-delivered interventions developed specifically for the treatment of clinical levels of maternal depression, anxiety, or comorbid depression and anxiety during the perinatal period only. We also included more recent studies of internet-delivered interventions that have been published since these earlier reviews were conducted, including one study evaluating a therapist-assisted iCBT intervention for women with major depressive disorder (MDD) during pregnancy (Forsell et al. 2017) and a therapist-assisted iCBT intervention for antenatal women with severe fear of childbirth (Nieminen et al. 2016). We sought to examine the overall effect of internet-delivered interventions on anxiety and depression symptoms, establish their relative efficacy compared with that of control conditions, and examine acceptability as indicated by adherence rates and reported participant satisfaction.

Methods

Inclusion criteria

To be included in this review, studies had to meet the following criteria:

(i) *Participants:* Participants aged over 18 years, who were pregnant or in the postpartum period (defined as ≤ 12 months after childbirth), and met the criteria for clinical anxiety and/or depression, according to clinical cut-off scores on a validated self-report measure, or a current anxiety or depressive disorder established using a formal diagnostic interview.

(ii) *Interventions:* Internet-delivered psychotherapeutic interventions of any therapy modality explicitly targeted at reducing anxiety and/or depressive symptoms within the context of the perinatal period (i.e., not general depression interventions). Self-guided and clinician-guided interventions were included.

(iii) *Outcomes:* Studies that reported at least one validated self-report measure of anxiety or depression at pre-treatment and post-treatment were included. We used the primary outcome measure as reported by the study investigators.

(iv) *Study design:* RCTs, uncontrolled (open) trials, and feasibility studies with a pre-post-study design were included.

Excluded studies

We excluded the following: (1) studies of psychosocial interventions that did not explicitly target perinatal anxiety or depression (e.g., general well-being); (2) studies that evaluated technology-based interventions (e.g., telephone) with no internet component; (3) studies that included insufficient data to allow for effect size calculation and where we could not obtain said data; and (4) studies that focused on populations under age 18 or a postpartum period > 12 months. Studies not

published in a peer-reviewed journal or in the English language were excluded, as were qualitative studies, protocols, dissertations, and case studies.

Selection and coding of studies

Relevant studies were identified through comprehensive systematic searches of electronic databases, up to 17 April 2018. The following were the databases included: PsycINFO, Medline, Cochrane Central Register of Controlled Trials, Embase, PubMed, CINAHL, and Maternity and Infant Care. A combination of perinatal terms, anxiety and depression terms, computer terms, and psychotherapy terms were used to search the databases (see Appendix A for example of search terms). After the duplicates were removed, titles and abstracts were independently screened to determine eligibility (SL, AJ). All eligible papers were retrieved for full-text screening and independently reviewed (SL, AG). Methodology and outcome data were extracted into a Microsoft Excel spreadsheet before being transferred to Comprehensive Meta-Analysis (CMA version 3.0; Biostat, Inc.) for analysis.

Risk of bias in individual studies

The methodological quality and risk of bias of included RCTs were assessed using the "Risk of Bias" tool, developed by the Cochrane Collaboration (Higgins and Green 2011) with all papers reviewed independently (SL, AJ). Specific domains of bias addressed include selection bias, performance bias, detection bias, attrition bias, and reporting bias.

Statistical analyses

Within-group effects (uncontrolled effect size) of treatment on anxiety and depression symptom severity from pre- to post-treatment were calculated by subtracting the average symptom severity at post-treatment from the average symptom severity at pre-treatment, divided by the pooled standard deviation on the primary outcome measure. The between-group effects (controlled effect size) were calculated by dividing the difference between the treatment and control condition by the pooled standard deviation. All effect sizes were corrected for upward bias using Hedges *g* (Hedges 1981) and mean effect sizes calculated according to the random effects model (Borenstein et al. 2010). Effect sizes were weighted by the study sample size. As the correlation between pre- and post-time-points was not available in most studies, we used a conservative value of 0.50 (Balk et al. 2012). Within- and between-group effect sizes were calculated so that positive effect sizes represent a reduction in symptoms, with sizes of 0.2, 0.5, and 0.8 referring to small, moderate, and large effect sizes, respectively (Cohen 1988). The I^2 statistic was calculated to provide a relative test of heterogeneity, with values of 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively. Duval and Tweedie's Trim and Fill procedure was calculated to correct the variance of the effects observed within the funnel plot and to provide the best estimate of the unbiased effect size (Duval and Tweedie 2000).

Results

Study selection

Figure 1 presents the flow chart. Searches yielded 6412 studies after the duplicates were removed. Thirty studies were potentially eligible for inclusion based on title and abstract. After the full-text review, seven studies met the eligibility criteria.

Study characteristics

Characteristics of the included studies are summarized in Table 1. Of the seven studies included, five were RCTs and two were open uncontrolled pilot studies, with a total of 595 participants. All studies recruited women who had self-reported clinical levels of depression or anxiety symptoms, according to clinical cut-off scores on a validated measure at application. Three studies also required participants to meet diagnostic criteria for MDD according to a clinical diagnostic interview. Of the seven studies included, six distinct intervention programs were evaluated, with most interventions developed for depression and one for fear of childbirth. No interventions targeted specific anxiety disorders, or comorbid depression and anxiety. Treatment engagement and methodological quality of each study are presented in Table 2.

CBT-based interventions for depression and anxiety

Antenatal interventions Two studies evaluated iCBT interventions for pregnant women. In an open feasibility study, Nieminen et al. (2016) recruited 28 nulliparous women with severe fear of childbirth via an online website. The intervention consisted of eight modules delivered over 2 weeks, with weekly online therapist support. Of the 28 women who started the intervention, 15 completed all eight modules. Of these women, there were large improvements (Cohen's $d = 0.95$) in fear of childbirth symptoms from pre- to post-treatment according to the Wijma Delivery Expectancy Questionnaire (W-DEQ; Wijma et al. 1998). Participant satisfaction was positive.

Forsell et al. (2017) conducted an RCT and recruited pregnant women (mean age 31 years) with a clinical diagnosis of MDD via self-referral. Women were randomized to iCBT in addition to maternity care ($n = 22$) or to treatment as usual (TAU), which consisted of usual maternity care only ($n = 20$). The intervention consisted of seven modules and three optional modules delivered over 10 weeks, with online

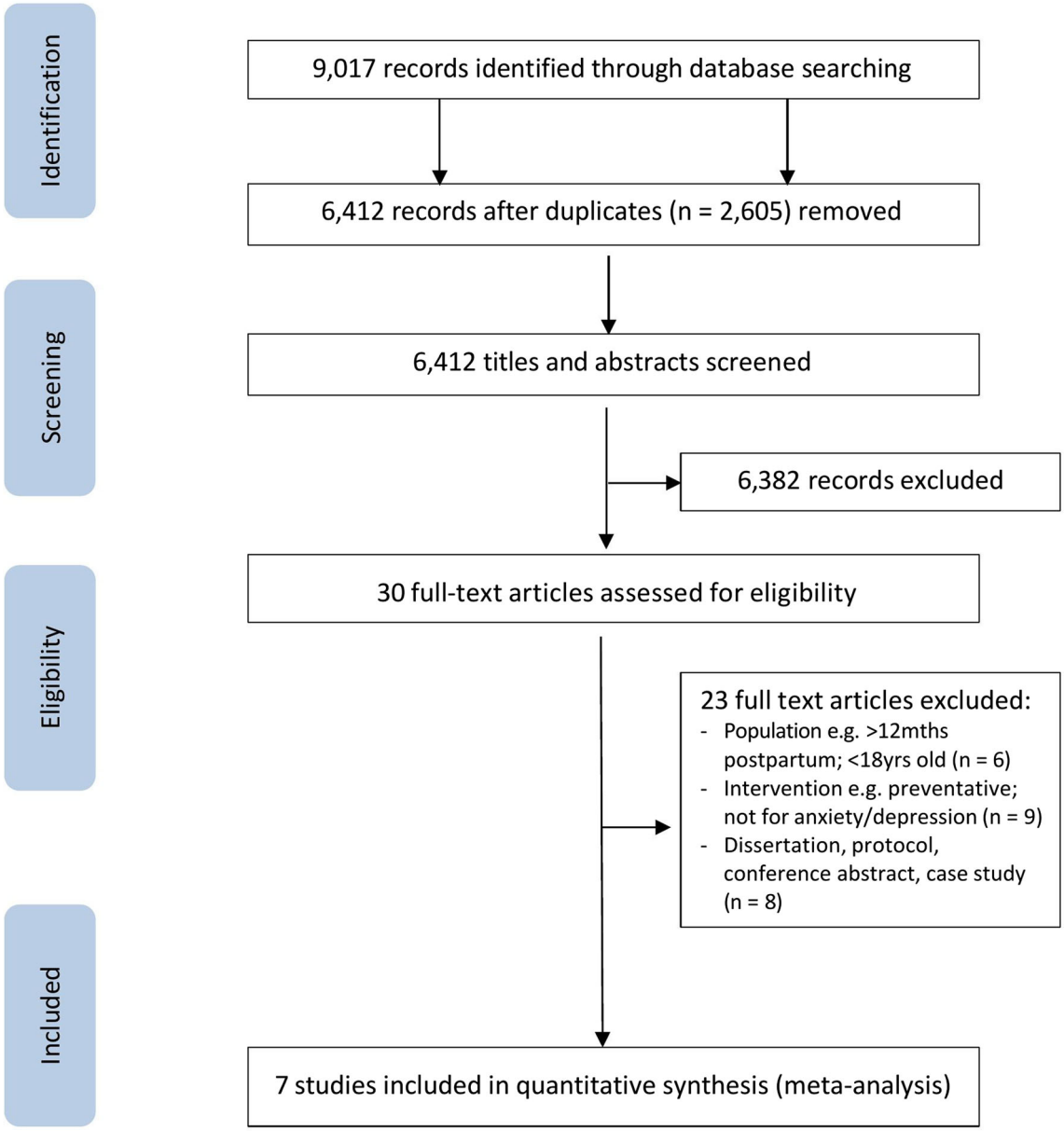

Fig. 1 Flowchart illustrating the identification of included studies

therapist support. Participants completed an average of five modules, with 82% completing more than six. Attrition was low with most participants (> 85%) completing post-treatment assessment. Participants in the iCBT group demonstrated greater improvements in depression symptom severity from pre- to post-treatment, according to the Montgomery-Asberg Depression Rating Scale (MADRS-S; Montgomery and Asberg 1979), compared with those in the TAU group(Hedges $g = 1.21$). The iCBT group also demonstrated significant improvements in anxiety symptom severity from pre- to post-treatment according to the Generalized Anxiety Disorder 7-item scale (GAD-7; Spitzer et al. 2006); however, this was not significantly different with those in TAU. Participant satisfaction was positive.

Postpartum interventions Three studies explored the effects of iCBT for maternal depression during the postpartum period. Two studies (Danaher et al. 2013; Milgrom et al. 2016) evaluated the same iCBT intervention, which consisted of six modules delivered over 6–12 weeks with participants supported by a telephone coach. Danaher et al. (2013) evaluated the feasibility of "MomMoodBooster" in an open trial conducted across two international research sites (Iowa, USA; Melbourne, Australia). Fifty-three postpartum women were recruited via self-referral and met the criteria for clinical levels of depressive symptoms. Program adherence was high with 87% of participants completing all six lessons of the program. Attrition was low with over 80% of participants completing post-treatment and follow-up assessments. Depression symptom severity

Table 1 Study characteristics of trials evaluating internet-delivered interventions for perinatal anxiety and depression ($n = 7$)

Study	Country	Study design	Participants	Eligibility criteria (for depression and/or anxiety)	Intervention format and support	Program content	Outcome measure
Danaher et al. (2013)	USA/AUS	OT: $N = 53$ ($n = 27$ from the USA; $n = 26$ from AUS)	Postpartum women mean age 31.9 years; mean months postpartum 5.5	Clinically elevated symptoms of depression on EPDS (> 12) or PHQ-9 (> 9)	iCBT for postpartum depression "MomMoodBooster," 6 sequential sessions delivered over 6–12 weeks; program support provided weekly by graduate research assistants or research psychologists via phone	Content included managing mood, increasing pleasant activities, managing negative thoughts, increasing positive thoughts, planning for the future; peer-based web forum, and partner support website available	Self-report: PHQ-9; HRSD
Forsell et al. (2017)	SWE	RCT: $N = 42$ iCBT: $n = 22$; TAU: $n = 20$	Antenatal women mean age 31 years; mean gestational age 17.3 weeks	DSM-IV diagnosis of MDD (and MADRS-S > 15)	iCBT for antenatal depression, 7–10 modules delivered over 10 weeks; program support provided by CBT-trained therapist via an online platform	Adapted version of iCBT for depression in relation to pregnancy; each module included reading material, assessments, homework, and work-sheets; content included psychoeducation, behavioral activation, cognitive restructuring, relationships, relapse prevention, and optional modules for anxiety and worry, and sleep problems	Clinician-administered: SCID-I; Self-report: MADRS-S; EPDS; GAD-7
Milgrom et al. (2016)	AUS	RCT: $N = 43$ iCBT $n = 21$; TAU $n = 22$	Postpartum women mean age 31.6 years; mean months postpartum 6.3	DSM-IV diagnosis of major/minor depression	iCBT for postpartum depression "MumMoodBooster," 6 sequential sessions delivered over 6–12 weeks; program support provided by graduate psychology trainees and psychologists via phone	Content included managing mood, increasing pleasant activities, managing negative thoughts, increasing positive thoughts, planning for the future; peer-based web forum, and partner support website available	Clinician-administered: SCID-IV; Self-report: BDI-II; DASS
Nieminen et al. (2016)	SWE	OT: $N = 28$	Antenatal women mean age 30.5 years; mean gestational age 24 weeks	Clinically elevated symptoms of fear of childbirth on W-DEQ, version A (> 86)	iCBT for severe fear of childbirth, 8 modules delivered online over 8 weeks; program support provided by MSc psychology students and obstetrician via an online platform	Each module consisted of (1) information track, (2) therapy track, (3) homework questions; content included psychoeducation, goal setting, breathing retraining, cognitive restructuring, exposure in vitro and in vivo, assertiveness training, relapse prevention	Self-report: W-DEQ
O'Mahen et al. (2013)	UK	RCT: $N = 910$, iCBT: $n = 462$; TAU: $n = 448$; Completed baseline questionnaires iCBT: $n = 172$; TAU: $n = 138$	Postpartum women mean age 32.2 years; mean months postpartum, not reported	Clinically elevated symptoms of depression on EPDS (> 12)	iBA for postpartum depression "NetMums," 11 weekly sessions delivered over 11–15 weeks; program support provided weekly by a specialist health visitor or clinical psychologist via online clinic	iBA manual adapted to postnatal period and online delivery; content included self-monitoring, functional analysis, alternative behaviors, problem-solving, contingency planning, communication strategies, rumination strategies, relapse prevention; iBA-specific online chat room available (moderated by parent supporters)	Self-report: EPDS

Table 1 (continued)

Study	Country	Study design	Participants	Eligibility criteria (for depression and/or anxiety)	Intervention format and support	Program content	Outcome measure
O'Mahen et al. (2014)	UK	RCT: $N = 83$, iCBT: $n = 41$; TAU: $n = 42$	Postpartum women mean age, not reported; mean months postpartum, not reported	DSM-IV diagnosis of MDD (and EPDS > 12)	iBA for postpartum depression "NetMumsHWD," 12 sessions delivered over 15 weeks; program support provided weekly by mental health workers (clinical qualification in psychological therapies) via phone	Modified 12-session treatment consisting of 5 core modules (e.g., mood/activity monitoring, behavior/contingency planning, problem-solving, prioritizing) and relapse prevention; six optional modules (e.g., support and communication); online chat room, and additional resources available	Self-report: EPDS; GAD-7
Pugh et al. (2016)	Canada	RCT: $N = 50$, iCBT: $n = 25$; WLC: $n = 25$	Postpartum women mean age 30.92; mean months postpartum, not reported	Elevated symptoms of depression on EPDS (> 10); Only clinical subsample data used in analyses (i.e., EPDS > 12)	iCBT for postpartum depression "Maternal Depression Online," 7 sequential modules delivered over 7 weeks; program support provided weekly by clinical psychology doctoral students via email	An existing iCBT program for depression tailored to women in the postpartum period[a]	Clinician-administered: MINI; Self-report: EPDS; DASS

AUS Australia, *USA* United States of America, *CAN* Canada, *SWE* Sweden, *MDD* major depressive disorder, *RCT* randomized controlled trial, *TAU* treatment as usual, *OT* open trial, *iCBT* internet-delivered cognitive behavioral therapy, *iBA* internet-delivered behavioral activation, *PHQ* Patient Health Questionnaire, *HRSD* Hamilton Rating Scale for Depression, *SCID-I* structured clinical interview for DSM Axis 1 disorders, *MADRS-S* Montgomery-Asberg Depression Rating Scale self-report version, *EPDS* Edinburgh Postnatal Depression Scale *GAD-7* General Anxiety Disorder 7-item scale, *BDI* Beck Depression Inventory, *BAI* Beck Anxiety Inventory, *SCID-IV* Structured Clinical Interview for DSM-IV, *BDI-II* Beck Depression Inventory—second edition, *DASS* Depression Anxiety Stress Scales—short form, *W-DEQ* Wijma Delivery Expectancy/Experience Questionnaire, version A (before delivery)

[a] No further information reported

Table 2 Treatment engagement and attrition rates ($n = 7$), and quality assessment ($n = 5$) of included studies

Study	Treatment engagement and attrition	Quality Assessment[a]				
		Selection bias	Performance bias	Detection bias	Attrition bias	Reporting bias
Danaher et al. (2013)	Of those in iCBT, 87% of participants completed all six treatment sessions; attrition rates were less than 15% at post-treatment and 13% for 6-month follow-up	–	–	–	–	–
Forsell et al. (2017)	Participants completed an average five out of a possible 10 modules; attrition rates between pre- and post-treatment were less than 14% for iCBT and 15% for TAU	Low	High	Unclear	Low	Unclear
Milgrom et al. (2016)	All participants completed four or more sessions, with 86% completing all six sessions; attrition rates were low with only 2 participants in iCBT not providing post-treatment data	Low	High	Low	Low	Low
Nieminen et al. (2016)	Of the 28 participants who started, 15 completed all 8 weeks of treatment and were included in post-treatment analyses (54%); 4/28 participants did not provide postpartum follow-up data (14%)	–	–	–	–	–
O'Mahen et al. (2013)	For those in iCBT, engagement with the chat room was low (7%; individual program use not assessed); high drop-out (81%) from online sign-up/randomization to baseline assessment; attrition rates between pre- and post-treatment assessment ranged from 61 to 76% for iCBT and 64–767% for TAU	Low	High	Unclear	Low	Unclear
O'Mahen et al. (2014)	Of those in iCBT, participants completed an average 5 of 12 sessions; 5% completed 8 or more sessions; attrition rates between pre- and post-treatment were 10% for iCBT and 19% for TAU; at 6-month follow-up assessment, attrition rates for iCBT and TAU were 24% and 32%, respectively	Low	High	Unclear	Unclear	Unclear
Pugh et al. (2016)	Of those in iCBT, participants completed an average 6 of 7 modules, with 60% completing all modules; attrition rates for iCBT and WLC groups were 16% and 12.5%, respectively between pre- and post-treatment assessments; and 28.5% for iCBT between post-treatment and follow-up	Low	High	Unclear	Unclear	Unclear

[a] Quality assessment was conducted on randomized controlled trial studies only; with selection bias = random sequence generation, allocation concealment; performance bias = blinding of participants and personnel; detection bias = blinding of outcome assessment; attrition bias = incomplete outcome data; reporting bias = selective outcome reporting

significantly improved according to the Patient Health Questionnaire (PHQ-9; Kroenke et al. 2001), with large within-group differences between baseline and post-treatment (partial $r = 0.77$), and between baseline and 6-month follow-up (partial $r = 0.82$). Participant satisfaction was positive.

Milgrom et al. (2016) evaluated the efficacy of "MumMoodBooster" in an RCT conducted in Australia. Postpartum women with a diagnosis of MDD were recruited via self-referral and randomized to iCBT ($n = 21$) or TAU ($n = 22$). Program adherence was high with 86% of participants completing all six sessions. According to the Beck Depression Inventory (BDI-II; Beck et al. 1996), participants in the iCBT group demonstrated greater improvements in depression symptom severity from pre- to post-treatment compared with those in the TAU group(Cohen's $d = 0.83$). There were no significant improvements in anxiety symptom severity from pre- to post-treatment according to the anxiety subscale of the Depression Anxiety Stress Scale (DASS-21; Lovibond and Lovibond 1995). Participants were moderately satisfied with the program.

Pugh et al. (2016) conducted an RCT to evaluate the efficacy of a therapist-assisted iCBT intervention for postpartum depression. Women were recruited via self-referral and randomized to iCBT ($n = 25$) or waitlist control (WLC; $n = 25$). The intervention consisted of seven modules delivered over 7 weeks, with weekly therapist support via email. Attrition rates were low (< 16%) between pre- and post-treatment, with 60% of participants completing all seven modules of the intervention. Participants in iCBT ($n = 21$) demonstrated greater improvements in depression symptom severity from pre- to post-treatment, according to the Edinburgh Postnatal Depression Scale (EPDS; Cox et al. 1987), compared with those in WLC ($n = 20$), with improvements maintained at 4-week follow-up. There were no differences between groups in anxiety symptom severity from pre- to post-treatment according to the DASS-21 anxiety subscale. Participants reported a high level of satisfaction with the program.

Behavioral activation-based interventions for depression

Postpartum interventions Two studies evaluated the same internet-delivered behavioral activation (iBA) intervention, yet will be reported separately given the revised intervention involved significant modifications to the program structure and level of support provided. O'Mahen et al. (2013) conducted an RCT to evaluate a guided an iBA intervention for women with clinically elevated symptoms of postpartum depression. Women were self-referred and randomized to iBA ($n = 462$) or TAU ($n = 448$). The intervention consisted of 11 sessions completed over 15 weeks, with weekly therapist support via an online clinic. While recruitment to the study was high ($n = 910$), less than 40% completed the baseline questionnaires and only one-third of participants completed the program. Engagement with online support was low. Of those that completed the intervention and provided post-treatment data, fewer women in the iBA group were classified as depressed according to the EPDS than those in TAU (OR of 2.16). Participants reported struggling to "keep up" with the program.

In 2014, O'Mahen and colleagues conducted an RCT to evaluate a revised version of their guided iBA intervention for postpartum depression. The program content was modified to a modular approach and was completed over 15 weeks. Therapist support was changed to weekly telephone calls. This intervention was evaluated in a sample of women with a clinical diagnosis of MDD recruited via self-referral and randomized to iBA plus TAU ($n = 41$) or TAU alone ($n = 42$). While more than 70% of participants completed post-treatment and 6-month follow-up questionnaires, program adherence was low with participants completed an average of five out of 12 sessions, and only 5% completed more than eight sessions. Those who received iCBT demonstrated greater improvements in depression symptoms according to the EPDS (Cohen's $d = -0.87$) and anxiety symptoms according to the GAD-7 (Cohen's $d = -0.59$) from pre- to post-treatment compared with those who received TAU. Participant satisfaction was not reported.

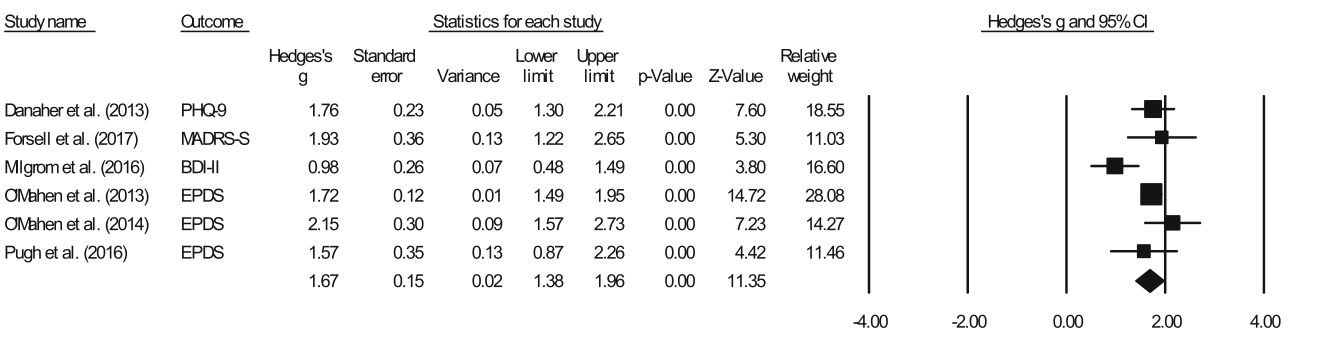

Fig. 2 Forest plot and uncontrolled (within-group) effect sizes for depression outcomes of pre-post intervention studies

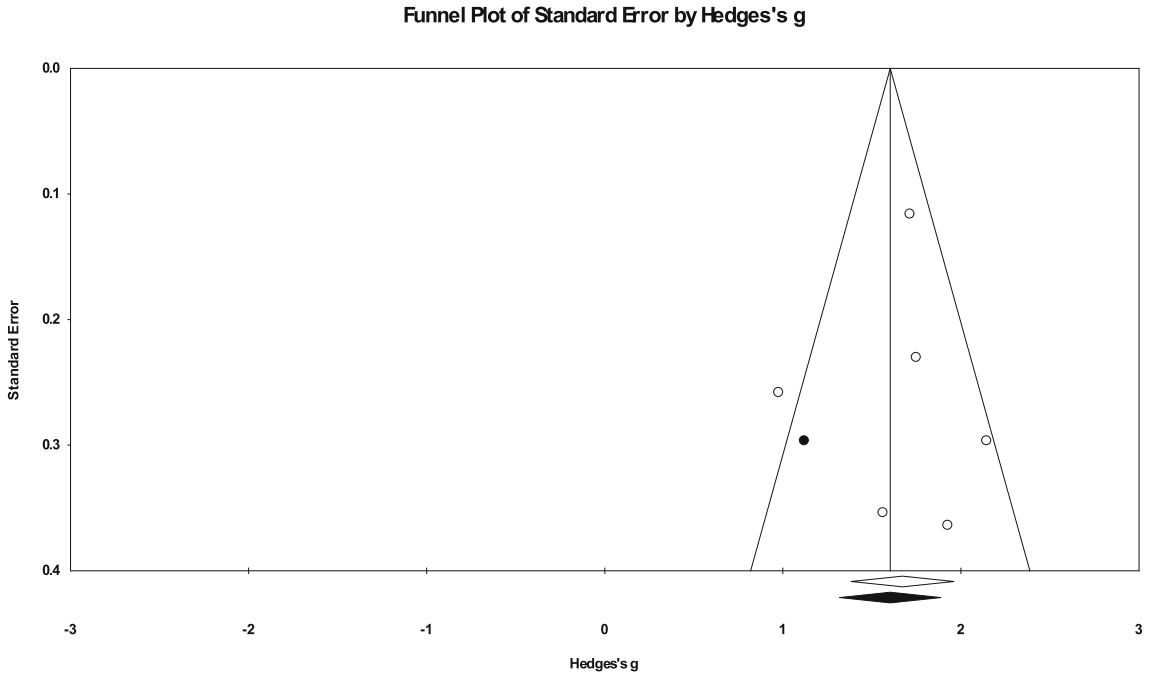

Fig. 3 Publication bias funnel plot for depression outcomes of pre-post intervention studies

Treatment effects on maternal depression and anxiety

Uncontrolled effect sizes for pre-post-intervention studies The analysis of effects for depression outcomes indicated that the interventions resulted in significant improvements in symptom severity from pre- to post-treatment (see Fig. 2 for forest plot). There was a large within-groups mean effect size (Hedges *g*) of 1.67 ($n = 6$) (95% CI 1.38–1.96, $P < 0.01$) for depression outcomes with moderate and non-significant heterogeneity ($Q = 10.56$, $I^2 = 52.64$, $P = 0.06$). After the inspection of the funnel plot (see Fig. 3), we adjusted the potential publication bias using the Trim and Fill procedure, the corrected average effect size reduced from 1.67 to 1.63 ($n =$ 1 trimmed) (95% CI 1.47–1.79; $Q = 14.90$).

For anxiety outcomes, there was a large within-groups mean effect size (Hedges *g*) of 1.08 ($n = 5$) (95% CI 0.80–1.36, $P < 0.01$) with low and non-significant heterogeneity ($Q = 5.34$, $I^2 = 25.11$, $P = 0.25$; see Fig. 4 for forest plot). After the inspection of the funnel plot (see Fig. 5), we adjusted the potential publication bias using the Trim and Fill procedure, the corrected average effect size reduced from 1.08 to 0.99 ($n = 1$ trimmed) (95% CI 0.77–1.22; $Q = 9.15$).

Controlled effect sizes for intervention vs. control group studies The analysis of pre- to post-treatment effects for depression outcomes indicated the superiority of treatment interventions compared with that of control conditions (see Fig. 6 for forest plot). There was a moderate mean between-groups effect size (Hedges *g*) of 0.60 ($n = 5$) (95% CI: 0.43–0.78, $P < 0.01$) with non-significant heterogeneity ($Q = 3.51$, $I^2 = 0$, $P = 0.48$). After the inspection of the funnel plot (see Fig. 7), we adjusted the potential publication bias using the Trim and Fill procedure, the

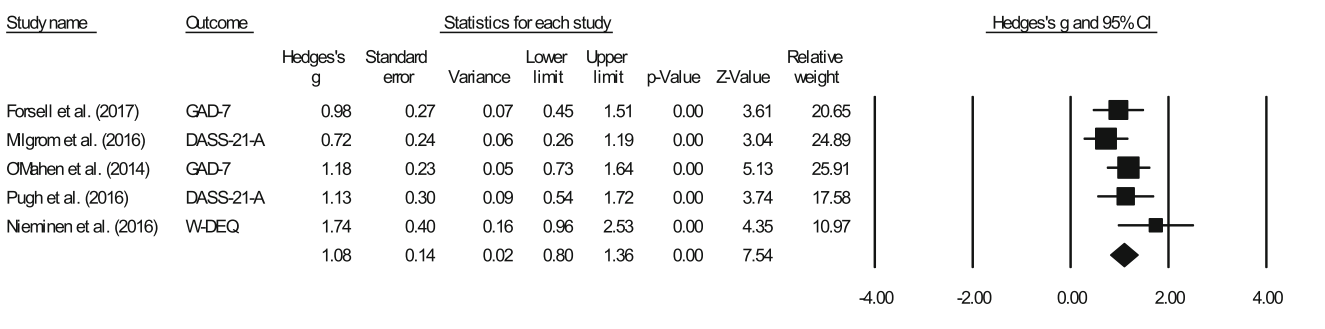

Fig. 4 Forest plot and uncontrolled (within-group) effect sizes for anxiety outcomes of pre-post intervention studies

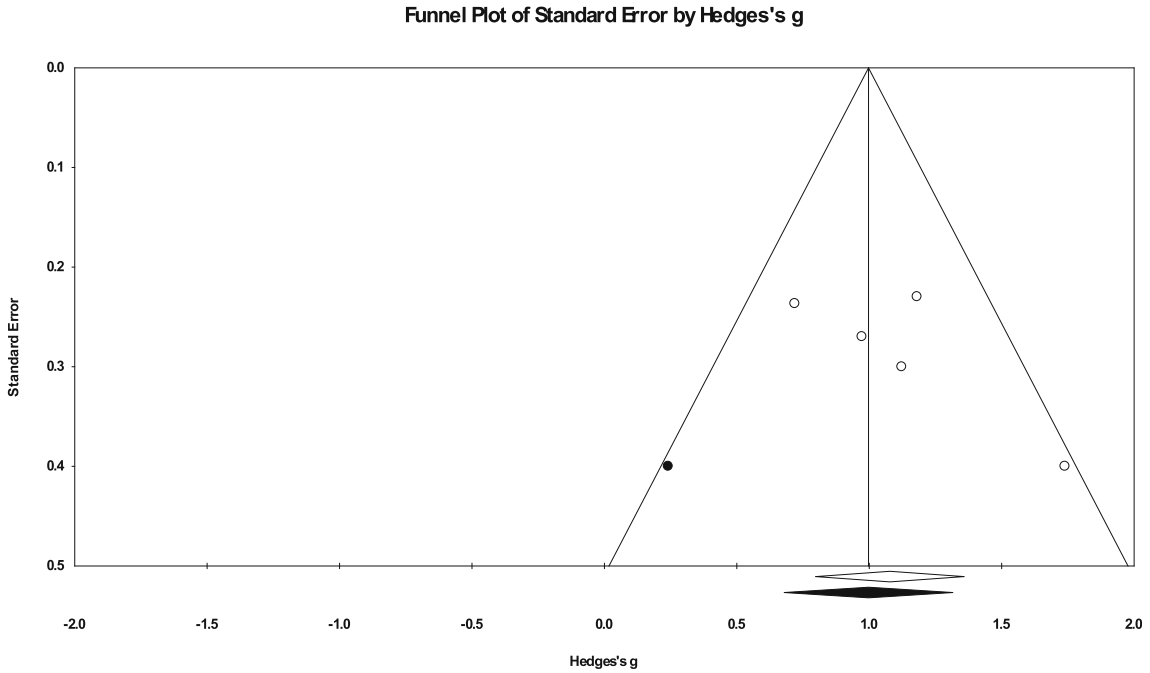

Fig. 5 Publication bias funnel plot for anxiety outcomes of pre-post intervention studies

corrected average effect size reduced from 0.60 to 0.55 ($n = 2$ trimmed) (95% CI 0.38–0.71; $Q = 7.66$).

For anxiety outcomes, there was a mean moderate between-groups effect size (Hedges g) of 0.54 ($n = 4$) (95% CI 0.24–0.85, $P < 0.01$) in favor of internet-delivered perinatal interventions compared with that of control groups with non-significant heterogeneity ($Q = 1.41$, $I^2 = 0$, $P = 0.70$; see Fig. 8 for forest plot). Visual inspection of the forest plot and funnel plot indicated no outliers or publication bias (see Fig. 9).

Discussion

This paper presents a systematic review of internet-delivered psychological treatments for clinical levels of maternal anxiety and depression during the perinatal period, along with a meta-analysis of the preliminary efficacy of these interventions. We identified seven studies including five RCTs and two uncontrolled pilot trials, with a total of 595 participants. Of the seven studies, six distinct interventions were evaluated. Four targeted postpartum depression, one targeted antenatal depression, and one targeted antenatal fear of childbirth. No interventions targeted the reduction of anxiety disorders, or comorbid depression and anxiety. We found that the internet-delivered interventions included in this study demonstrated large and significant improvements in depression (Hedges g of 1.63) and anxiety symptom severity (Hedges g of 0.99) from pre-treatment to post-treatment. We also found that the internet-delivered interventions outperformed control conditions overall, with medium between-group effect sizes for depression (Hedges g of 0.55) and anxiety (Hedges g of 0.54). This study provides evidence for the efficacy of internet-delivered interventions in reducing depression and anxiety symptom severity during the perinatal period.

For depression outcomes, the overall controlled effect size in this review ($g = 0.55$) is comparable with the findings of

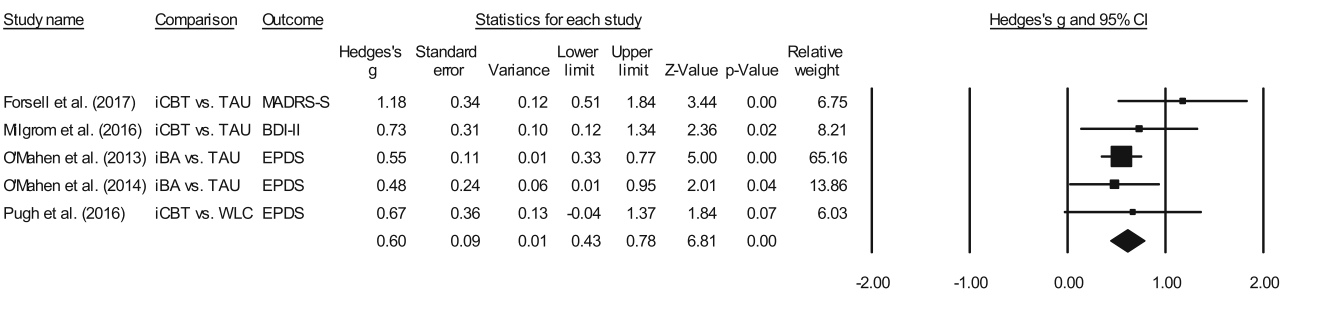

Fig. 6 Forest plot and controlled (between-group) effect sizes for depression outcomes of intervention vs. control group studies

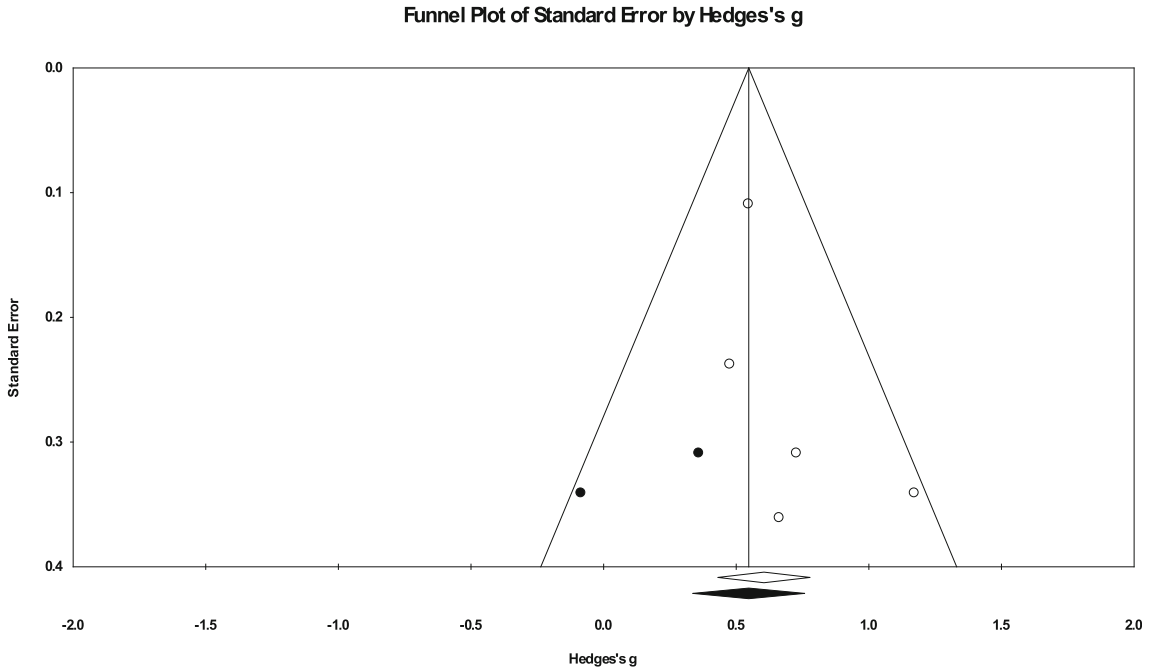

Fig. 7 Publication bias funnel plot for depression outcomes of intervention vs. control group studies

meta-analyses examining treatments for perinatal depression compared with that of control groups (pharmacological and psychological interventions, $g = 0.65$; Sockol et al. 2011; psychological interventions only, $g = 0.50$; Cuijpers et al. 2008), as well as psychological treatments for adult depression compared with control groups in the general population (overall $g = 0.67$, adjusted for publication bias $g = 0.42$; Cuijpers et al. 2010b). Given only three studies which required participants to meet the diagnostic criteria for MDD, future research should explore whether diagnostic status, comorbidity, symptom severity, and outcome measures used influence the treatment outcomes. Future studies should also investigate how internet-delivered interventions for perinatal depression compare with face-to-face psychotherapy. Evidence in the general adult population has found that there are limited differences between iCBT and face-to-face therapy for depression (Carlbring et al. 2018); however, this needs to be examined within the perinatal context.

In regard to anxiety outcomes, at an individual level, the majority of RCTs demonstrated non-significant between-group differences in generalized anxiety outcome measures. However, when pooled using meta-analysis we found a medium and significant group difference favoring the internet-delivered interventions over control conditions. This is an important finding as no interventions were tailored to anxiety and no RCTs recruited women with a diagnosed anxiety disorder. Further, most studies relied on general measures of anxiety which may limit the accurate detection of perinatal-specific anxiety. Future research should ensure studies are adequately powered with large-enough sample sizes to detect group differences in treatment effects on anxiety. The use of psychometrically robust measures of perinatal anxiety and depression is also essential. Given the treatment of perinatal anxiety has received very little attention to date (see review; Loughnan et al. 2018) it is imperative that researchers and clinicians focus

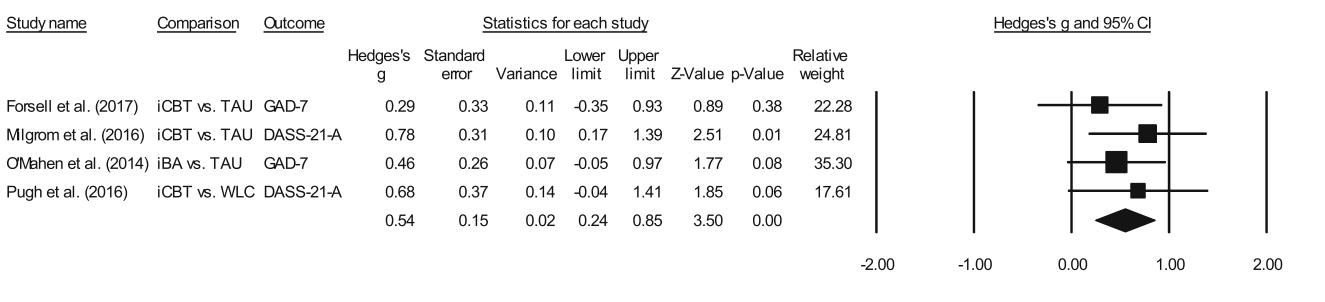

Fig. 8 Forest plot and controlled (between-group) effect sizes for anxiety outcomes of intervention vs. control group studies

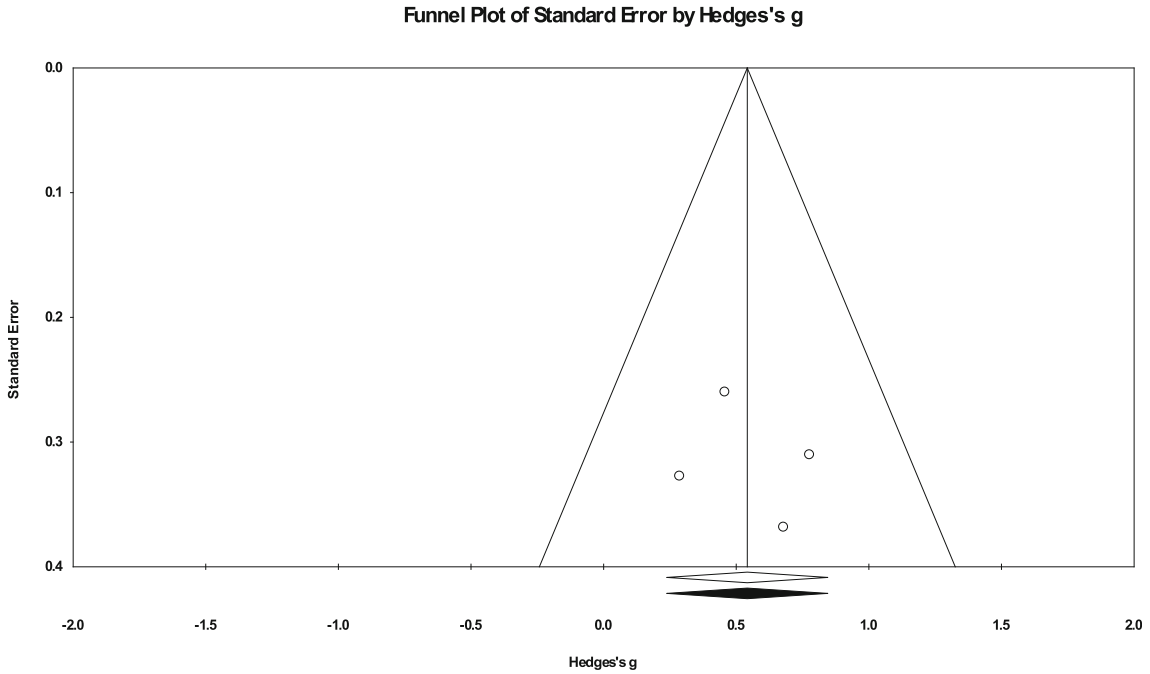

Fig. 9 Publication bias funnel plot for anxiety outcomes of intervention vs. control group studies

on the development of internet-delivered interventions for anxiety disorders in perinatal women.

This review also aimed to examine acceptability as indicated by adherence rates and participant satisfaction. The majority of studies reported low attrition rates (< 30% drop-out between pre- and post-treatment), moderate to high program adherence (60–80% completed all sessions), with most participants satisfied with the intervention program. Interestingly, both postpartum iBA interventions, which had the highest number of treatment sessions (> 11) and longest treatment period (15 weeks), demonstrated the lowest program adherence. Future research should seek to identify the optimal number of intervention sessions and duration of the treatment period to encourage participant adherence, and whether the type of therapist support (e.g., telephone vs. online chatroom) produces different treatment effects and adherence rates. It is important to note, however, that the samples in these studies consisted mostly of self-referred, partnered, and well-educated women residing in high-income developed countries with widespread access to technology. Future research needs to test whether these internet interventions are acceptable and effective for perinatal women from a diverse range of cultural and ethnic backgrounds, and/or lower socioeconomic status, who may be less likely to self-refer and seek help online. Our findings also indicate a need for more high-quality RCTs, particularly given that most studies were characterized by several methodological limitations. While it is not possible to reduce all risk of bias for this area of treatment research, future studies should aim to improve methodological quality through consistent reporting of participant characteristics (e.g., time since childbirth) and outcomes (e.g., acceptability/satisfaction of intervention), blinding of outcome assessments where possible, and taking into account attrition through the use of intent-to-treat analyses.

The results of this review need to be considered in the context of some limitations. The number of studies and sample sizes were small in comparison with evidence for internet-delivered interventions for anxiety and depression in the general adult population (e.g., 64 efficacy trials; Andrews et al. 2018). The majority of studies also used usual care control conditions, in which it is not possible to control the effects of other variables or treatments on clinical outcomes. Previous iCBT research shows that the size of the treatment effect is often larger when compared with that in WLC (Andrews et al. 2010); however, it is possible that for most of these studies, the usual care control condition was a "no treatment" condition given the low rates of concurrent medication use or psychotherapy. Future studies should ensure large enough sample sizes to detect treatment effects relative to usual care control conditions, comparing iCBT with attention control groups, and to explore the factors associated with usual care that contribute to improved symptoms of depression and anxiety. Further, we were limited to examining outcomes based on self-report measures, which may have resulted in inflated estimates of effect sizes. Future research would benefit from examining whether diagnostic status and comorbid diagnoses influence treatment response. It is also unclear if positive effects continue long-term as only three studies included follow-up assessments. Future research would benefit from administering diagnostic assessments at pre- and post-treatment, and

evaluating long-term outcomes. We also excluded studies that were not published in peer-reviewed journals and studies not published in the English language, which may have introduced potential bias. Further, we reported outcomes only for completers which may have biased our findings and led to overestimates of effect sizes. Future research should examine what factors influence treatment response and adherence, particularly whether clinician guidance enhances treatment uptake and adherence (Cuijpers et al. 2010a).

Conclusion

This systematic review and meta-analysis provide support for the efficacy and acceptability of internet-delivered interventions for perinatal women. We found large improvements in anxiety and depression symptom severity; however, the between-group difference compared with control conditions was only moderate. We conclude that this field is currently very limited with further RCTs required, particularly to examine long-term treatment outcomes. It is concerning that very few interventions have targeted symptoms during pregnancy, and none have targeted generalized anxiety alone, or comorbid with depression. These are important areas of investigation for researchers and clinicians given the potential clinical value of internet-delivered interventions for perinatal women.

Authors' contributions SL, JN, and GA designed the study and wrote the protocol and search strategy. SL, AJ, and AG conducted the searches, screened the titles, abstracts, and full-texts for eligibility for inclusion into the meta-analysis, and coded the risk of bias of all RCTs. SL extracted the data from the manuscripts, independently checked by AJ, and conducted the data analysis with supervision from JN. All authors contributed to and have approved the final version of the manuscript for publication.

Funding This study was supported by the Australian Rotary Health and the David Henning Memorial Foundation in the form of a Ph.D. scholarship awarded to Siobhan Loughnan. Jill Newby is supported by an Australian National Health and Medical Research Council (NHMRC)/ Medical Research Future Fund Career Development Fellowship (1145382).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Protocol and registration The protocol for this systematic review was developed according to the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins and Green 2011) and was registered with PROSPERO [CRD42016038032]. All reporting of this systematic review follows the PRISMA guidelines (Moher et al. 2009).

Disclaimer NHMRC, Rotary Health Australia, and the David Henning Memorial Foundation had no role in the study design, collection, data analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Appendix

PsychINFO Search

1. (Perinatal OR peripartum OR antenatal OR antepartum OR prenatal OR pregnan* OR postnatal OR postpartum OR birth OR (after birth)).mp. [mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
2. (Well-being OR (mental health) OR (mental disorder) OR psychopathology OR (psychological disorder) OR anxiety OR (anxiety disorder) OR stress OR depression OR (major depressive disorder) OR (major depression) OR affective OR mood OR emotion* OR unipolar OR (baby blues) OR psychosocial) mp. [mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
3. (Intervention OR treatment OR therap* OR (treatment outcome) OR self-help OR counsel$ing OR psychotherapy* OR bibliotherapy OR (behave$ change) OR CBT OR (cognitive behave$ therapy) OR (cognitive therapy) OR (interpersonal psychotherapy) OR (psychodynamic therapy) OR relaxation).mp. [mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
4. (Internet OR computer OR computer* OR online OR web OR e-therapy OR e-mental OR e-health OR telehealth OR telecare OR teletherapy OR telemedicine OR telemental OR technolog* OR virtual OR cyber OR cyberpsychology OR cybertherapy OR iCBT OR cCBT OR web-based OR web-guided OR web-supported OR web-delivered OR web-assisted OR web-aided OR web-facilitated OR computer-based OR computer-guided OR computer-supported OR computer-delivered OR computer-assisted OR computer-aided OR computer-facilitated OR internet-based OR internet-guided OR internet-supported OR internet-delivered OR internet-assisted OR internet-aided OR internet-facilitated OR online-based OR online-supported OR online-delivered OR online-assisted OR online-aided OR online-facilitated). mp. [mp = title, abstract, heading word, table of contents, key concepts, original title, tests & measures]
5. 1 and 2 and 3
6. limit 4 to (human, adulthood, and English language)

References

Andrews G, Cuijpers P, Craske MG, McEvoy P, Titov N (2010) Computer therapy for the anxiety and depressive disorders is effective, acceptable and practical health care: a meta-analysis. PLoS One 5(10):e13196

Andrews G, Basu A, Cuijpers P, Craske MG, McEvoy P, English C, Newby JM (2018) Computer therapy for the anxiety and depressive

disorders is effective, acceptable and practical health care: an updated meta-analysis (in press). J Anxiety Disord 55:70–78
Ashford MT, Olander EK, Ayers S (2016) Computer- or web-based interventions for perinatal mental health: a systematic review. J Affect Disord 197:134–146
Balk EM, Earley A, Patel K, Trikalinos TA, Dahabreh IJ (2012) Empirical assessment of within-arm correlation imputation in trials of continuous outcomes. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK115797/pdf/Bookshelf_NBK115797.pdf: Agency for Healthcare Research and Quality
Beck AT, Steer RA, Brown GK (1996) Beck depression inventory (2nd edition) - manual. The Psychological Corporation, San Antonio, TX
Borenstein M, Hedges LV, Higgins J, Rothstein HR (2010) A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods 1(2):97–111
Carlbring P, Andersson G, Cuijpers P, Riper H, Hedman-Lagerlöf E (2018) Internet-based vs. face-to-face cognitive behavior therapy for psychiatric and somatic disorders: an updated systematic review and meta-analysis. Cogn Behav Ther 47(1):1–18
Cohen J (1988) Statistical power analysis for the behavioral sciences, 2nd edn. Lawrence Earlbaum Associates, Hillsdale, NJ
Cox JL, Holden JM, Sagovsky R (1987) Detection of postnatal depression: development of the 10-item Edinburgh Postnatal Depression Scale. Br J Psychiatry 150:782–786
Cuijpers P, Brännmark JG, van Straten A (2008) Psychological treatment of postpartum depression: a meta-analysis. J Clin Psychol 64(1):103–118
Cuijpers P, Donker T, van Straten A, Li J, Andersson G (2010a) Is guided self-help as effective as face-to-face psychotherapy for depression and anxiety disorders? A systematic review and meta-analysis of comparative outcome studies. Psychol Med 40(12):1943–1957
Cuijpers P, Smit F, Bohlmeijer E, Hollon SD, Andersson G (2010b) Efficacy of cognitive–behavioural therapy and other psychological treatments for adult depression: meta-analytic study of publication bias. Br J Psychiatry 196(3):173–178
Danaher BG, Milgrom J, Seeley JR, Stuart S, Schembri C, Tyler MS, … Kosty DB (2013) MomMoodBooster web-based intervention for postpartum depression: feasibility trial results. J Med Internet Res 15(11)
Dennis CL, Chung-Lee L (2006) Postpartum depression help-seeking barriers and maternal treatment preferences: a qualitative systematic review. Birth 33(4):323–331
Dennis CL, Falah-Hassani K, Shiri R (2017) Prevalence of antenatal and postnatal anxiety: systematic review and meta-analysis. Br J Psychiatry 210:315–323. https://doi.org/10.1192/bjp.bp.116.187179
Duval S, Tweedie R (2000) Trim and fill: a simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. Biometrics 56(2):455–463
Forsell E, Bendix M, Holländare F, von Schultz BS, Nasiell J, Blomdahl-Wetterholm M, … Söderberg E (2017) Internet delivered cognitive behavior therapy for antenatal depression: a randomised controlled trial. J Affect Disord 221:56–64
Goodman JH (2009) Women's attitudes, preferences, and perceived barriers to treatment for perinatal depression. Birth 36(1):60–69
Hedges LV (1981) Distribution theory for Glass's estimator of effect size and related estimators. J Educ Stat 6(2):107–128
Hedman E, Ljótsson B, Kaldo V, Hesser H, El Alaoui S, Kraepelien M, … Andersson G (2014) Effectiveness of internet-based cognitive behaviour therapy for depression in routine psychiatric care. J Affect Disord 155:49–58
Higgins J, Green SM (2011) Cochrane handbook for systematic reviews of interventions version 5.1.0 [updated March 2011]. Retrieved from www.handbook.cochrane.org
Kim DR, Hantsoo L, Thase ME, Sammel M, Epperson C (2014) Computer-assisted cognitive behavioral therapy for pregnant women with major depressive disorder. J Women's Health 23(10):842–848
Kroenke K, Spitzer R, Williams J (2001) The PHQ-9: validity of a brief depression severity measure [electronic version]. J Gen Intern Med 16(9):606–613
Lau Y, Htun TP, Wong SN, Tam WSW, Klainin-Yobas P (2017) Therapist-supported internet-based cognitive behavior therapy for stress, anxiety, and depressive symptoms among postpartum women: a systematic review and meta-analysis. J Med Internet Res 19(4)
Lee EW, Denison FC, Hor K, Reynolds RM (2016) Web-based interventions for prevention and treatment of perinatal mood disorders: a systematic review. BMC Pregnancy Childbirth 16(1):38
Loughnan SA, Wallace M, Joubert AE, Haskelberg H, Andrews G, Newby JM (2018) A systematic review of psychological treatments for clinical anxiety during the perinatal period. Arch Women's Mental Health 21:481–490. https://doi.org/10.1007/s00737-018-0812-7
Lovibond P, Lovibond (1995) Manual for the depression anxiety stress scales. In: The Psychology Foundation of Australia Inc
Milgrom J, Danaher BG, Gemmill AW, Holt C, Holt CJ, Seeley JR, … Ericksen, J. (2016) Internet cognitive behavioral therapy for women with postnatal depression: a randomized controlled trial of MumMoodBooster. J Med Internet Res 18(3)
Moher D, Liberati A, Tetzlaff J, Altman DG (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 6(7):e1000097
Montgomery SA, Asberg M (1979) A new depression scale designed to be sensitive to change. Br J Psychiatry 134(4):382–389
Nieminen K, Andersson G, Wijma B, Ryding E-L, Wijma K (2016) Treatment of nulliparous women with severe fear of childbirth via the Internet: a feasibility study. J Psychosom Obstet Gynecol 37(2):37–43
O'Mahen HA, Woodford J, McGinley J, Warren FC, Richards DA, Lynch TR, Taylor RS (2013) Internet-based behavioral activation—treatment for postnatal depression (Netmums): a randomized controlled trial. J Affect Disord 150(3):814–822
O'Mahen H, Richards D, Woodford J, Wilkinson E, McGinley J, Taylor R, Warren F (2014) Netmums: a phase II randomized controlled trial of a guided Internet behavioural activation treatment for postpartum depression. Psychol Med 44(8):1675–1689
Pugh NE, Hadjistavropoulos HD, Dirkse D (2016) A randomised controlled trial of therapist-assisted, internet-delivered cognitive behavior therapy for women with maternal depression. PLoS One 11(3):e0149186
Sockol L, Epperson CN, Barber JP (2011) A meta-analysis of treatments for perinatal depression. Clin Psychol Rev 31(5):839–849
Spitzer RL, Kroenke K, Williams JB, Löwe B (2006) A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med 166(10):1092–1097
Stein A, Pearson RM, Goodman SH, Rapa E, Rahman A, McCallum M, … Pariante CM (2014) Effects of perinatal mental disorders on the fetus and child. Lancet 384(9956):1800–1819
Wijma K, Wijma B, Zar M (1998) Psychometric aspects of the W-DEQ; a new questionnaire for the measurement of fear of childbirth. J Psychosom Obstet Gynecol 19(2):84–97
Woody C, Ferrari A, Siskind D, Whiteford H, Harris M (2017) A systematic review and meta-regression of the prevalence and incidence of perinatal depression. J Affect Disord 219:86–92
Woolhouse H, Brown S, Krastev A, Perlen S, Gunn J (2009) Seeking help for anxiety and depression after childbirth: results of the maternal health study. Arch Womens Ment Health 12(2):75–83