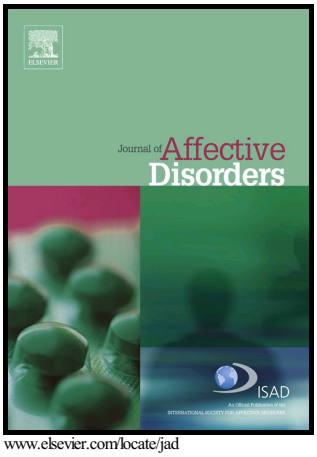
Computer- or web-based interventions for perinatal mental health: A systematic review

Miriam T. Ashford, Ellinor K. Olander, Susan Ayers



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Title: Computer- or web-based interventions for perinatal mental health: A systematic review

Authors: Miriam T. Ashford[1], Ellinor K. Olander, and Susan Ayers

Affiliation: Centre for Maternal and Child Health Research, City University London, UK

Abstract

Background: Treating prenatal mental health issues is of great importance, but access to treatment is often poor. One way of accessing treatment is through computer- or web-based interventions. Reviews have shown that these interventions can be effective for a variety of mental health disorder across different populations. However, their effectiveness for women in the perinatal period has not been reviewed. This review therefore aimed to provide a first overview of computer- or web-based interventions for women's perinatal mental health issues by systematically identifying and reviewing their characteristics and efficacy.

Methods: Twelve electronic databases were searched for published and unpublished literature using keywords, supplemented by hand searches. Data were extracted for characteristics of the intervention and the study, study findings and the methodological quality was assessed.

Results: The majority of the eleven eligible studies were randomized controlled trials. Interventions were targeted at depression, stress, and complicated grief during the antenatal or postpartum period or the time after pregnancy loss. Findings suggest that computer- or web-based interventions targeted at improving mental health, especially depression and complicated grief, may be effective.

Limitations: Findings and their generalizability is limited by the heterogeneity of reviewed interventions and study designs, as well as methodological limitations.

[1] City University London, Northampton Square, London, EC1V 0HB, United-Kingdom, telephone: +447429023870, e-mail: miriam.ashford@city.ac.uk.

Conclusions: This systematic review constitutes the first synthesis of research on computer- or web-based interventions for perinatal mental health issues and provides preliminary support that this could be a promising form of treatment during this period. However, there are significant gaps in the current evidence-base so further research is needed.

Keywords: Mental health; Perinatal; Online; Computer; Intervention; Systematic review

Introduction

The perinatal period from pregnancy to one year after birth is a time of social, psychological, and biological changes for women (Barnes, 2014; Gavin et al., 2005; Redshaw and Martin, 2011). Positive and negative emotions are common and likely to vary in intensity and over time (Najman et al., 2010). During the perinatal period, some women develop mental health conditions of differing levels of severity, ranging from mild to moderate depression and anxiety disorders to more severe conditions such as psychosis, bipolar disorder, and post-traumatic stress disorder (PTSD) (Howard et al., 2014; Jones et al., 2014). Reported prevalence rates suggest that 10–15% of women suffer from depression during the perinatal period (Bennett et al., 2004; Gavin et al., 2005), 5% -12% from anxiety disorders (Reck et al., 2008; Ross and McLean, 2006; Yelland et al., 2010), 3% from PTSD after childbirth (Grekin and O'Hara, 2014), and about 1–2 per 1000 suffer from psychosis (Munk-Olsen et al., 2006; Vesga-López et al., 2008).

The availability of efficient and timely interventions is important (Misri and Kendrick, 2007), especially when considering the adverse effects on the somatic and psychological health of mother, infant and family (Glasheen et al., 2010; Grigoriadis et al., 2013; Oates, 2003; Stein et al., 2014), as well as the potential cost to society (Bauer et al., 2014). Despite treatments being available which are considered effective in preventing and improving these

adverse consequences (Dennis, 2005; Dennis and Hodnett, 2007; Leis et al., 2009; Poobalan et al., 2007; Sockol et al., 2011), mental health conditions in the perinatal period often go unrecognized or untreated (Bauer et al., 2014; Goodman and Tyer-Viola, 2010; Hendrick, 2003). This is due to factors such as low screening and diagnosis rates, as well as the reluctance of women with emotional difficulties during this period to seek help and disclose their difficulties (Gjerdingen and Yawn, 2007; O'Mahen and Flynn, 2008; Vesga-López et al., 2008; Woolhouse et al., 2009). Instead of using formal treatment, women have reported seeking help more frequently from informal sources, such as family and printed material (O'Mahen and Flynn, 2008). "Being too busy to get around to seeking help" and "feeling too embarrassed or having no-one they felt comfortable talking to" (Woolhouse et al., 2009, p. 80) have been identified as two reasons for not seeking help. Similarly, the "lack of time", "stigma", and "childcare issues" were among the most reported treatment barriers by women with postpartum depression (Goodman, 2009). In addition, the inability to disclose feelings has been identified as a major barrier to seeking help for women with postpartum depression (Dennis and Chung-Lee, 2006). Providing convenient and potentially anonymous access to effective treatment is therefore critical.

One increasingly popular approach of enhancing access to treatment is through the use of computer- or web-based intervention programs. These interventions are designed in a way that allows people to work independently through therapy material with or without minimal assistance from a therapist or other mental health professional. Computer- or web-based interventions can be delivered offline or online via a computer, tablet, or smart phone. In this format, treatment can be completed at anytime and anywhere and can be accessed by large numbers of people across wide geographical regions in a cost-effective manner (Griffiths and Christensen, 2007; Hayward et al., 2007; Kaltenthaler et al., 2006, 2002; Muñoz, 2010). The anonymity offered by computer- and web-based interventions may attract people who

experience difficulties with disclosing mental health disorders (Corrigan, 2004; Gega et al., 2004; Rüsch et al., 2005).

Computer or web-based interventions may therefore be particularly useful during the perinatal period. The anticipated advantages are that women are not required to attend time consuming and potentially inconvenient face-to-face sessions. It also allows women to do as little or as much as they want per day or session, which might make it easier to fit the treatment within the variable and demanding schedule of coping with a new baby. Moreover, web-based interventions offer anonymity which might help women overcome the stigma of accessing help. These aspects of the perinatal period therefore suggest that web-based interventions may be an appropriate alternative or supplement to regular treatment.

The efficacy of computer- and web-based interventions for various mental health conditions in other populations is well established. Meta-analyses found that computer- and web-based interventions can be as effective as face-to-face treatments and superior to control groups with substantial effect sizes for a variety of mental health disorders, including major depression, social phobia, panic disorder, generalized anxiety disorder and stress (Andrews et al., 2010; Barak et al., 2008). Results from systematic reviews also suggest that computer- and web-based interventions are acceptable and effective across different populations including children and adolescents (Calear and Christensen, 2010; Richardson et al., 2010; Siemer et al., 2011), students (Farrer et al., 2013), and older adults (Preschl et al., 2011).

Despite this substantial evidence showing the benefits of computer- and web-based interventions for a variety of mental health disorders in other populations, the evidence of computer- or web-based interventions for women's mental health during the perinatal period has not yet been established. A few programs have been developed for the use during the perinatal period, but the results of these have not been systematically reviewed. This review therefore aimed to provide a first overview of computer- and web-based interventions

targeted at perinatal mental health issues by systematically identifying and synthesizing the research findings, including the interventions' effectiveness in preventing or reducing mental health issues in this population.

Methods

Search Strategy

The following twelve electronic databases were systematically searched on December 9th 2014: Academic Search Complete, Medline, PsychINFO, PsychARTICLES, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Gender Studies Database, Embase, Cochrane Library, Web of Science, Scopus, and ProQuest. A combination of mental health terms (e.g. depression, anxiety), population terms (e.g. pregnancy, postpartum), computer terms (e.g. computer, internet, web) and treatment terms (e.g. therapy, intervention, treatment) was used for searching titles, keywords and abstracts with no specific search period time range being specified. The exact search terms can be found in Online Supplement 1. Grey literature was included to limit the potential for publication bias. To find unpublished studies, the Web of Science and ProQuest databases were searched for conference proceedings and theses. The authors from conference presentations were contacted to provide additional information so that these studies could be included. In addition, reference lists of eligible and included papers were searched for relevant references and new publication database alerts were set up for the specified search terms.

Selection Process and Criteria

After duplicates were removed, all titles and abstracts were screened for inclusion eligibility. Inclusion criteria were that the program (a) targeted women in the perinatal period (start pregnancy – 1 year postpartum); (b) was designed to prevent or improve mental health

issues; (c) was delivered via computer- or web-based; (d) the program included a self-help component (access to therapy material without or with minimal assistance of a therapist or mental health professional); and the study (e) reported mental health outcomes; (f) was primary research; (g) had a pre-post and/or randomized controlled trial intervention study design; (h) and was published in English. Studies were excluded if they investigated (a) online support groups only, (b) e-counselling (therapeutic content not available on a website, but through contact with a therapist via Skype, email or instant messaging), and (c) were qualitative, case studies, systematic reviews or study protocols, (d) as well as studies for which only insufficient information on the outcomes was available. All papers that appeared eligible based on their title/abstract were retrieved for full-text screening. The first author (MA) read all papers, assessed eligibility and noted the reasons for exclusion. Any questions concerning eligibility were resolved through team discussions.

Data Extraction and Synthesis

A data extraction form was developed and the extracted information included: study characteristics (authors, year, country of origin, research design, sample size, inclusion and exclusion criteria, recruitment, comparator, mental health outcome measures, measurement time points, length of follow-up, attrition), study results (main findings for mental health outcome measures (including effect sizes) and intervention characteristics (language, name, problem area, program/intervention format, structure of program/intervention, number of modules, module content, therapeutic approaches, therapist contact, duration of intervention). Due to the small number of studies and their heterogeneous methodological designs and quality (e.g. small and diverse sample sizes, diversity of outcome measures and inclusion criteria), data synthesis in the form of meta-analysis was inappropriate and information was synthesized and reported narratively. If sufficient data were available, within-group, and between-group effect sizes were calculated using means and standard deviations.

Quality Assessment

The methodological quality of included papers was evaluated using a 14-item checklist for assessing the quality of quantitative studies by Kmet et al. (2004). 14 dimensions were rated on a 4-point scale of 2 = yes, 1 = partial, 0 = no and N/A. A summary score was calculated for each paper, which reflects its overall methodological quality. First the total sum ((number of "yes" * 2) + (number of "partial" *1)) and the total possible sum (28 – (number of "N/A" * 2)) were calculated and then the summary score was calculated (total sum / total possible sum). Higher summary scores indicate higher methodological quality. To ensure reliability, all papers were double-scored by an independent researcher. Between the two assessors the percent agreement ranged between 92.9% and a 100% and Cohen's Kappa between 0.77 and 1. See Online Supplement 2 for more information about the inter-rater agreement and reliability for each paper. Disagreements were discussed until 100% agreement was reached.

Results

Study Selection

Using the specified search terms, the 12 searched databases produced a total of 9003 papers and four additional papers were identified from reference screening and database alerts. Figure 1 shows the flow diagram of study selection from initial screening to final the sample included in the review. A total of 11 papers met all eligibility criteria and were included in the review.

FIGURE 1 'Flowchart of Study Selection' HERE

Study Characteristics

An overview of the study characteristics can be found in Table 1. The majority of studies were journal articles (8/11), two were doctoral theses (2/11), and one was a peer-reviewed

conference abstract (1/11). A variety of study designs were used, varying sample sizes and attritions were found, and the majority of studies received an average to high methodological rating.

Study Design. Study designs included randomized controlled trials (RCT) (7/11; Kersting et al., 2013, 2011; King, 2009; O'Mahen et al., 2014, 2013; Pugh, 2014; Scherer et al., 2013), a modified partially randomized patient preference trial (1/11; Klein et al., 2012) and quasi-experimental pretest-posttest studies without a control group (3/11; Cornsweet Barber et al., 2013; Danaher et al., 2013; Kim et al., 2014). All studies measured outcomes before and after the intervention and six out of 11 studies also included follow-up measures ranging from 1 month to 12 months after the intervention.

Study Sample. Sample sizes ranged from 12 to 910 participants. Sample attrition between pre- and post-intervention time points ranged from 0% (Cornsweet Barber et al., 2013) to 62% (O'Mahen et al., 2013a). Reported attrition rates for follow-up measurements taken at various time points after the first post-intervention measurement ranged from 13.2% to 60.9 %. See Table 1 for more information on attrition of each study.

Referral of participants to studies varied. Referral methods included self-referral only (6/11; Cornsweet Barber et al., 2013; Kersting et al., 2011; King, 2009; O'Mahen et al., 2014, 2013; Pugh, 2014), health professional referral only (1/11; Klein et al., 2012) and combinations of self-referral and health professional referral (n=4/11; Danaher et al., 2013; Kersting et al., 2013; Kim et al., 2014; Scherer et al., 2013). The majority of studies included only women (9/11) and three out of 11 studies included women and their partners (Kersting et al., 2013, 2011; Klein et al., 2012).

TABLE 1 'Characteristics of Included Studies' HERE

Methodological Quality. Table 2 provides the ratings for each of the included studies on the 14 quality criteria and an overall summary score. The majority of the reviewed studies

received average to high methodological scores. The main limitation identified was the possible sampling bias from the use of self-referral recruitment strategies.

TABLE 2 'Quality Assessment Scores and Percentages of Included Studies' HERE

Intervention Characteristics

Within the 11 reviewed papers nine distinct intervention programs were identified and Table 1 has more detailed information on intervention characteristics. For one intervention targeting complicated grief and mental health after pregnancy loss, one study reported pilot data (Kersting et al., 2013) and another data from a full RCT (Kersting et al., 2011). Two studies evaluated an intervention called 'NetMumsHWD' (O'Mahen et al., 2014, 2013). However, the design of the intervention changed considerably after the first evaluation and therefore both interventions are reported separately in Table 3. The reviewed interventions targeted a variety of mental health issues focusing on a specific time during the perinatal period and varied in their employed technology, treatment focus, and approaches.

Origin and Languages. Interventions originate from several different countries. The reviewed interventions were developed in the USA (3/9), the UK (2/9), USA & Australia (1/9), New Zealand (1/9), Germany (1/9), and Switzerland (1/9) with the majority of interventions being in English (7/9) and two out of nine in German.

Targeted Mental Health Issue. The nine intervention programs varied in the mental health issue and time frame they were developed for. For pregnant women interventions were developed for depression (1/9; Kim et al., 2014), stress and anxiety (1/9; Cornsweet Barber et al., 2013) and mental health of women diagnosed with preterm labor (1/9; Scherer et al., 2013). For the postpartum period interventions were developed for stress (King, 2009) and depression. The majority of postpartum interventions targeted depression (3 out of 4; Danaher et al., 2013; O'Mahen et al., 2014, 2013; Pugh, 2014). Two out of nine interventions

were for couples after pregnancy loss and targeted complicated grief (Kersting et al., 2013, 2011) and one out of nine was for overall psychological health (Klein et al., 2012).

Intervention Format. The majority of interventions were web-based (7/9) and two out of nine were computer-based. Four out of nine interventions were designed to prevent the development of mental health issues through stress management (Cornsweet Barber et al., 2013; King, 2009; Scherer et al., 2013) and by promoting mental well-being (Klein et al., 2012). Five out of nine were developed to reduce existing antenatal depression (1/9; Kim et al., 2014), postpartum depression (3/9; Danaher et al., 2013; O'Mahen et al., 2014, 2013; Pugh, 2014), and complicated grief after pregnancy loss (1/9; Kersting et al., 2013, 2011).

Interventions employed a number of different therapeutic approaches including cognitive behavioral therapy (5/9), behavioral activation (1/9; O'Mahen et al., 2014, 2013), a combination of relaxation, biofeedback and mindfulness principles (1/9; Cornsweet Barber et al., 2013) and a combination of relaxation methods with stress management techniques (n=1; King, 2009). One intervention did not state a specific therapeutic approach (Klein et al., 2012). Some sort of therapist contact was included in the majority of programs (6/9). Contact was either face-to-face (1/9), on the phone (2/9), via email (3/9), or in real-time online (1/9) and occurred mostly on a weekly basis. Content of support sessions included mood checks, answering questions and written feedback. The duration of the interventions ranged from 4 to 17 weeks. Rather than a fixed number of weeks, four out of nine interventions specified ranges from 6-8 weeks to 8-12 weeks and one out of nine interventions stated a minimum of six weeks. The number of modules to be covered during those specified durations ranged from four modules to 15 steps. One program (1/9) had a total of 199 sections.

Mental Health Outcomes

The effect of interventions on mental health outcomes are summarized in Table 1. Figure 2 reports a forest plot showing the between-group (intervention vs control) post-treatment

effect sizes of RTCs studies and Figure 3 shows a forest plot for pre-post-test studies for those with sufficient data to calculate within-group post-treatment effects. Cohen's d effect sizes were calculated and interpretation are based on Cohen's guidelines (Cohen, 1988). For within group effect sizes a positive value indicates that the post-treatment measurement is favored and for between-group effect sizes a positive value indicates that the intervention groups is favored over the control group.

Depression. All studies measured depression as an outcome, with three studies reporting more than one depression outcome (Danaher et al., 2013; Kim et al., 2014; Pugh, 2014). For seven (7/8) controlled studies, effect sizes for eight depression outcomes were calculated. For those eight depression measures, a significantly greater depression symptom reduction in the intervention groups was found for the majority of measures (6/8), which was supported by positive effect sizes ranging from medium (d=0.55, 95%, CI 0.33 to 0.76) to large (d=1.03, 95%, CI 0.35 to 1.67) (Mdn=0.46). Two measures (2/8) (King, 2009; Scherer et al., 2013) found greater depression symptom reduction in the control group, but the effect sizes were non-significant. Klein et al. (2012) reported significantly greater symptoms reduction in the control group when using per protocol analysis, but not when using an intention-to-treat analysis. In the three (3/11) studies using an uncontrolled design, Cornsweet Barber et al. (2013) reported statistically significant reduction in depression scores after the interventions and in other two studies (Danaher et al., 2013; Kim et al., 2014) depression symptoms reduced significantly from the pre to post intervention measurement supported by large positive effect sizes.

Anxiety. Although only one out 11 interventions specifically targeted anxiety (Cornsweet Barber et al., 2013), it was measured as an outcome in eight studies (8/11) of interventions designed to reduce postpartum depression, postpartum stress, complicated grief after pregnancy loss and to promote antenatal mental health for women diagnosed with preterm

labor. Results for anxiety were mixed, but predominately no significant outcomes were found. For eight anxiety measures across six RCTs effect sizes were calculated. For those, both positive (4/8) and negative effect sizes (4/8) were found (d=-0.61, 95%, CI -1.20 to 0.01 to d=0.51, 95%, CI -0.01 to 1.02; Mdn=-0.02), indicating that in half of the measures anxiety symptom reduction was greater in the intervention group and in the other half symptom reduction was greater in the control group. The effect sizes ranged from no effect to medium effect sizes, but were all not significant. For the modified partially randomized patient preference trial Klein et al. (2012) reported a significantly greater symptom reduction in the control group when using a per protocol analysis compared to an intention-to-treat analysis. For one out of two uncontrolled studies an effect size could be calculated (Kim et al., 2014). For this study a medium positive effect size indicated that symptoms reduced after the treatment, but the effect was non-significant (d=0.50, 95%, CI -0.32 to 1.28). Cornsweet Barber et al. (2013) intervention was targeted at anxiety, but even though the reported anxiety scores decreased after the intervention, the decrease was not significant.

Other Mental Health Outcomes. Other mental health outcomes such as general mental health, grief, stress and posttraumatic stress were measured in five RCT studies with mixed results. In two studies evaluating an intervention for complicated grief after pregnancy loss, medium positive and significant effect sizes indicated that symptom reduction on an overall mental health measure, a grief measure and a posttraumatic stress measure was greater in the intervention group compared to the control group. Inconsistent effects were found for stress with one study finding a large positive effect (d=0.98, 95%, CI 0.30 to 1.61; Pugh, 2014), one finding no effect (King, 2009) and the other a small non-significant negative effect size (Scherer et al., 2013).

FIGURE 2 “Forest Plot and Between-group Post-treatment Effect Sizes for Mental Health Outcomes of Intervention vs. Control Group” & FIGURE 3 “Forest Plot and Within-group

Post-treatment Effect Sizes for Mental Health Outcomes of Pre-post Intervention Studies" HERE

Discussion

This is the first systematic review to provide an overview of the nature and effectiveness of computer- and web-based mental health interventions for women during the perinatal period. The identified interventions were diverse and varied in terms of the targeted mental health issues and time of use during the perinatal period. Despite this diversity, the results of this review suggest that computer- and web-based mental health interventions may be promising approach to the treatment and reduction of maternal mental health issues during the perinatal period, particularly depression.

For depression, findings were predominately positive indicating that web-based interventions may be effective in treating depression symptoms during the perinatal period. Two studies did not find a positive effect, however this could be explained by the fact that the these two interventions were targeted at stress (King, 2009) and stress and mental health in general (Scherer et al., 2013) rather than depression. For anxiety, results were mixed, but predominately no significant effects were found. However, as previously mentioned, only one of the seven interventions measuring anxiety specifically targeted anxiety (Cornsweet Barber et al., 2013). Results for other mental health issues were also mixed. An intervention targeted at complicated grief was successful in improving the overall mental health, grief and posttraumatic stress, but only one out of three studies measuring stress found a significant reduction of stress symptoms. Negative outcomes found for anxiety, depression and stress measures may be related to the fact that four interventions were of a preventative nature by being designed to manage stress or promote mental health rather than being designed to reduce existing symptoms. This indicates that preventative computer- or web-based

interventions may not be as effective as those targeted at reducing an existing mental health issue. Even though it has been reported that preventative interventions can be successful in the perinatal period, no evidence of long-term success was found (Boath et al., 2005). Other reviews concluded that no specific preventive approach can be recommended for perinatal mental health issues (Dennis, 2005, 2004). To improve the effectiveness of preventative interventions during this period it has been suggested that it is important to identify women "at risk" (Dennis, 2005). When considering the here presented mental health outcomes results it is also important to be aware that in order to evaluate interventions intended to reduce mental health issues, most studies relied on self-report screening questionnaires rather than diagnostic assessment tools administered and assessed by a trained professional such as Structured Clinical Interview for DSM Disorders (First et al., 1997) for eligibility screening. It is unclear whether the interventions would have produced the same results for those with diagnosed mental health issues and potentially more severe issues. Due to the small number of trials and the diversity of the interventions in regards to the perinatal period, target mental health issues, as well as therapeutic approach, it is difficult to draw definite conclusions about the effect of computer- and web-based perinatal mental health interventions. However, findings of this first review are encouraging and suggest that computer- or web-based interventions targeted at reducing mental health issues, especially depression and complicated grief, may be effective.

The majority of studies received average to high scores on the quality appraisal tool. Most studies were limited by their recruitment strategy, introducing a possible sampling bias. In all except for three studies (Kim et al., 2014; Klein et al., 2012; Scherer et al., 2013), participants were recruited only through online or offline advertisements or promotional material distributed in relevant centers or events. Sample sizes of four studies were rated as small or inadequate (Cornsweet Barber et al., 2013; Danaher et al., 2013; Kim et al., 2014; Scherer et

al., 2013). Concerning allocation concealment, none of the studies were designed to allow for participant blinding and the blinding of the investigators and/or outcome assessors was in except for two cases (Kim et al., 2014; O'Mahen et al., 2014) not reported or is was unclear who and how they were blinded. Two studies reported only limited baseline or demographic information (Cornsweet Barber et al., 2013; Klein et al., 2012) and for one study the report of results was deemed not sufficient (Cornsweet Barber et al., 2013). A limited report of estimates of variance for main results/outcomes was identified in two studies (Cornsweet Barber et al., 2013; Kersting et al., 2011). Report of baseline or demographic information differences to control for confounding was often not reported or done (Cornsweet Barber et al., 2013; Danaher et al., 2013; O'Mahen et al., 2013b, 2014). An overall lack of robust fully powered RCTs has to be taken into consideration when interpreting the presented findings.

Despite an overall recommendation for more high quality RCTs, three crucial areas to improve future development and research of computer- and web-based interventions for maternal perinatal mental health issues were identified based on the findings from this review and will be discussed.

Researchers should use recruitment strategies that target clinical samples and hard-to-reach populations. Most studies used primarily media-recruitment where participants enter the study through self-referral rather than being systematically identified through referral from health care professionals. Hence, the recruitment relies on individual's motivation which may lead to a different recruited demographic which limits the generalizability of the findings. However, self-selected samples are not necessarily a limitation, especially if interventions are specifically designed around self-referral. Based on the reported participant demographic details, the majority of participants were Caucasian and had a relatively high level of education. Not self-selected participants including other ethnicities and other education groups need to be recruited and tested to confirm effectiveness. To reach hard-to-

reach populations it has been argued that adapted and culturally sensitive recruitment strategies are necessary (Sadler et al., 2010; Shaghaghi et al., 2011) and researchers should incorporate extended recruitment timeframes, higher resourcing costs and community partnerships (Bonevski et al., 2014). Also, most studies did not include clinical samples so it remains unclear whether the interventions are also effective for those with diagnosed mental health issues and potentially more severe issues.

The development and evaluation of interventions for all the prominent mental health issues during the perinatal period is needed. Interventions targeted a variety of mental health problems during the perinatal period, including depression, stress, anxiety and grief. The majority of programs were designed for postpartum depression, with a few for antenatal depression, stress management and grief. Interestingly, only one intervention was designed to prevent anxiety together with stress during pregnancy. No intervention was available for perinatal anxiety specifically, post-traumatic stress disorder (PTSD) after childbirth, or postpartum psychosis. However, due to the severe nature of postpartum psychosis, drug treatments are considered most appropriate and effective (Doucet et al., 2011; Sit et al., 2006). Similarly, support for the effectiveness of computer- or web-based interventions for PTSD is currently limited (Amstadter et al., 2009; Reger and Gahm, 2009) and evidence supports high intensity interventions such as individual trauma-focused cognitive behavioral therapy and eye movement desensitization and reprocessing (EMDR) in the treatment of PTSD (Bisson et al., 2013). The findings that the majority of computer- and web-based interventions targets depression reflects the popularity and focus on perinatal depression interventions in the published literature compared to anxiety. For perinatal anxiety in particular, similar prevalence rates to perinatal depression have been reported and it has even been suggested that postpartum anxiety disorders may be more common than postpartum depressive disorders (Paul et al., 2013; Reck et al., 2008; Wenzel et al., 2005). This highlights

a significant gap in the current state of knowledge concerning the treatment of perinatal anxiety in general, as well as using technology to support perinatal anxiety treatment. However, it should be noted that the systematic search identified several other perinatal mental health related computer- or web-based interventions, which were excluded from the review due to the study design. Several of the excluded studies qualitatively assessed acceptability and feasibility. To enhance the knowledgebase it would be interesting for future research to synthesis these findings. In addition, a look on recently published trial protocols reveals that several trials are underway. This highlights the current interest and rapid development in this field.

Developers and researchers should focus on designing interventions which target specific perinatal issues and needs. All reviewed studies specified clearly whether the intervention was targeted at the antenatal or postpartum period or pregnancy loss. However, two interventions were not designed for the perinatal period specifically, meaning the intervention content was not targeted at specific perinatal needs or issues. Thus it appears that so far there are relatively few interventions specifically developed for mental health issues during this period. This is striking considering that women during the perinatal period face changes, difficulties, and mental health issues specific to this period. It has been suggested that treatments targeted at perinatal-specific needs and issues, for example by including perinatal specific themes, may help with treatment relevance and acceptability (O'Mahen et al., 2012). In addition, the interventions were all developed and tested in Western and high income countries and it remains unknown whether the interventions would be effective in other countries, especially those with different cultures. It has been shown that interventions targeted to a specific cultural group and in participants native language were more effective compared to non-targeted interventions (Griner and Smith, 2006).

Strengths and Limitations

Several strengths and limitations of this review can be noted. A clear systematic search and study eligibility strategy and review protocol was used and the PRISMA methodology and guidelines were followed. The inclusion of theses and conference abstracts resulted in different levels of details for the data extraction. However, authors were contacted if information was missing and by including grey literature it was attempted to limit the potential for publication bias. The search, study eligibility assessment, and data extraction was only done by one reviewer, but any questions concerning eligibility were resolved through team discussions. The methodological quality of studies was assessed by two independent assessors to limit the subjective bias in the methodological analysis. The independent assessment resulted in high inter-rater reliability scores. The restriction of the inclusion criteria to English papers may have caused this review to be biased and limit its generalizability. However, including papers written in English only is in line with similar reviews (Calear and Christensen, 2010). The heterogeneous nature of included study designs and intervention designs made it difficult to compare and synthesize findings and for that reason a meta-analysis was not possible. The strength of evidence was limited by small recruitment strategies, small sample sizes, high attrition rates, and some studies using no-control group designs.

Conclusions

This systematic review addresses an important gap in the knowledge by providing an overview of currently existing computer- and web-based maternal mental health interventions during the perinatal period and their effectiveness. The review suggests that computer- or web-based interventions for perinatal maternal health issues may be promising, but are part of a still developing field. There is a need for systematic reviews evaluating the evidence for more specific populations within this period, as well as further well designed and large RCT studies to further investigate the potential and effectiveness of those interventions for the

perinatal period, as well as interventions designed for perinatal mental health needs and a variety of prominent mental health issues during this period.

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Table 1

Characteristics of Included Studies

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)
Kersting et al. (2011) Not specified	- German - German	*Target:* Complicated grief and mental health after pregnancy loss *Type:* Treatment *Technology format:* Web-based *Number of modules & length:* 10 assignments 5 weeks	CBT *Support:* - Written feedback for writing assignment - Assignments personalized by therapist	RCT (pilot) *Comparator:* Waitlist control group	I=45 C=33 *Inclusion:* Mothers who had lost a child during pregnancy through miscarriage, termination of pregnancy due to fetal anomaly, or still birth *Recruitment:* - Newspaper articles - Information on related websites & own website - Flyers in 5 cooperating centers & in associated clinics and medical surgeries	*Measures:* IES ICG BSI *Times:* 1) Pre-treatment 2) Post-treatment 3) 3 months follow-up	A significant group × time interaction effect emerged for posttraumatic stress grief, general psychopathology and depression indicating that improvement from pre-treatment to post-treatment was significantly higher in the treatment group than in the waiting list control group. The reduction was maintained at 3-months follow-up. *Attrition rate:* Post-treatment BC: 24.4% Post-treatment IC: 26.7% Follow-up IC from pre-treatment: 35.6% Follow-up IC from post-treatment: 6.8%
Kersting et al. (2013) Not specified	- German - German	*Target:* Complicated grief and mental health after pregnancy loss *Type:* Treatme	CBT *Support:* - Written feedback for writing assignment - Assignments personalized by therapist	RCT *Comparator:* Waitlist control group	I=115 C=113 Female: n=210 Male: n=18 *Inclusion:* Mothers and partners who had lost a child during pregnancy	*Measures:* IES ICG BSI *Times:* 1) Pre-treatment 2) Post-treatment, 3) 3 months follow-up 4) 12 months	Compared to the wait-list control group, the intervention group showed significantly reduced symptoms of posttraumatic stress, prolonged

		nt *Technology format:* Web-based *Number of modules & length:* 10 assignments 5 weeks			through miscarriage, termination of pregnancy due to fetal anomaly, or still birth\ *Recruitment:* - Radio - TV - Newspaper	follow up	grief, depression, and anxiety. Significant improvement in all symptoms of PTSD and prolonged grief was found from the post-treatment evaluation to the 12-month follow-up. *Attrition rate:* Post-treatment B: 12.7% Post-treatment IC: 13.9% Follow-up 3 months IC from pre-treatment: 26.1% Follow-up 3 months IC from post-treatment: 14.1% Follow-up 6 months IC from

Table 1
Continued.

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)
					- Parents affected by pregnancy loss notified by health care professionals and clinics		pre-treatment: 60.9% Follow-up 6 months IC from 3 months follow-up: 47.1%
King (2009) Living-SMART	- USA - English	*Target:* Postpartum stress management *Type:* Stress management *Technology*	Herbert Benson's theory of relaxation responses & stress management techniques *Support:* None	RCT *Comparator:* Face-to-face	I=29 C=28 *Inclusion:* Given birth within last 12 months *Recruitment:* - Support groups for moms - Local	*Measures:* PSS STAI BDI-II *Times:* 1) Pre-treatment 2) Post-treatment	Participants in the intervention group showed stress and anxiety post-treatment scores that were significantly lower than pre-treatment

		format: Web-based *Number of modules & length:* 4 treatment sections 4 weeks			Internet community search engines (Yahoo, Google, and craigslist) - Social networking sites - Flyers in local businesses, medical offices, and hospitals		scores (but not for depression scores). Participants in the offline program format did not obtain change scores that were significantly lower than pre-treatment scores. Compared to the control group, the intervention group showed significantly higher reductions in stress and anxiety. *Attrition rate:* Post-treatment BC: 33.3% Post-treatment IC: 41.4%
O'Mahen et al. (2013) Netmums	- UK - English	*Target:* Postpartum depression *Type:* Treatment *Technology format:* Web-based *Number of modules & length:* 11 sessions 15 weeks	Behavioral activation *Support:* - Online real-time responses through online clinic - Weekly	RCT *Comparator:* TAU waiting list control condition	I=462 C=448 *Inclusion:* Score greater than 12 on EPDS Given birth within last 12 months *Recruitment:* Online: - Advertisement on website - Newsletter - Email	*Measures:* EPDS *Times:* 1) At sign-up 2) 15-weeks post-randomization	Women in the intervention condition showed significantly greater reduction of depression compared to women in TAU in both the completer analysis and when all non-responders were counted as depressed. *Attrition rate:* Post-treatment BC: 62% Post-treatment IC: 60.8%

Table 1
Continued.

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)

O'Mahen et al. (2014) Netmums-HWD	- UK - English	*Target:* Postpartum depression *Type:* Treatment *Technology format:* Web-based *Number of modules & length:* 12 sessions 17 weeks	Behavioral activation *Support:* - Phone call support - Weekly	RCT *Comparator:* TAU	I=41 C= 42 *Inclusion:* Score greater than 12 on EPDS Given birth within last 12 months *Recruitment:* Online: - Advertisement on website - Newsletter - Email - Twitter - Facebook	*Measures:* EPDS GAD-7 *Times:* 1) Pre-treatment 2) Post-treatment (17 weeks) 3) Six months post-treatment follow-up	Significant reduction and large effect sizes favoring women of the intervention condition compared to women in TAU for depression and depression post-treatment. Large effect size for depression at six months postpartum. *Attrition rate:* Post-treatment BC: 14.5% Post-treatment IC: 7.3% Follow-up IC from pre-treatment: 28.9% Follow-up IC from post-treatment: 16.9%
Scherer (2013) TOPAS – Therapie-Online-Programm zur Angst- und Stressbewäl-tigung	- Switzerland - German	*Target:* Antenatal Mental health for women diagnosed with preterm labor *Type:* Stress management program *Technology format:* Web-based *Number of modules & length:* 6	CBT *Support:* - Written exchange - Weekly	RCT *Comparator:* Distraction placebo analogue procedure (6 online-sessions), based on distraction, irrelevant to the target problem	I=22 C=22 *Inclusion:* Diagnosed PTL between 18th and 32nd week of gestation *Recruitment:* - Relevant websites - Women's magazines - Referral from collaborating obstetric clinics, gynecologist, and midwives	*Measures:* PSS Pregnancy-Related Anxiety Test STAI EPDS *Times:* 1) Pre-treatment 2) Post-treatment, 3) After birth	Stress, anxiety and depression levels declined significantly from pre-treatment to post-treatment in both groups. No-significant group x time effects. *Attrition rate:* Not collected. Authors estimated 45-50%

		module s At least 6 weeks					

Table 1
Continued.

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)
Pugh (2014) Maternal Depression Online	- USA - English	*Target:* Postpartum depression *Type:* Treatment *Technology format:* Web-based *Number of modules & length:* 7 modules 7-10 weeks	CBT *Support:* - Email contact - Weekly	RCT *Comparator:* Waitlist control group	I=25 C=25 *Inclusion:* Score of 10 or higher on the EPDS *Recruitment:* - Newspaper articles - Newsletter editorials - Radio & TV - Information presentations to support groups - Booths at community events - Social media - Webpages - Announcements at community organizations offering mother-infant classes & hospital maternity wards, pharmacies, community mental health clinics, and medical clinics	*Measures:* EPDS DASS *Times:* 1) Pre-treatment 2) Post-treatment, 3) 1 month follow-up	For the intervention group, depression scores reduced significantly more quickly over time compared to the waitlist control group. *Attrition rate:* Post-treatment BC: 16% Post-treatment IC: 16% Follow-up IC from pre-treatment: 44% Follow-up IC from post-treatment: 33.3%

Klein et al. (2012) Miscarriage Matters	- UK - English	*Target:* Mental health of women and partners after miscarriage *Type:* Mental wellbeing promotion intervention *Technology format:* Web-based	Comprehensive coverage of obstetric and psychological matters relating to miscarriage and subsequent pregnancy in accordance with RCOG	External pilot of a modified partially randomized patient preference *Comparator:* Control group	I=48 C=19 Female: n=43 Male: n=38 *Inclusion:* Women and partner who experienced the complete management of the index miscarriage before 24 weeks of gestation	*Measures:* HADS SF-36 *Times:* 1) Pre-treatment 2) Three months after registration	No significant between group differences on with intention-to-treat analysis. Sensitivity (per protocol) analysis found that intervention group was significantly less anxious and depressed at 3 months after program registration and the intervention group reported significantly higher levels of emotional wellbeing. *Attrition rate:* Post-treatment BC: 35.8%

Table 1
Continued.

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)
		Number of modules & length: 199 sections 12 weeks	*Support:* None		*Recruitment:* Consultant-led early pregnancy units		Post-treatment IC: 37.5%
Cornsweet Barber et al. (2013) Not specified	- New Zealand - English	*Target:* Antenatal stress and anxiety *Type:* Stress management *Technology format:* Comput	Relaxation, mindfulness, & biofeedback *Support:* None	Quasi-experimental pretest-posttest design without a group *Comparator:* None	N=9 *Inclusion:* Pregnant women *Recruitment:* - Professional networks - Newspaper - Television - Discussion	*Measures:* PSS EPDS STAI-Trait *Times:* 1) Pre-treatment 2) Within 2 weeks of treatment completion	Significant reduction in depression. Changes for anxiety and perceived stress were in expected direction, but not statistically significant. *Attrition rate:* Post-treatment:

		er-based *Number of modules & length:* 15 steps 8-12 weeks			at parent and antenatal classes - Snowballing from initial participants		0%
Danaher et al. (2013) MomMoodBooster	- USA & Australia - English	*Target:* Postpartum depression *Type:* Treatment *Technology format:* Web-based *Number of modules & length:* 6 sessions 6-12 weeks	CBT *Support:* - Phone calls from personal coach - weekly	- Quasi-experimental pretest-posttest design without a group - Feasibility trial *Comparator:* None	N=53 *Inclusion:* EPDS score from 12-20 or PHQ-9 score from 10-19 Given birth within last 9 months *Recruitment:* Two different research sites (US & Australia): - Birth records - Nurse/health professional referrals - Online advertisements - News stories to local universities & hospital settings	*Measures:* HRSD PHQ-9 *Times:* 1) Pre-treatment 2) Post-treatment (3 months following pre-treatment) 3) Follow-up (6 months following pre-treatment)	Participants showed significant reductions on clinically rated and self-reported depression. 77% reported clinically important reductions in depression. *Attrition rate:* Post-treatment: 11.3% Follow-up from pre-treatment: 13.3% Follow-up from post-treatment: 2.1%

Table 1
Continued.

Study & intervention name	Origin & language	Intervention format	Therapeutic approach & support	Design & comparator	Sample & recruitment	Mental health outcome measurements & times	Outcomes (mental health & attrition rates)
Kim et al. (2014) Good Days Ahead	- USA - English	*Target:* Antenatal depression (progra	CBT *Support:* - Face-to-face sessions - Weekly	Quasi-experimental pretest-posttest design without a	N=12 *Inclusion:* Score of ≥14 on HRSD Diagnosis	*Measures:* HRSD BDI BAI EPDS *Times:*	Significant reductions in depression and anxiety after intervention. 80% of

m not tailored to antenatal period) *Type:* Treatment *Technology format:* Computer-based *Number of modules & length:* 8 sessions 6-8 weeks	group - Blinded evaluator *Comparator:* None	of major depressive disorder based on SCID 10-32 weeks gestational age *Recruitment:* Advertising and referral in a single site	1) Pre-treatment 2) After session 4 3) After session 8 4) Three months after therapy completion	participants showed intervention response. 60% showed remission. *Attrition rate:* Post-treatment: 16.7% Follow-up from pre-treatment: 33.3% Follow-up from post-treatment: 20%	

Note. BAI: Beck Anxiety Inventory; BC: Both conditions (intervention and control condition combined); BDI: Beck Depression Inventory; BSI: Brief Symptom Scale (general psychopathology, anxiety, and depression); CBT: Cognitive-behavioral therapy; DASS: Depression Anxiety Stress Scale; EPDS: Edinburgh Postnatal Depression Scale; GAD-7: Generalized Anxiety Disorder Scale; HRSD: Hamilton Rating Scale for Depression; IC: Intervention condition; ICG : Inventory of Complicated Grief; IES: Impact Event Scale (posttraumatic stress reactions); PHQ-9: Patient Health Questionnaire (Depression); PSS: Perceived Stress Scale; RCOG: Royal College of Obstetricians and Gynecologists; RCT: Randomized Controlled Trial; SCID: Structured Clinical Interview for DSM Disorders; SF-36: Short Form (36) Health Survey; STAI: State Trait Anxiety Inventory; TAU: Treatment as usual.

Table 2
Quality Assessment Scores and Percentages of Included Studies

	Crit. 1	Crit. 2	Crit. 3	Crit. 4	Crit. 5	Crit. 6	Crit. 7	Crit. 8	Crit. 9	Crit. 10	Crit. 11	Crit. 12	Crit. 13	Crit. 14	Summary score
Cornsweet Barber et al. (2013)	2	2	1	1	N/A	N/A	N/A	2	1	1	0	1	0	2	0.59
Danaher et al. (2013)	1	1	1	2	N/A	N/A	N/A	2	1	2	2	1	2	2	0.77
Kersting et al. (2011)	2	2	1	2	2	0	N/A	2	2	2	0	2	2	1	0.77
Kersting et al. (2013)	2	2	1	2	2	0	N/A	2	2	2	2	2	2	2	0.88
Kim et al. (2014)	2	2	2	2	N/A	2	N/A	2	0	2	2	2	2	2	0.92
King (2009)*	2	2	1	2	2	0	N/A	2	2	2	2	2	2	2	0.88
Klein et al. (2012)	2	2	2	1	2	N/A	N/A	2	2	2	2	2	2	2	0.96
Pugh (2014)*	2	2	1	2	2	1	N/A	2	2	2	2	2	2	2	0.92
O'Mahen et al. (2013)	2	2	1	2	2	1	N/A	2	2	2	2	1	2	2	0.88
O'Mahen et al. (2014)	2	2	1	2	2	2	N/A	2	2	2	2	1	2	2	0.92
Scherer et al. (2013)*	2	2	2	N/A	2	N/A	N/A	2	1	N/A	N/A	N/A	N/A	N/A	0.92

Note. * = King (2009) and Pugh (2014) were doctoral dissertations and Scherer et al (2013) was a conference abstract and additional information was provided by the authors. Crit. 1: Question / objective sufficiently described?; Crit. 2: Study design evident and appropriate?; Crit. 3: Method of subject/comparison group selection or source of information/input variables described and appropriate?; Crit. 4: Subject (and comparison group, if applicable) characteristics sufficiently described?; Crit. 5: If interventional and random allocation was possible, was it described?; Crit. 6: If interventional and blinding of investigators was possible, was it reported?; Crit. 7: If interventional and blinding of subjects was possible, was it reported?; Crit. 8: Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? means of assessment reported?; Crit. 9: Sample size appropriate?; Crit. 10: Analytic methods described/justified and appropriate?; Crit. 11: Some estimate of variance is reported for the main results?; Crit. 12: Controlled for confounding?; Crit. 13: Results reported in sufficient detail?; Crit. 14: Conclusions supported by the results?

Highlights

- A range of computerized interventions for perinatal mental health are available.
- Computerized interventions vary in their target group and treatment design.
- Preliminary evidence was found that computerized interventions may be effective.
- More computerized interventions for perinatal mental health are being developed

FIGURE 1. Flowchart of Study Selection

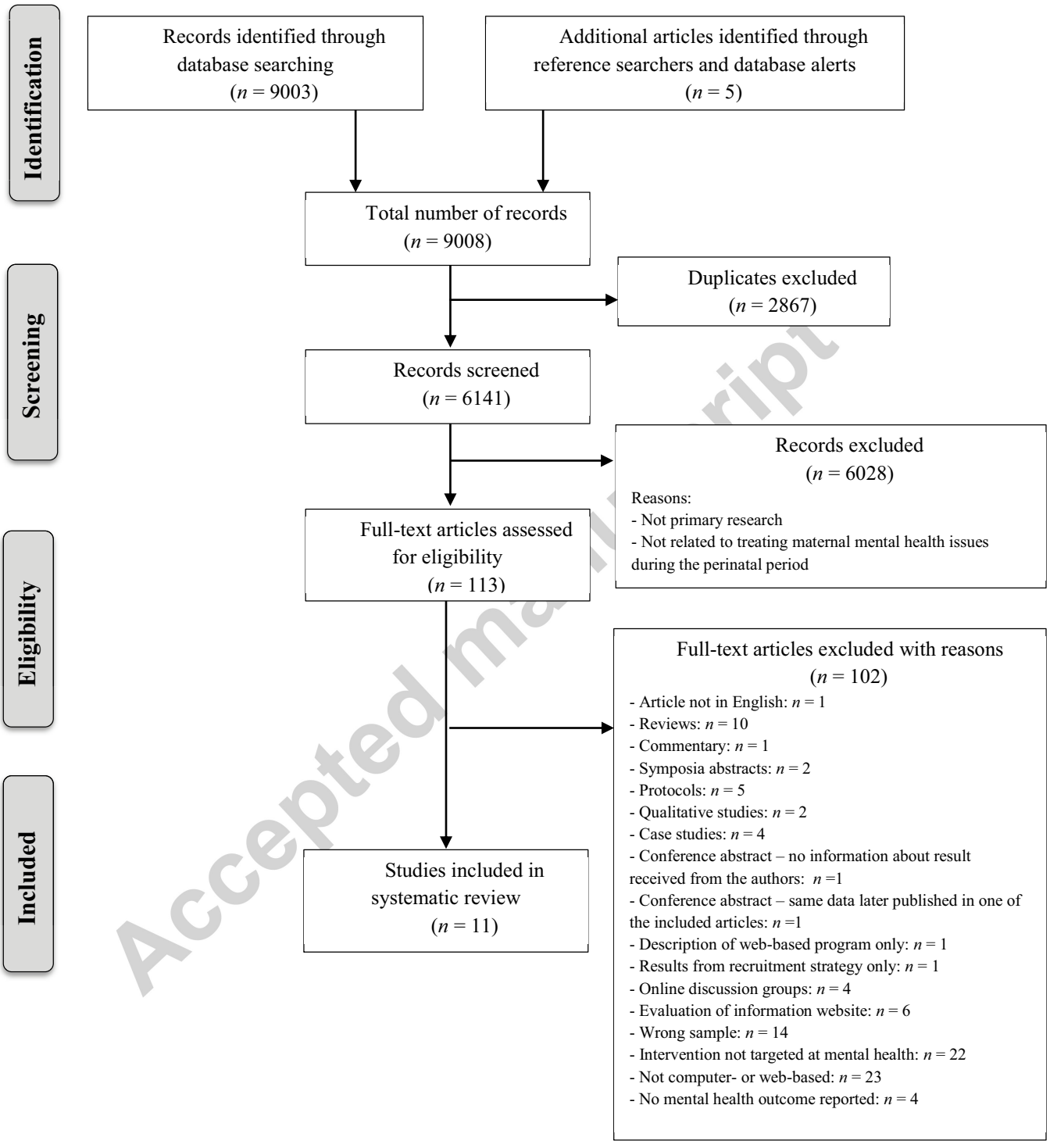
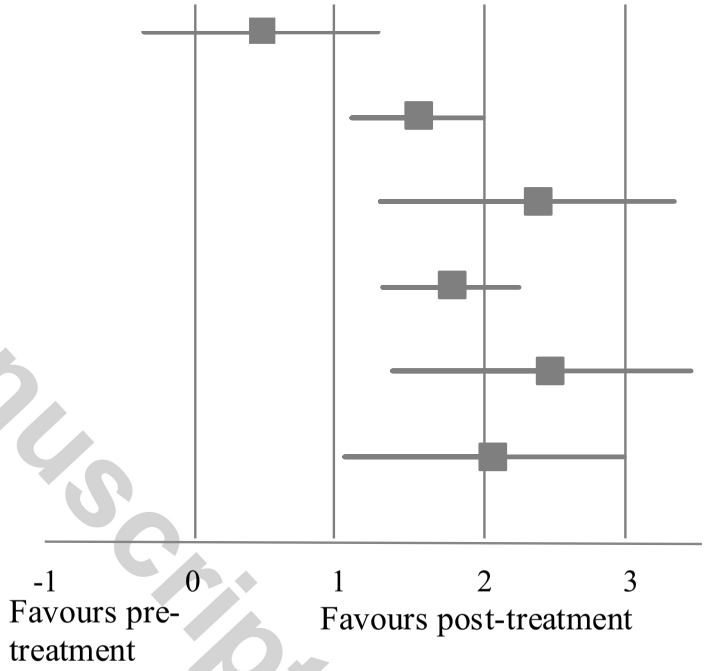


FIGURE 3. Forest Plot and Within-group Post-treatment Effect Sizes for Mental Health Outcomes of Pre-post Intervention Studies

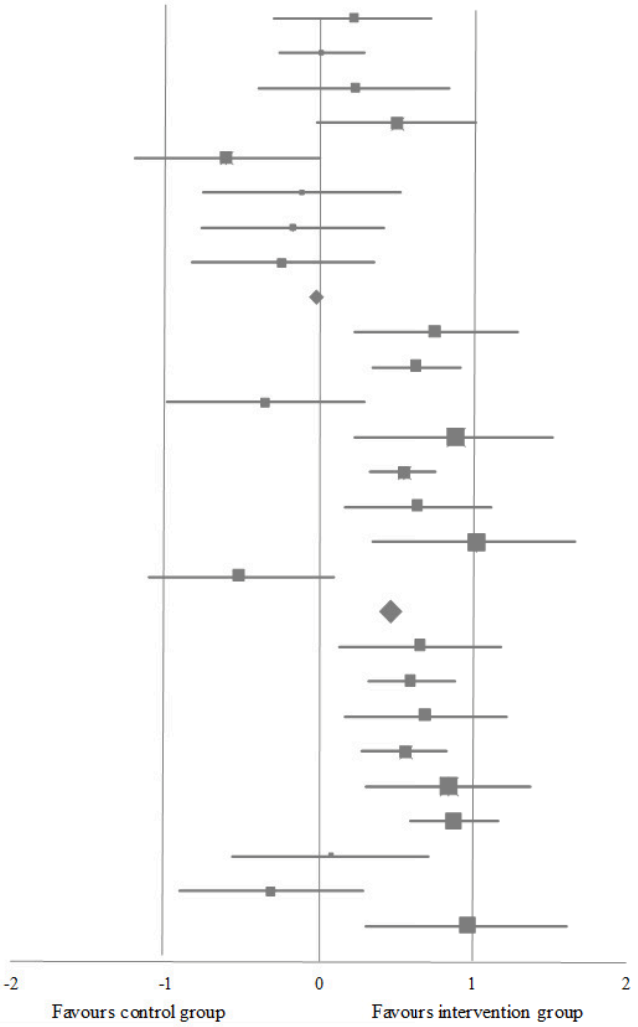
Study name	Mental health outcome	Outcome measure	Effect size	CI lower	CI upper
Kim et al. (2014)	Anxiety	BAI	0.50	-0.32	1.28
Danaher et al. (2013)	Depression	PHQ-9	1.56	1.10	2.00
Kim et al. (2014)	Depression	HRSD	2.38	1.30	3.31
Danaher et al. (2013)	Depression	HRSD	1.79	1.31	2.24
Kim et al. (2014)	Depression	BDI	2.47	1.37	3.42
Kim et al. (2014)	Postpartum Depression	EPDS	2.08	1.05	2.97



Note. BAI: Beck Anxiety Inventory; BDI: Beck Depression Inventory; BSI: Brief Symptom Scale (general psychopathology, anxiety, and depression); EPDS: Edinburgh Postnatal Depression Scale; HRSD: Hamilton Rating Scale for Depression; PHQ-9: Patient Health Questionnaire (Depression).

FIGURE 2. Forest Plot and Between-group Post-treatment Effect Sizes for Mental Health Outcomes of Intervention vs. Control Group

Study	Outcome mental health	Outcome measure	Effect size	CI lower	CI upper
Kersting et al. (2011)	Anxiety	BSI Anxiety	0.23	-0.29	0.74
Kersting et al. (2013)	Anxiety	BSI Anxiety	0.02	-0.26	0.30
Pugh (2014)	Anxiety	DASS Anxiety	0.23	-0.39	0.85
O'Mahen et al. (2014)	Anxiety	GAD-7	0.51	-0.01	1.02
Scherer et al. (2013)	Anxiety	PRAT	-0.61	-1.20	0.01
King (2009)	Anxiety	STAI	-0.11	-0.75	0.53
Scherer et al. (2013)	Anxiety	STAI-Trait	-0.17	-0.76	0.42
Scherer et al. (2013)	Anxiety	STAI-State	-0.24	-0.83	0.36
Total anxiety			-0.02	-0.56	0.53
Kersting et al. (2011)	Depression	BSI Depression	0.77	0.23	1.30
Kersting et al. (2013)	Depression	BSI Depression	0.64	0.35	0.92
King (2009)	Depression	BDI-II	-0.35	-0.99	0.30
Pugh (2014)	Depression	DASS Depression	0.89	0.23	1.53
O'Mahen et al. (2013)	Postpartum depression	EPDS	0.55	0.33	0.76
O'Mahen et al. (2014)	Postpartum depression	EPDS	0.65	0.17	1.12
Pugh (2014)	Postpartum depression	EPDS	1.03	0.35	1.67
Scherer et al. (2013)	Postpartum depression	EPDS	-0.52	-1.11	0.09
Total depression			0.46	-0.05	0.96
Kersting et al. (2011)	General Mental Health	BSI Mental Health	0.67	0.13	1.19
Kersting et al. (2013)	General Mental Health	BSI Mental Health	0.61	0.32	0.89
Kersting et al. (2011)	Grief	ICG	0.71	0.17	1.23
Kersting et al. (2013)	Grief	ICG	0.56	0.27	0.84
Kersting et al. (2011)	Posttraumatic stress	IES	0.85	0.30	1.38
Kersting et al. (2013)	Posttraumatic stress	IES	0.88	0.59	1.17
King (2009)	Stress	PSS	0.08	-0.56	0.72
Scherer et al. (2013)	Stress	PSS	-0.32	-0.91	0.28
Pugh (2014)	Stress	DASS Stress	0.98	0.30	1.61



Note. BAI: Beck Anxiety Inventory; BDI: Beck Depression Inventory; BSI: Brief Symptom Scale (general psychopathology, anxiety, and depression); DASS: Depression Anxiety Stress Scale; EPDS: Edinburgh Postnatal Depression Scale; GAD-7: Generalized Anxiety Disorder Scale; ICG: Inventory of Complicated Grief; IES: Impact Event Scale (posttraumatic stress reactions); PSS: Perceived Stress Scale; PRAT: Pregnancy-Related Anxiety Test; STAI: State Trait Anxiety Inventory.