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Review article

Effects of mindfulness-based interventions (MBIs) on depression in pregnant women: A systematic review and meta-analysis

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ABSTRACT

Objective: We synthesized the effects of mindfulness-based interventions (MBIs) on depression in pregnant women.

Method: Ten electronic databases were searched from inception to September 2022. We reviewed studies on outcomes for pregnant women with depression receiving mindfulness-based interventions. We only reviewed studies written in English. A random-effects model was used to compute the effect size. Funnel plot, *Q* statistics, and I^2 were used to test the heterogeneity across studies. We examined moderators to explore sources of heterogeneity.

Results: Across 19 included studies ($N = 1480$), 717 pregnant women participated in mindfulness interventions; 763 served as controls. Mean age ranged from 25.3 to 33.6 years. Overall, mindfulness-based interventions showed reduced depression compared to control groups ($g = 0.457$, 95%CI 0.254, 0.659, $I^2 = 68$ %). With subgroup analysis, mindfulness-based cognitive therapy had a greater effect on reducing depressive symptoms ($g = 1.13$) than mindfulness-based stress reduction ($g = 0.64$) and adapted mindfulness-based interventions ($g = 0.31$). No quality indicators moderated the ES of mindfulness-based interventions on depression.

Conclusion: Mindfulness-based interventions significantly improved depression among pregnant women, especially mindfulness-based cognitive therapy (MBCT). Clinicians and health providers should consider using MBIs as alternative complementary treatment for improving and preventing depression in pregnant women.

1. Introduction

Depression is a common psychological problem that affects pregnant women worldwide (Corcoran et al., 2022; Dadi et al., 2020; Elrassas et al., 2022; Endomba et al., 2021; Pobee et al., 2022). Pregnant women are more prone than the general population to suffer from clinical depression (Corcoran et al., 2022; Zhang et al., 2022). According to an umbrella review of 306 primary studies with 877,246 participants by Dadi et al. (2020), antenatal depression prevalence ranged from 15 to 65 %. Depression prevalence in low and middle-income countries was higher than in high-income countries. Similarly, a systematic review of 64 primary studies by Corcoran et al.[1] found that about 33.82 % of pregnant women had experience with depression, especially in low-income countries (Corcoran et al., 2022).

Antidepressants, electroconvulsive therapy (ECT), and psychotherapy may all be helpful in treating depression in pregnant women, but there are medical risks involved for the fetus. However, alternative and complementary treatments can be used for reducing depression symptoms in pregnant women. Mindfulness-based interventions (MBIs) are considered a safe alternative treatment for depression in pregnant women. Mindfulness-based interventions frequently include mindfulness-based stress reduction (MBSR), which emphasizes stress management techniques paired with mindfulness meditation, body awareness and yoga. The current study synthesizes the effects of MBIs on depression in pregnant women.

2. Background

Depression may have a negative effect on fetal development, birth outcomes and child functioning (Dadi et al., 2020). The risk of low birth

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weight and preterm birth was 1.49 (95%CI 1.32,1.68) and 1.40 (95%CI 1.16, 1.69) times higher among infants born from depressed mothers (Dadi et al., 2020). Also, in cases of untreated depression in women who were pregnant, negative biological consequences were found in the developing fetuses (hyperactivity and irregular heart rate); newborn infants (decreased dopamine levels, altered EEG pattern and increased rates of premature death and neonatal intensive care unit admission) and children (increased salivary cortisol levels, internalizing and externalizing problems and overweight), (Gentile, 2017). Moreover, depression during pregnancy can affect maternal health-seeking behavior and adherence with medical and psychological interventions and increase risk behaviors such as substance use and misuse (Dadi et al., 2020).

Although antidepressants, electroconvulsive therapy and psychotherapy may be beneficial in the treatment of depression in pregnant women, they are not without risks. Some researchers found that these treatments had a negative impact on fetuses and infants. For instance, a systematic review and meta-analysis by Leung et al. (2021) reported that using antidepressants during pregnancy was associated with a 2.3-fold higher incidence of seizure of offspring. In a similar study by Wiggs et al. (2022), it was reported that children of women who reported use of antidepressants in pregnancy had an elevated risk of neonatal seizure and epilepsy (risk ratio [RR] 1.41, 95 % CI 1.03–1.94; hazard ratio [HR] 1.21, 95 % CI 1.03–1.43, respectively). Importantly, newborns or children of mothers who used antidepressants during their pregnancy had a high risk of preterm birth, low birth weight, spontaneous abortion, persistent pulmonary hypertension, autism spectrum disorders and ADHD compared to mothers who did not use these medications (Uguz, 2021). Moreover, a systematic review by Rose et al. (2020) reported that using ECT in pregnancy had adverse effects for mother and fetus such as placental abruption, preeclampsia, prolonged seizure, vaginal bleeding, fetal heart rate change, preterm delivery and fetal death (Rose et al., 2020). Thus, using antidepressants and ECT in pregnant women should be carefully implemented and be performed in the setting of a multidisciplinary care team with anesthesiology, psychiatry, maternal-fetal medicine and obstetrics working closely together to ensure positive outcomes for the mother and her fetus (Angelotta and Wisner, 2017; Leung et al., 2021). Also, there are many barriers including cost, opposition to treatment (e.g., fear of exposing the fetus to antidepressant medication or lack of interest in psychotherapy), unavailability of psychotherapy and stigma (Angelotta and Wisner, 2017; Meltzer-Brody, 2014). In addition, some clinicians are reluctant to use pharmacotherapy because they lack sufficient expertise, and the large literature is often inconsistent (Falek et al., 2022; Rose et al., 2020). Thus, alternative and complementary therapies to improve depressive symptoms for pregnant women are growing. One of these therapies is MBIs.

Mindfulness is defined as paying intentional attention to the current moment while being nonjudgmental (Kabat-Zinn, 2003). Individuals who practice mindfulness become more aware of their thoughts, emotions and experiences. Notably, mindfulness training is recognized as cognitive training because it encourages people to grasp the connection between their thoughts, feelings and behaviors related to depression (Segal and Walsh, 2016). With mindfulness, they train their minds to be more flexible, reasonable and positive. As a result, practicing mindfulness can help to reduce the severity of depression symptoms. Typically, MBIs include mindfulness-based stress reduction (MBSR), which focuses on stress management strategies combined with mindfulness meditation, body awareness and yoga (Zhang et al., 2019). On the other hand, mindfulness-based cognitive therapy (MBCT) was developed for patients to learn about the relationship between thoughts, emotions and behaviors, and teach them to become more flexible, reasonable and positive (Segal and Walsh, 2016; Zemestani and Fazeli Nikoo, 2020). For adapted mindfulness-based interventions, researchers adapt the components of their mindfulness intervention to their population (Gambrel and Piercy, 2014;Sun et al., 2021;Zhang and Emory, 2015).

Meta-analyses researchers reported that MBIs have beneficial effects on depression in both clinically and non-clinically depressed pregnant women, but these meta-analyses have considerable limitations (Corbally and Wilkinson, 2021;Dhillon et al., 2017;Taylor et al., 2016). For example, a meta-analysis by Corbally and Wilkinson (2021) found that MBIs had a trivial effect on reducing depression in pregnant women ($d = -0.20$, 95%CI -0.40, -0.00, $p = .04$). However, Corbally and Wilkinson (2021) included only a small number of primary studies (s = 8) and did not test the subgroup analysis to explore the source of heterogeneity. Similar to a meta-analysis study by Dhillon et al. (2017) found that non-RCT MBIs had a positive impact on reducing depressive symptoms ($d = -0.59$, 95%CI -0.93, 0.28, $p < .001$). However, Dhillon et al. (2017) included only four primary studies, which is limited to explore the subgroup analysis. In another systematic review and meta-analysis study by Taylor et al. (2016) found that MBIs had a small effect on reducing depressive symptom ($g = -0.07$, 95%CI -0.28, 0.14, $p = .05$). Again, the number of included primary studies was small ($s = 8$), and they did not conduct moderator analysis.

Overall, the prior meta-analytic researchers included a small number ($s = 4$–8) of primary studies (Corbally and Wilkinson, 2021; Dhillon et al., 2017; Taylor et al., 2016). Although they found a positive effect, the small number of primary studies prohibited moderator analyses and did not provide the total picture of MBI effects on depressive symptoms in pregnant women. Importantly, no prior meta-analytic researchers focused exclusively on the effects of MBIs on depression among pregnant women and conducted moderator analyses. Therefore, the purpose of this systematic review and meta-analysis was to test the effect of MBIs on depressive symptoms in pregnant women and explore participants, methods and intervention characteristics as moderators to the effect.

3. Methods

This systematic review and meta-analysis protocol was registered with PROSPERO: CRD42022373530.

3.1. Search strategy and selection criteria

We reported the systematic review and meta-analysis according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009; Page et al., 2021a; Page et al., 2021b). The content of eleven databases including Academic Search Completed (1990+), CINAHL (1937+), Clinical Trials (2000+), Cochrane (1995+), Mindfulness-Springer link (2010+), Ovid APA (1967+), Ovid Medline (1946+), ProQuest & Theses (1996+), PubMed (1809+), ScienceDirect (1880+) and Scopus (1788+) was searched from inception to September 24, 2022. In addition, we reviewed reference lists of eligible studies (ancestry search). The following search terms were applied: (Mindful* OR meditat* OR meditation) AND (prenatal OR antenatal OR pregnan*) AND (depress* OR depression OR depressed OR depressive). Truncating terms with an asterisk included all forms of the terms and helped us retrieve a greater number of papers with related terms. Moreover, subject headings were reviewed to obtain a broader range of results.

3.2. Inclusion and exclusion criteria

We included primary studies that were conducted with pregnant women to test the effects of MBIs on depression measured as a quantitative outcome and that were written in English. To determine the effects of MBIs, we retrieved studies that specifically compared MBIs with comparison groups without mindfulness intervention (e.g., usual care group, waitlist control group, control group without any treatment). To minimize the selection bias, we included all MBI formats (e.g., individual, group and mixed format) and experimental designs (e.g., RCT or quasi).

We excluded studies if they were qualitative, systematic reviews, meta-analyses or secondary data analyses except to use them for

ancestry searches. The first and second authors independently screened the titles and abstracts of the studies to determine which met inclusion criteria. If disagreements existed, we resolved them through discussion or consulted the third researcher to reach consensus.

3.3. Data extraction and coding

Three of the authors (CR, SP, SO) independently assessed the eligibility of all studies, based on the selection criteria. For each included study, the following data were independently extracted by two researchers (CR & SP): the source of information (i.e., country, year of publication and publication status); methods included quality indicators (e.g., assignment into group, concealed allocation, blinded data collector, intention-to-treat, a priori of power, participants' characteristics at baseline, equality of baseline characteristics between groups, intervention fidelity); intervention (e.g., type of MBI, number of sessions per week, duration of each session, number of days across the intervention, intervention components and days after depression were measured); participants' characteristics (e.g., age, sample size of each group) and outcome (e.g., depression instrument, reliability of scale, mean, depression score). In data extraction and quality assessment, the third researcher (SO) performed the verification. All discrepancies were discussed and resolved among the three researchers.

3.4. Statistical analysis

Using SPSS version 28, we described study characteristics. We then used Comprehensive Meta-Analysis (CMA) version 3.0 to compute primary study ESs. Because depression was measured multiple ways across the primary studies, we used the standardized mean differences of depression scores between the post-intervention and control groups using Hedges' g with 95 % confidence intervals (CIs). A standardized mean difference allows comparison of ESs across studies with measures of different metrics (Borenstein et al., 2009;Borenstein et al., 2021). In initial analysis, we focused on posttest scores across groups. To further understand the effects of mindfulness interventions, we examined pretest/posttest effect sizes within groups. Significant improvements in the control groups would have suggested that depression had improved spontaneously (Borenstein et al., 2021; Cuijpers et al., 2017). Although pre- and post-intervention depression scores are often correlated in single-group design studies, few researchers report correlations between pre- and post- measures. Thus, we estimated a strong positive correlation ($r = 0.8$) to be conservative, then re-analyzed with no correlation ($r = 0.0$) using within group analyses (Conn et al., 2009). We used Hedges' g because Cohen's d has a slight bias, which tends to overestimate the ES with a small number of primary studies. We used the random-effects model in which CMA weights each study by the inverse of the within- and between-studies variance to estimate the mean of the true effects. Studies with higher precision were weighted more heavily than studies with lower precision (Borenstein et al., 2009; Borenstein et al., 2021).

3.5. Heterogeneity assessment

We assessed the heterogeneity across studies by visual inspection of the forest plot and the Q and I^2 statistics (Borenstein et al., 2021). The Q statistic reflects total dispersion across ESs (i.e., weighted sum of squares). A significant Q statistic ($p < .05$) represents considerable heterogeneity. The I^2 statistic quantifies heterogeneity as the ratio of true heterogeneity to total variance across ESs. An I^2 statistic of 25 %, 50 % and 75 % reflects low, moderate and high, respectively. A value of 0 % indicates that there is no heterogeneity observed, whereas the values of I^2 higher than 50 % indicate substantial heterogeneity (Borenstein et al., 2009, 2021). Also, we reported the tau squared (Tau^2) as the variance of the effect size parameters across the studies and it reflects the variance of the true effect size (Higgins and Green, 2011). When heterogeneity existed, we performed the moderator analysis to explore the source of heterogeneity. For categorical moderators, we used an ANOVA analog and we used meta-regression for continuous moderators (Borenstein et al., 2021). When the number of primary studies was less than six in subgroups that were significantly different, we used the Hartung, Knapp, Sidik and Jonkman (HKSJ) adjustment to compute a CI for average effect (Jackson et al., 2017; Reangsing et al., 2023; van Aert and Jackson, 2019). The HKSJ adjustment modifies the standard error of the mean and multiplies it by the t distribution instead of the Z distribution used in the standard analysis. The HKSJ adjustment yields a wider and more accurate CI when there are a small number of primary studies in analysis (van Aert and Jackson, 2019), and therefore a more accurate inference for the average effect than the conventional method (Jackson et al., 2017; Reangsing et al., 2023).

3.6. Assessment of methodological quality

Primary study quality assessment is an essential component of meta-analysis. Low-quality studies can distort the summary effect estimate. There are many rating scales (e.g., The Jadad scale and the CoChrane risk of bias tool2; RoB2) for assessing the study quality, but they have questionable validity and do not adequately reflect design quality. Thus we treated study quality empirically and examined the quality indicators as moderator (Conn and Rantz, 2003). Quality indicators included assignment into groups (random vs. non-random), allocation concealment, masked data collector, a priori power analysis, fidelity of intervention, comparison of participants' characteristics at baseline, and intention-to-treat analysis. For instance, we compared ESs between randomized trials and non-randomized trials, and we compared ESs of studies with intention-to-treat with those without intention-to-treat. Differences in ESs between the presence or absence of a quality indicator provided some estimate of its effect (Borenstein et al., 2021).

3.7. Estimation of bias

To estimate the publication bias, we used the funnel plot, Begg and Mazumdar rank correlation test, and Egger's regression test (Borenstein et al., 2021). A funnel plot is a simple scatterplot of effect estimates against standard error of individual studies. A funnel plot that is visually asymmetrical suggests publication bias. Significant result ($p < .05$) of the Begg and Mazumdar rank correlation test or the Egger regression test also suggests publication bias (Borenstein et al., 2021).

3.8. Ethical approval

This meta-analysis does not require ethical approval or patient consent because the data used in the meta-analysis were extracted for primary studies that had declared ethical approval, and no original raw data was utilized.

4. Results

4.1. Demographic of study

Our initial search identified 1621 records in the ten databases; after 620 duplicates were removed, 1007 studies remained. We found six articles by hand and ancestry searches. During the review of abstracts, an additional 973 articles were excluded because they did not include MBIs and/or any number of inclusion criteria. Of the remaining 34 studies, 15 studies were excluded because they were narrative/systematic review/meta-analysis ($s = 9$), qualitative studies ($s = 3$), and research protocol ($s = 3$). Finally, 19 primary studies met inclusion criteria and were included in this systematic review and meta-analysis. Fig. 1 shows a PRISMA flow diagram of the search results (Fig. 3).

Of 19 primary studies that met the inclusion criteria ($s = 19$), 19 were between-group comparisons ($k = 20$), 17 were pre-posttest MBI group comparisons, and 17 were pre-posttest control comparisons. All

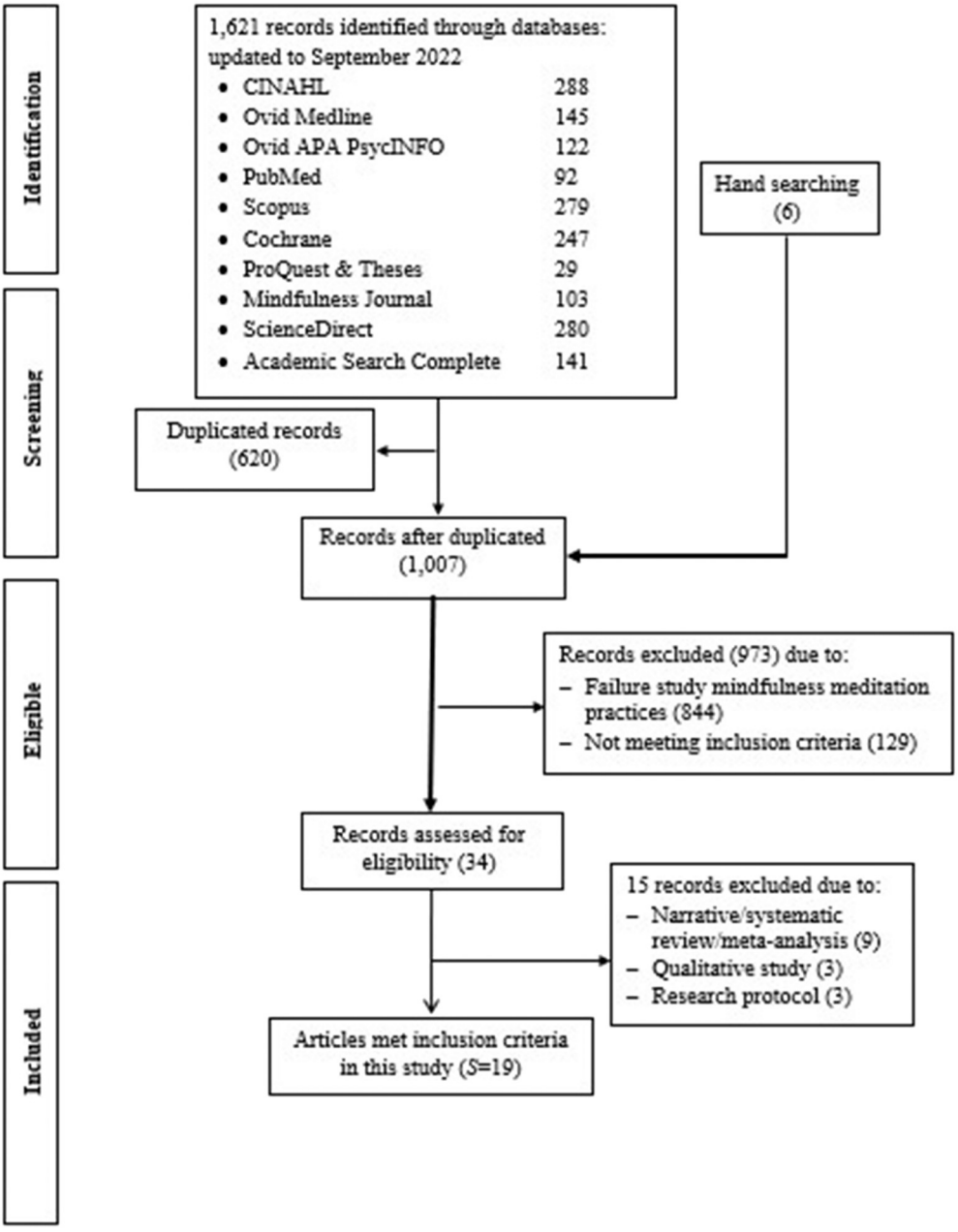

Fig. 1. PRISMA Flow of Included Primary Studies.

Table 1
Characteristics of Primary Studies ($s = 19$).

Characteristics	*s*	Min	Q1	Mdn.	Q3	Max	Mean	SD
Mean age (years)	16	25.30	28.73	31.18	32.29	33.57	30.30	2.52
Total Sample size at analysis								
– MBI group	19	9.00	13.50	29.00	53.00	96.00	35.85	24.92
Control group	19	10.00	15.75	32.00	53.00	97.00	38.15	25.54
Weeks of structured MBI	19	1.00	6.00	8.00	8.00	8.00	6.80	2.02
Days across intervention (length)	19	3.00	35.00	49.00	49.00	49.00	40.73	13.74
Structured MBI session/week	17	1.00	1.00	1.00	1.00	1.00	1.06	0.236
Structured MBI min./session	15	30.00	97.50	120.00	120.00	135.00	106.56	33.45
Dose (length x duration)	15	630.0	3255.0	5880.0	5880.0	6615.0	4801.56	1854.06
Days after intervention measured	19	0.00	0.00	0.00	47.25	366.00	44.75	87.96
% Attrition, MBI group	19	0.00	7.50	20.93	38.80	85.05	26.30	24.11
% Attrition, Control group	19	0.00	5.50	16.64	33.17	64.52	23.05	21.54

s = number of studies providing data, Min = minimum, Q1 = first quartile, Mdn = median, Q3 = third quartile, Max = maximum, MBI = mindfulness-based intervention.

studies had been published between 2008 and 2021. A total of 1480 participants were included across the 19 primary studies; 717 participants practiced mindfulness and 763 served as controls. Six of the 19 studies were conducted in the United States (Dimidjian et al., 2016; Duncan et al., 2017; Epel et al., 2019; Gambrel and Piercy, 2014; Vieten and Astin, 2008; Zhang and Emory, 2015); four in China (Chan, 2015; Yang et al., 2019; Zhang et al., 2019; Zhang et al., 2021); three in Sweden (Lönnberg et al., 2021a; Lönnberg et al., 2020; Lönnberg et al., 2021b); two each in Iran (Hosseinian et al., 2016; Nejad et al., 2021) and Australia (Beattie et al., 2015; Woolhouse et al., 2014); and one each in the United Kingdom (Krusche et al., 2018), Canada (MacKinnon et al., 2021), and Taiwan (Pan et al., 2019). Participants mean age ranged from 25.3 to 33.6 years (mean = 30.3 ± 2.5). See Table 1. Seven instruments were used to measure depressive symptoms, including Edinburgh Postnatal Depression Scale (EPDS, s = 9); Center for Epidemiological Studies Depression (CESD, s = 3); Patient Heath Questionnaire (PHQ, s = 2); Depression Anxiety and Stress Scale-21 (DASS-21, s = 2); Hamilton Depression Scale (s = 1); Self-Rating Depression Scale (SDS, s = 1); and Beck Depression Inventory (BDI, s = 1). The reliability of these measures ranged from 0.83 to 0.91 (s = 5).

Specific interventions included adapted MBI (s = 14); MBCT (s = 3); and MBSR (s = 2). Table 1 shows the intervention descriptives including total weeks of interventions, number of sessions/week of structured/unstructured sessions, and duration of each session in minutes/session (Tables 2 and 3).

4.2. Effects of MBIs

Overall, we meta-analyzed 19 trials involving a total 1480 participants. The meta-analysis showed a statistically significant reduction of depressive symptoms after mindfulness practicing compared controls (g = 0.457, 95%CI[0.25, 0.66], Q = 57.6, p < .001). There was evidence of significant heterogeneity among studies (I^2 = 68 %). Fig. 2 depicts a forest plot of the effect of MBIs on the reduction in depressive symptoms compared with controls. While the effect sizes showed that mindfulness interventions tended to improve depressive symptoms compared to control groups, only nine comparisons showed a significant effect size. Additionally, single group pre-posttest comparisons showed significant effects within mindfulness intervention groups when samples were correlated 0.8 (g = 0.454, 95%CI[0.27, 0.64], p < .001) as well as not correlated (g = 0.516, 95%CI[0.31, 73], p < .001), but were not significant within control groups, resulting in 0.047 (95%CI[−0.10, 0.21], p = .484 for correlated samples (r = 0.8) and 0.055 (95%CI[−0.12, 0.21], p = .576 for uncorrelated samples (r = 0.0). Thus, these pre-post findings support a conclusion that the improvements within mindfulness intervention groups were likely not due to spontaneous recovery. We also examined separately the effects of each type of MBIs. We found that MBSR had a moderate effect on a reduction in depressive symptoms among pregnant women compared control groups (g = 0.65, 95%CI 0.35, 0.94, p < .001, s = 2). Also, MBCT had a significant impact to decrease depressive symptoms (g = 1.18, 95%CI 0.24, 2.12, p = .014, s = 3). Moreover, adapted MBIs had a moderate effect on a reduction in depressive symptoms compared controls (g = 0.31, 95%CI 0.12, 0.50, p = .001, s = 14). Supplementary Figs. 1, 2, & 3 depicts a forest plot of the effect of each type of MBIs on depressive symptoms compared with controls in pregnant women.

4.3. Subgroup analyses

Because we found moderate heterogeneity across studies (Q = 156.5, I^2 = 68 %, tau^2 = 0.428, p < .001), we conducted subgroup analyses to explore the source of the heterogeneity. There was only one moderator that influenced effect size. Providing MBCT had a greater effect (g = 1.129, 95%CI [0.62, 1.64], p < .001) than providing MBSR (g = 0.639, 95%CI [0.13, 1.15], p = .014) and adapted MBI (g = 0.309, 95%CI [0.09, 0.52], p = .004), respectively. Due to the small number of primary studies in the subgroup analysis (s = 2–3), we used the HKSJ adjustment; finding remain significant (F = 3.96, p = .0009). No quality indicator moderated the effect size.

4.4. Publication bias

The funnel plot was visually slightly asymmetrical, suggesting the possibility of publication bias. The Begg and Mazumdar rank correlation test resulted in a Kendall's tau that was −0.046 (p = 349), which reflects a low potential for publication bias (Begg and Mazumdar, 1994). Egger's regression intercept resulted in an intercept of 0.412 (95%CI[−2.18, 3.00], p = .370). These results do not support publication bias.

5. Discussion

5.1. Effects of MBIs

This is the first systematic review and meta-analysis to summarize primary studies on the effects of MBIs on depression in pregnant women. We located 19 studies and found a moderate significant effect size. Our work constitutes the most comprehensive meta-analysis of this topic thus far. Of the 19 primary studies, 17 were randomized trials, whereas previous meta-analysts included 4 to 10 (Corbally and Wilkinson, 2021; Dhillon et al., 2017; Shi and MacBeth, 2017; Taylor et al., 2016; Yan et al., 2022). Unlike others, we also computed the effects of two quasi-experimental studies (Epel et al., 2019; Hosseinian et al., 2016). We then compared effect sizes across the randomized and non-randomized studies and found no difference (Table 4). Therefore, our meta-analysis is novel in that it provides a comprehensive examination of the effects of MBIs on depressive symptoms in pregnant women with a greater number of primary studies (s = 19) than prior meta-analyses (s = 4–10). In addition, we conducted moderator analyses that provide future research directions.

Table 2
Effect size of MBI vs Control groups.

Comparison	MBI group							
	k	ES	p(ES)	95 % CI	SE	I^2	Q	p(Q)
MBI vs. Control groups	19	0.457	<0.001	0.254, 0.659	0.103	68.75	57.60	<0.001
Single group MBI								
pre- vs. post (r = 0.0)	17	0.516	<0.001	0.308, 0.725	0.106	57.92	38.02	0.002
pre- vs. post (r = 0.8)	17	0.454	<0.001	0.272, 0.636	0.093	89.84	157.45	<0.001
Control group								
pre- vs. post (r = 0.0)	17	0.047	0.576	−0.116, 0.209	0.083	44.48	28.82	0.025
pre- vs. post (r = 0.8)	17	0.055	0.484	−0.100, 0.211	0.079	88.23	135.94	<0.001

Table 3
Categorical Moderator Results for Depression Comparing MBI versus Control Groups.

Moderator	*k*	ES	SE	Var.	95%CI	Z	*p*(Z)	Q_{bet}	$p(Q_{bet})$
Source characteristics									
Funding								0.11	0.739
Unfunded	5	0.393	0.221	0.049	−0.040, 0.825	1.78	0.075		
Funded	14	0.477	0.122	0.015	0.237, 717	3.89	<0.001		
Method characteristics									
Assignment into group								0.26	0.610
Randomization	18	0.434	0.117	0.014	0.205, 0.663	3.72	<0.001		
Non-randomization	2	0.590	0.283	0.080	0.036, 1.145	2.09	0.037		
Blinded data collection								0.10	0.750
No	14	0.434	0.129	0.017	0.182, 0.687	3.37	0.001		
Yes	5	0.509	0.195	0.038	0.127, 0.890	2.61	0.009		
Intention-to-treat								0.74	0.391
No	15	0.404	0.124	0.015	0.161, 0.647	3.26	0.001		
Yes	4	0.618	0.216	0.047	0.194, 1.042	2.89	0.004		
Concealed allocation								2.45	0.118
No	10	0.616	0.143	0.020	0.336, 0.895	4.31	<0.001		
Yes	9	0.302	0.141	0.020	0.026, 0.578	2.14	0.032		
Power of sample								2.20	0.138
No	4	0.166	0.150	0.022	−0.128, 0.460	1.11	0.269		
Yes	4	0.526	0.191	0.036	0.152, 0.899	2.76	0.006		
Fidelity								0.53	0.469
No	14	0.510	0.128	0.016	0.259, 0.760	3.98	<0.001		
Yes	5	0.347	0.185	0.034	−0.016, 0.710	1.87	0.061		
Intervention characteristics									
MBI type								9.07	0.011
MBSR	2	0.639	0.260	0.068	0.129, 1.148	2.46	0.014		
MBCT	3	1.129	0.260	0.068	0.620, 1.639	4.35	<0.001		
Adapted MBI	14	0.309	0.108	0.012	0.098, 0.520	2.87	0.004		
MBI format								0.28	0.595
Individual	4	0.357	0.215	0.046	−0.065, 0.779	1.66	0.098		
Group	15	0.489	0.122	0.015	0.250, 0.727	4.02	<0.001		
Group discussion								1.94	0.164
No	7	0.669	0.185	0.034	0.306, 1.032	3.61	<0.001		
Yes	12	0.354	0.129	0.017	0.102, 0.607	2.75	0.006		
Guided meditation								0.13	0.715
No	5	0.387	0.217	0.047	−0.038, 0.813	1.78	0.075		
Yes	14	0.477	0.118	0.014	0.246, 0.708	4.05	<0.001		
Outcome measure									
Days after intervention measured								1.44	0.230
Immediate post-MBI	11	0.553	0.128	0.016	0.303, 0.804	4.32	<0.001		
Delayed follow-up	8	0.309	0.158	0.025	0.000, 0.619	1.96	0.050		

k = number of comparisons, Q = heterogeneity statistics, SE = standard error, MBSR = mindfulness-based stress reduction, MBCT = mindfulness-based cognitive therapy, Adapted MBIs = Adapted mindfulness-based interventions, Var. = variance, NR = not reported.

5.2. Moderator effects

Mindfulness-based cognitive therapy (MBCT) showed a greater improvement in depression than MBSR and adapted MBIs, respectively. One explanation might be that MBCT is based on cognitive behavioral therapy and mindfulness. Cognitive behavioral therapy was developed based on the cognitive model, which posits that emotions and behaviors are influenced by perceptions of situations. Thus, MBCT might be more beneficial in dealing with depression than other types of MBIs because it cooperates with cognitive behavioral therapy, a treatment with evidence supporting its usefulness with depression (Segal and Walsh, 2016). In contrast, MBSR and adapted MBIs focused on refinement of mindfulness techniques through relaxation techniques and using coping strategies to manage stressors related to depression (Kabat-Zinn, 2003). However, because only three research teams conducted MBCT on depression in pregnant women (Dimidjian et al., 2016; Hosseinian et al., 2016; MacKinnon et al., 2021), interpretation should be done with caution.

5.3. Strengths and limitations

This study has several strengths. Recognized as an effective mindfulness-based intervention method, MBIs had the advantage of short-term and strong maneuverability, and it is more convenient for pregnant women. Also, considering the effect of MBIs, this meta-analysis systematically evaluated the effect of MBIs on the depressive symptoms of pregnant women and found that proving MBCT had a greater effect than providing MBSR and adapted MBIs through subgroup analysis. Conducting meta-analyses with a small number of primary studies can result in an increased risk of false negative effect sizes. Conversely, our meta-analysis included a substantial number of primary studies ($s = 19$), which allowed us to implement moderator analyses. Thus, our meta-analysis provides a more complete picture of the effects of MBIs on depression in pregnant women.

However, our meta-analysis still has some limitations. Firstly, only English works of literature were included in this study. Excluding studies in other languages may result in bias. Secondly, previous studies have shown that the long-term effects of MBIs in pregnant women are significant. However, most of the included studies in this meta-analysis focused on the evaluation of short-term efficacy, while the long-term effect is still unclear. Further study is needed.

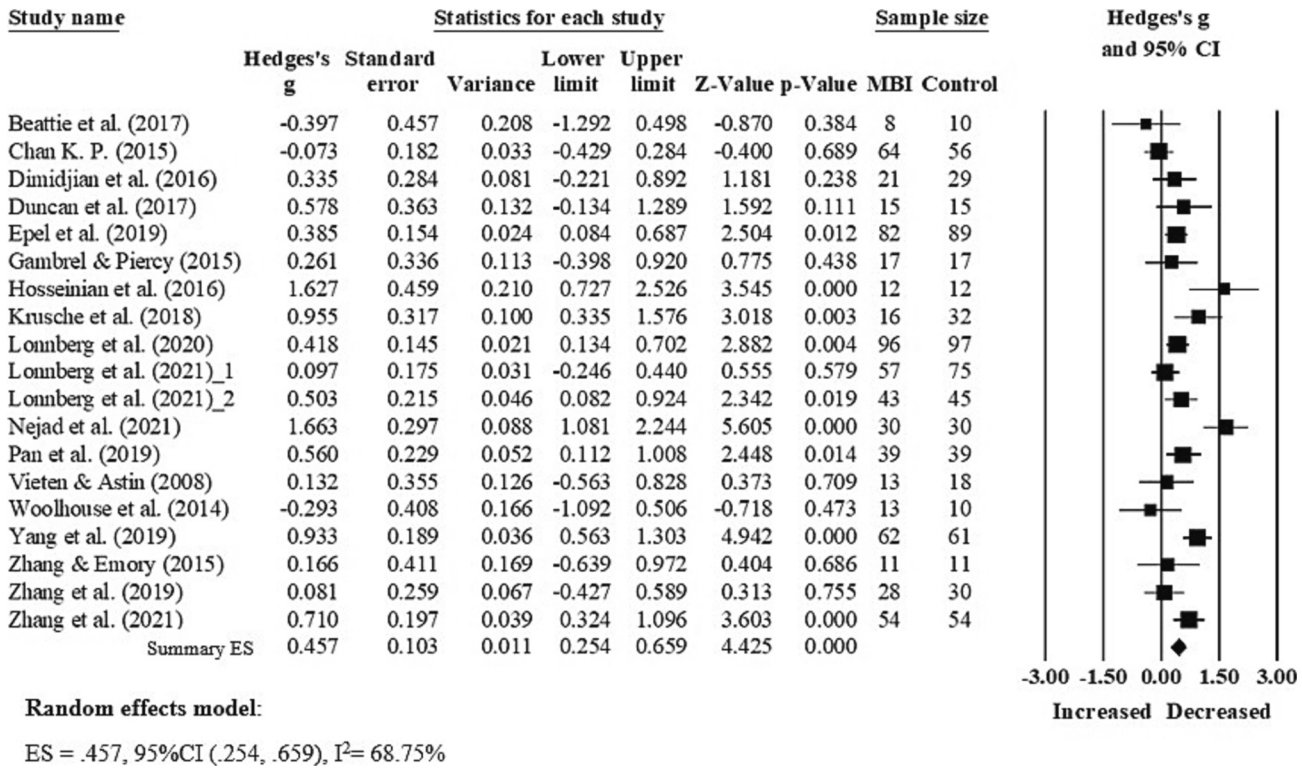

Fig. 2. Forest's plot of the effect of MBIs versus control group on depression in pregnant women.

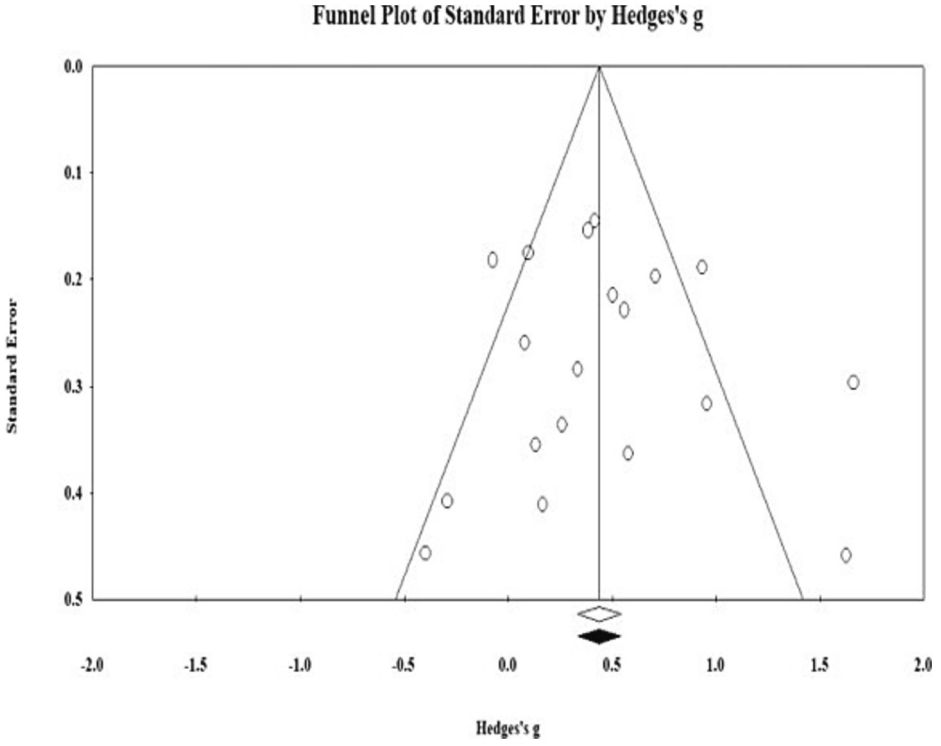

Fig. 3. Funnel plot.

5.4. Implications and recommendations

Western medicine often uses medication to treat depression. This systematic review and meta-analysis provide evidence for the use of MBIs in pregnant women. MBIs are a substitute for drugs that healthcare professionals might provide to patients to avoid depression and enhance prenatal mental health. Healthcare professionals could include patient education about MBIs and the kinds patients should consider trying as part of a visit. The benefits of using MBIs to treat depression and improve maternal mental health while pregnant may also be discussed with

Table 4
Continuous Moderators of the Effects of Mindfulness based intervention on Depression.

Moderator	*k*	Slope	SE	Tau^2	Q_{model}	*p*
Study characteristic						
Publication year	19	−0.016	0.034	0.126	52.49	0.640
Sample characteristic						
Age (mean)	14	0.029	0.058	0.108	39.30	0.622
Method characteristic						
%Attrition	19	−0.006	0.006	0.113	49.79	0.310
Reliability of depressive instruments	5	0.504	17.842	0.297	21.65	0.979
Intervention characteristics						
Intervention length (total day)	19	0.010	0.008	0.115	51.90	0.251
Duration of MBI min./ session	15	0.004	0.004	0.138	48.08	0.315
Dose (Length x Duration)	15	0.001	0.000	0.114	44.20	0.096
Days After intervention measured	19	−0.001	0.001	0.114	51.87	0.336

k = number of comparisons, Q = heterogeneity statistics.

prospective moms by healthcare providers.

Regarding implications for research, further research is needed to examine the effects of MBIs in pregnant women with major depressive disorder. Moreover, reports in languages other than English should be examined.

6. Conclusion

Through the systematic review and meta-analysis of MBIs on depressive symptoms in pregnant women, our findings reveal that MBIs can effectively help pregnant women improve their depressive symptoms. The results of the subgroup analysis suggest that providing MBCT had a greater effect on reducing depression than providing MBSR and adapted MBIs. Thus, clinicians and health professionals might use MBIs as alternative treatment to improve depression symptoms in pregnant women.

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Ethical approval

A systematic review and meta-analysis was not subject to ethical review.

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CRediT authorship contribution statement

Chuntana Reangsing: Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Conceptualization. **Sasinun Punsuwun:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization. **Sarah Oerther:** Writing – review & editing, Writing – original draft, Validation, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors confirm that the data supporting the findings of this study are available within the article ans its supplementary material. Raw data that support the findings of this study are available from the corresponding author, upon reasonable request.

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