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**Review Article**

# Non-Pharmacological Strategies for Postpartum Depression: A Network Meta-Analysis of Randomized Controlled Trials

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**Abstract**

**Objective:** Postpartum depression (PPD) has a significant impact on the mother, child and family. Pharmacologic therapy in breastfeeding mothers often causes side effects, so non-pharmacologic alternatives are needed. This study aims to systematically review and synthesize evidence from randomized controlled trials (RCTs) on the effectiveness of non-pharmacological interventions for PPD through a network meta-analysis.
**Method:** This network meta-analysis synthesizes evidence from RCTs evaluating non-pharmacological interventions for PPD. We reviewed 13 articles from PubMed, Science Direct, Scopus, and Cochrane Library. Network Meta-Analysis was performed using RStudio with a random effects model, while Rob 2.0, RoB-ME, and CINeMA were used to assess the risk of bias.
**Results:** The analysis showed that Therapy-Assisted Internet Cognitive Behavioral Therapy (TA-iCBT) had the highest benefit with a Mean Difference (MD) of 6.90 [95% CI 5.35 to 8.45], p = 0.005, as well as the highest effectiveness (P-score 0.891) and very low heterogeneity ($I^2$ = 0%). Qualitatively, other alternative therapies are also safe for the mother, but need to be tailored to the patient's needs.
**Conclusion:** In conclusion, TA-iCBT is the most effective non-pharmacological therapy for PPD and can be the main choice in the psychiatric treatment of PPD patients.

**Key words:** *Depression; Edinburgh Postnatal Depression Scale (EPDS); Network Meta-Analysis; Postpartum; Psychotherapy*

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Postpartum depression (PPD) affects approximately 20% of women globally, with higher rates in low-resource settings (1). Untreated PPD leads to adverse outcomes for mothers and children (2). Mothers with PPD are at risk of chronic depression, ongoing anxiety, and difficulty communicating with their children. The impact can also be felt by the child, who is at risk of developmental delays and long-lasting emotional and behavioral problems (3). Without treatment, PPD can result in a cycle of mental health problems that continues to recur within the family (4). While antidepressants are effective, 50% of women decline pharmacotherapy due to stigma or safety concerns (5), creating demand for non-pharmacological alternatives.

Psychological interventions such as health education, interpersonal psychotherapy (IPT), cognitive behavioral therapy (CBT), and problem-focused therapy are the main options in treating PPD. Non-pharmacological therapies are recognized to reduce depressive symptoms in the long term (6). Technological innovations in this field offer solutions that are more accessible, flexible and patient-centered (7). This is important because mothers with PPD often face challenges such as limited mobility due to postpartum recovery or caregiving obligations. With technology-based services, such as online CBT therapy support applications, mothers can receive more effective and affordable treatment, without the need to leave home (8).

While previous meta-analyses have examined individual non-pharmacological interventions for PPD (9), three critical gaps remain. First, no comprehensive network meta-analysis has directly compared all available interventions to establish a hierarchy of efficacy. Second, existing reviews often neglect implementation factors critical for low-resource settings, where 75% of PPD cases occur (10). Third, recent advances in digital interventions (e.g., app-based CBT) and novel approaches (e.g., partner-inclusive therapy) have not been systematically evaluated against traditional methods.

This study addresses these gaps by: conducting the first network meta-analysis comparing 12 intervention categories (from traditional psychotherapy to emerging digital tools), analyzing moderators like delivery format (group vs. individual) and provider type (specialist vs. peer-led) to identify scalable solutions, and incorporating data from 8 low- and middle-income countries to enhance global relevance. The results of this study are expected to be a reference for developing strategies for non-pharmacological treatments for PPD.

To date, there are no network meta-analyses that directly or indirectly evaluate the most effective non-pharmacological therapies to reduce Edinburgh Postnatal Depression Scale (EPDS) scores in PPD patients. Therefore, this study aims to assess the efficacy and effectiveness of various non-pharmacological therapies in reducing PPD symptoms based on EPDS scores.

## Materials and Methods

### *Study Design and Search Strategy*

This network meta-analysis and systematic review followed the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for Network Meta Analysis Checklist Items (Figure 1) and was guided by the Cochrane Handbook for Systematic Reviews of Interventions (11, 12). The protocol was registered in PROSPERO, an international database for systematic reviews (CRD420251026759). The systematic review was conducted from February until June 2025.

We conducted a data search of relevant studies in four databases, namely PubMed, ScienceDirect, Cochrane and Scopus until January 5, 2025 with the following main keywords (“postpartum depression” OR “perinatal depression”) AND (Exercise OR Yoga OR interpersonal therapy OR Cognitive behavioral therapy (CBT) OR psychodynamic therapy). Then, we added synonym words from Medical Subject Headings (MeSH) to form more specific keywords in each database.

### *Study Selection and Eligibility Criteria*

Search results from each database were collected and organized using Rayyan.ai. Afterwards, we removed duplicates and screened relevant titles and abstracts against the patient, intervention, comparison, and study design (PICO(s)) framework defined in Table 1.

**Table 1. Eligibility Criteria Based on the PICO(S) Framework on The Non-Pharmacological Strategies for Postpartum Depression**

| **Population** | **Patients with PPD** |
|---|---|
| Intervention | Therapy Assisted- internet Cognitive Behavioural Therapy (TA-iCBT), Usual Care with Waitlist; internet-based Cognitive Behavioural Therapy (iCBT); internet-based behavioral activation (iBA); CBT with Supportive Psychodynamic Intervention (CBT-SPI); CBT with Systemic Family Therapy (CBT-SFT); Wellness Intervention (telephone based); CBT; exercise, CBT combined with workshop (CBT workshop) |
| Comparison | Usual Care or Standard of Care |
| Outcome | EPDS, which measures the severity of PPD symptoms |
| Study | Randomized Controlled Trial Study |

Inclusion criteria: Randomized Controlled Trial studies; studies published within the last 10 years; studies on patients with PPD; studies employing Therapy-Assisted internet Cognitive Behavioural Therapy (TA-iCBT), Usual Care with Waiting List, internet-based Cognitive Behavioral Therapy (iCBT); internet-based behavioral activation (iBA), CBT with Supportive Psychodynamic Intervention (CBT-SPI), CBT with Systemic Family Therapy (CBT-SFT), health intervention (telephone-based), CBT, exercise, and CBT combined with workshops (CBT workshops) and exercise. Study outcomes were assessed by mean difference (MD) on EPDS. Participating patients were not taking any pharmacological management.

Exclusion criteria: Papers with animal studies, narrative reviews, systematic reviews, meta-analyses, non-comparative researches, in vitro studies, in vivo studies, technical reports, editor responses, scientific posters, study protocols, and conference abstracts.

***Data Extraction and Scale Results***

Five researchers (HAH, BNA, ZKN, SW, FM) extracted data from each included study using Google Sheets. BNA and ZKN did the double-checking. The data extracted by the researchers and assigned to study characteristics and outcomes included 1) First Author and publication date; 2) Study location; 3) Type of control treatment; 4) Total study participants; 5) Population characteristics; 6) Type of intervention; 7) Age of participants; 8) Main study scale (pre- and post-intervention, as well as MD); and 9) Total sample for each intervention.

The EPDS is a 10-item self-assessment tool specifically designed to assess emotional and cognitive symptoms associated with PPD. Each item on the EPDS is rated on a scale from 0 to 3, reflecting the respondent's experience over the past seven days. This scoring system allows for a total score that ranges from 0 to 30, where higher scores indicate more severe depressive symptoms (13). More fully, a score of 0 to 9 indicates a normal outcome and no depressive symptoms. A score of 10 to 12 indicates the presence of mild depressive symptoms, and the individual should be given supervision and assistance. A score of 13 to 15 indicates moderate depressive symptoms, and the individual should be given further assessment and intervention, such as counseling or therapy. Scores of 16 to 30 indicate major depression, indicating that the individual should seek immediate help as there is a risk of loss of life function and more intensive treatment is required (14).

***Methodological Quality Assessment***

Researchers assessed potential bias in each study using the Risk of Bias Tool for randomized trials (RoB 2.0) (15). RoB 2.0 consists of five sections and includes 28 questions that focus on areas such as randomization, intervention, outcome data, and reported outcomes. Two researchers (BNA and ZKN) conducted a quality bias assessment of the included studies. Furthermore, three researchers (HAH, SW, FM) conducted a re-evaluation of the bias assessment. Finally, one researcher (ZKN) conducted visual analysis using the RoBVIS software (16).

***Data Synthesis and Statistical Analysis***

The descriptions of original studies were summarised using tables and forest plots. We estimated the MD and 95% confidence interval (CI) using Rstudio. We used three R packages: “netmeta”, “meta”, ‘readxl’, and “metaphor” (17, 18). We also used the “netgraph” function to present graphs.

We used funnel plots in RStudio to evaluate the symmetry of the points, where asymmetry indicates a risk of publication bias, with low standard errors increasing that risk. Egger's regression analysis provided a quantitative assessment, where values close to zero indicate lower risk, while values above one and p-values $< 0.05$ signify significant bias. On the other hand, publication bias analysis was conducted through funnel plot and egger regression if the number of included studies was over ten. In addition, Restricted Maximum Likelihood (REML) with a random effects model was used to measure heterogeneity, with a significant level of $p < 0.05$. Meanwhile, P-score (0-1) was used to rank the treatment efficiency in the network meta-analysis based on the treatment effect (TE) and its standard error (seTE), where high TE and low seTE indicate optimal efficiency. P-score results are visualized through heat plots for more convenient interpretation (17–19).

To address within-study bias and reporting bias, we employed the Cochrane Risk of Bias Tool for Missing Evidence (RoB-ME). The assessment consisted of 11 questions organized into a four-step process. The first step involved identifying the risk of bias in the selected studies, focusing on the intervention and any unreported outcomes. The second step involved adjusting the criteria for including or excluding studies to align with the network meta-analysis criteria. The third and fourth steps focused on estimating and assessing the unreported outcomes of the EPDS in each included study.

We used the Confidence in Network Meta-Analysis (CINeMA) adaptation of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach to evaluate the credibility of the results. This included an assessment of risk of bias, imprecision (based on the position of the 95% CI on the forest plot relative to the no-effect line), indirectness (considering the availability of direct comparisons between interventions), and incoherence (through the omnibus incoherence test) to ensure the validity of the analysis (20–22). Additionally, we followed the guidelines of the GRADE handbook to ensure the correct order and criteria for the assessment of each domain in its entirety (23).

***Heterogeneity Assessment***

The significance level was set at $P < 0.05$, with heterogeneity criteria of 0-100% (low: 0-30%; moderate: 40-50%; substantial: 60-90%; high: 91-100%). We used rankogram (represented by heat plot) and netheat (to

evaluate inconsistency if there were > 1 closed loops). Interventions were coded I1-I13, including I1: TA-iCBT; I2: Usual Care with Waitlist; I3: Usual Care; I4: iCBT; I5: iBA; I6: CBT-SPI; I7: CBT-SFT; I8: Wellness Intervention (telephone based); I9: CBT; I10: Exercise; I11: CBT workshop; I12: interpersonal psychoteraphy; I13: peer-support.

## Results

***Study Selection***

From these search results, 224 articles were excluded after duplication removal and title screening based on the PICO(s) framework. A further 129 articles were excluded after abstract screening using the same criteria. After that, 43 articles were screened and 20 articles met the inclusion criteria. Of the remaining 20 articles that were evaluated in depth, seven articles were ineligible owing to irrelevant and insufficient data. Finally, 13 studies were selected for use in this network meta-analysis.

Thirteen RCT studies were analyzed quantitatively and qualitatively, with the number of participants varying from 41 to 910 patients. All the reviewed studies were rated as having a minimal risk of bias based on RoB 2.0 (Table 2).

**Table 2. Characteristics of the 13 Randomized Controlled Trials Included in the Network Meta-Analysis on The Non-Pharmacological Strategies for Postpartum Depression**

| Author / Country | Intervention | Control | Intervention Duration | Follow up Study | Results |
|---|---|---|---|---|---|
| Chabrol, et al., 2000 (19)/ France | CBT-SPI | Usual care | 12 weeks | 3 months postpartum | An intervention consisting of inpatient prevention sessions, followed by home visit-based therapy for women with major depression, was found to be effective in reducing PPD and improving recovery. |
| Shu-Shya, et al., 2008 (20)/ Taiwan | Exercise support program | Usual care | 3 months | 5 months postpartum | The intervention group had reduced EPDS scores and positive responses were received from participants. |
| C.L Dennis, et al., 2008 (21)/ Canada | Peer support | Usual care | Not explicitly stated (initiated within 48-72 hours) | 12 weeks and 24 weeks postpartum | The intervention group showed lower risk in developing postnatal depression. |
| Ling-lin Gao, et al., 2010 (22)/ China | IPT-oriented childbirth psychoeducation program | Routine antenatal education | Two 90-minute classes | 6 weeks postpartum | The intervention group showed reduction of depressive symptoms from normal range to a lower level within the normal range. |
| O Mahen, et al., 2012 (23)/ UK | iBA | Usual care with a waitlist system | 15 weeks | 15 weeks post-randomization | The intervention was effective in reducing depressive symptoms, when compared to usual care in the control group. |
| Hou, et al., 2014 (24)/ China | CBT-SFT | Usual care | 3 months (psychotherapy sessions were from 2 months to 5 months post-delivery) | 24 months after intervention | The combination of CBT and SFT significantly reduced depressive symptoms and improved sleep quality in patients with mild to moderate PPD. These positive effects can be found consistently for 24 months after the intervention. |
| Ngai, et al., 2015 (25)/ Hong Kong | *Telephone Based* CBT | Usual care | Not explicitly stated | 6 weeks and 6 months postpartum | Telephone-based CBT significantly reduced depressive symptoms when compared to usual postnatal care. The results showed that |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | telephone-based CBT is a flexible, accessible and economical method to treat postnatal depression. |
| Leung, et al., 2015 (26)/ Hong Kong | CBT | Usual care | 6 weekly sessions | Follow-up was conducted 3 months and 6 months after the intervention was completed. | The group-based CBT intervention over six short sessions was shown to significantly reduce depressive symptoms and received positive responses from participants. |
| A.J Daley, et al., 2015 (27)/ UK | Exercise Program | Usual care | 6 months | 6 months and 12 months post-randomization | The intervention group had a better effect on curing the population according to the EPDS than the control group and the intervention was recommended for self-harming postnatal women. |
| Pugh, et al., 2016 (28)/ Canada | TA-iCBT | Usual care with a waitlist system | Outcomes assessed at 7 to 10 weeks | 4 weeks post-treatment completion | Participants who took part in TA-iCBT showed a reduction in depressive symptoms, parenting stress, and general stress levels while experiencing improved psychological and environmental quality of life. |
| Jannati, et al., 2020(29)/ Iran | CBT | Usual care | Outcomes assessed at 2 months | 2 months after baseline | CBT-based apps effectively address PPD by helping the management of negative thoughts, improving problem-solving skills, and providing accessible therapy. |
| Lewis, et al., 2021 (30)/ USA | Exercise program | Usual care | 6 months | 6 months and 9 months post-randomization | Exercise and wellness were shown to help improve mental health postpartum, with exercise reducing stress and wellness interventions decreasing depressive symptoms at 6 months postpartum. However, these effects were not sustained at 9 months, highlighting the need for a sustained approach. |
| Babiy, et al., 2024 (31)/Canada | CBT | Usual care with a waitlist system to join the workshop 12 weeks later. | One-day workshop | 12 weeks after enrollment | This workshop significantly reduced depressive symptoms. In addition, there were changes in postpartum anxiety and a wide range of psychosocial benefits. |

These studies used the EPDS to measure symptoms of PPD, evaluating various non-pharmacological interventions, because EPDS is the most widely used tool in PPD research due to its specificity for perinatal populations.

The approaches studied included CBT, TA-iCBT, iBA, and iCBT, which offers flexibility through online intervention. In addition, some studies combine CBT with other therapies, such as CBT-SPI and CBT-SFT, for a more holistic approach.

Other interventions studied include CBT workshops, wellness programs, structured exercise, as well as standard care (Usual Care) and delayed care (Usual Care with Waitlist). The duration and frequency of the interventions varied, with study sites spread across different countries, including China, Iran, France, Canada, the United Kingdom, Hong Kong and the United States. These studies show a variety of innovative strategies in treating PPD, emphasizing accessibility, family support and multidisciplinary

approaches. The study selection process is summarized in the PRISMA flow chart (Figure 1).

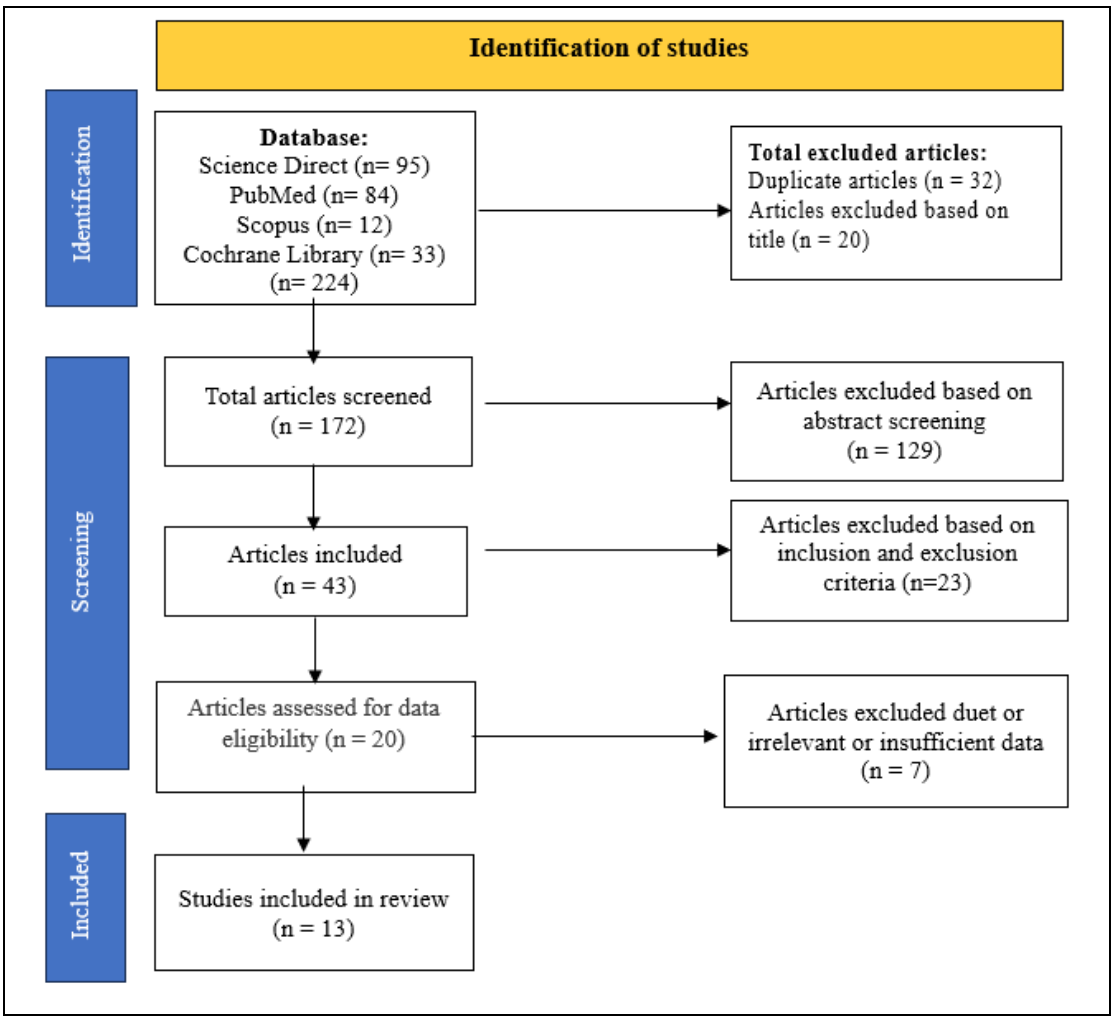


**Figure 1. PRISMA Flow Diagram of Study Selection on The Non-Pharmacological Strategies for Postpartum Depression**

***Network Meta-Analysis for MD EPDS Results***

The netgraph visualizes the interactions between interventions, where the size of the circle indicates the number of participants and the thickness of the line illustrates the number of studies comparing related interventions. The graph showed that iCBT, Wellness Intervention, and Exercise formed one closed loop displaying a network with sparse geometry. Its sparseness is considered to be a significant weakness in our analysis. Also, the consistency between direct and indirect evidence could only be assessed within this triangular loop. For all other comparisons, consistency could only be concluded from indirect comparisons.

TA-iCBT was most efficacious in reducing symptoms of PPD (MD: 6.90; 95% CI: 1.46-12.34), followed by CBT-SPI (MD: 6.89) and iBA (MD: 6.79), all of which were significant ($P < 0.0001$) compared to usual care. The full comparison is presented in Figure 2. The comparison of TA-iCBT with CBT-SPI (MD: 0.01; 95% CI: -1.62-1.64; $P = 0.99$) and iBA (MD: 0.11; 95% CI: -2.45-2.67; $P = 0.93$) was not significant, both crossing the no effect line.

Additionally, there was extremely high heterogeneity throughout the entire analysis ($I2 = 88.4\%$). The sources of this significant discrepancy could not be located because of the sparse network. We also addressed the issue of publication bias. The Egger's regression value was not statistically significant (ER = -0.06; $P = 0.9509$), despite the funnel plot's (Figure 3) visual inspection suggesting some asymmetry. Consequently, while small-study effects cannot be completely ruled out, there is no significant statistical evidence for publication bias.

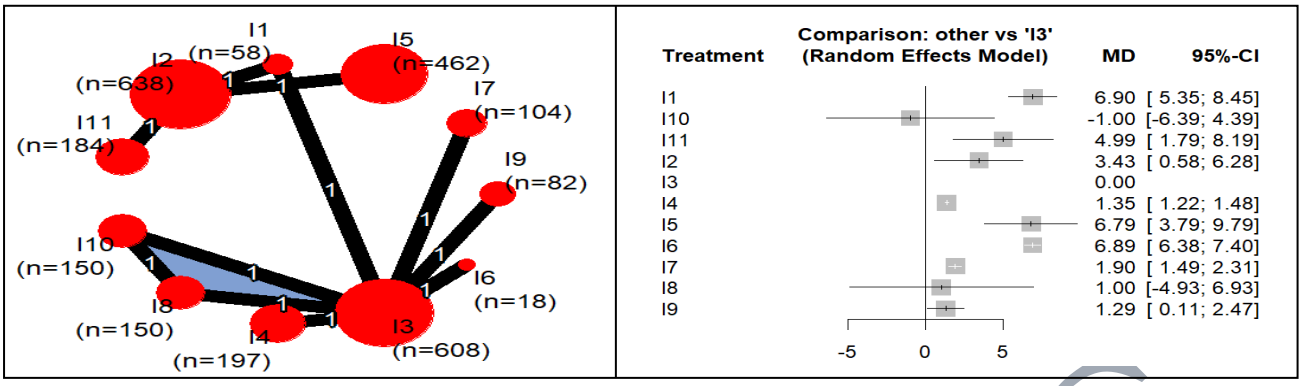


**Figure 2. Network Geometry of Interventions and Forest Plot of Mean Differences on The Non-Pharmacological Strategies for Postpartum Depression**

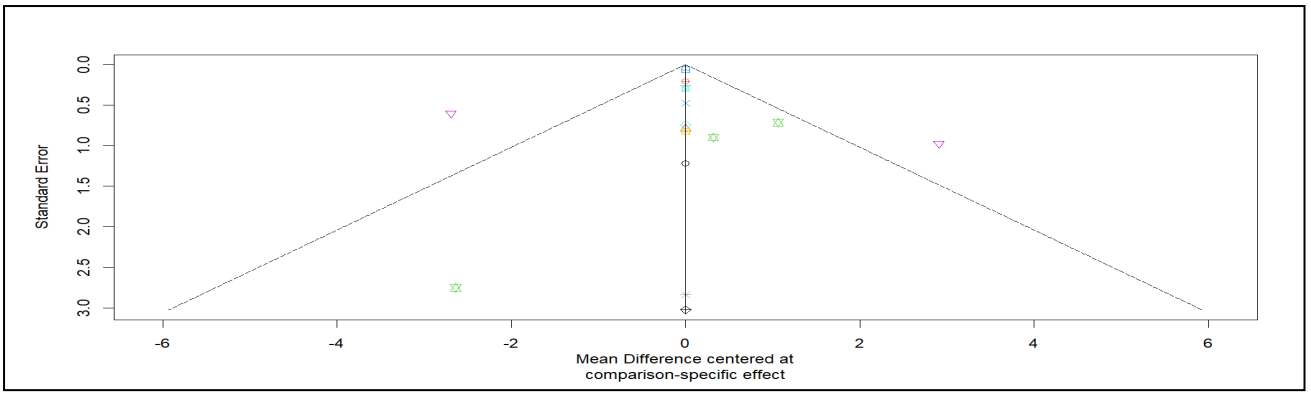


**Figure 3. Funnel Plot for Assessment of Publication Bias in Meta-Analysis on The Non-Pharmacological Strategies for Postpartum Depression**

The TA-iCBT had the highest P-score (0.816), indicating that this intervention is most probably more effective than all the other interventions involved in this network meta-analysis. Meanwhile, CBT-SPI ranked second (P-score: 0.804), followed by iBA (P-score: 0.755), CBT workshop (P-score: 0.619), CBT (P-score: 0.592), Usual Care with Waitlist (P-score: 0.483), IPT (P-score: 0.457), Wellness Intervention (telephone based) (P-score: 0.439), CBT-SFT (P-score: 0.387), Exercise (P-score: 0.386), iCBT (P-score: 0.337), Peer_support (P-score: 0.291) and Usual Care (P-score: 0.165). Although in that order, the P-score differences between TA-iCBT, iBA, and CBT-SPI were not clinically significant, making them possibly irrelevant (figure 4).

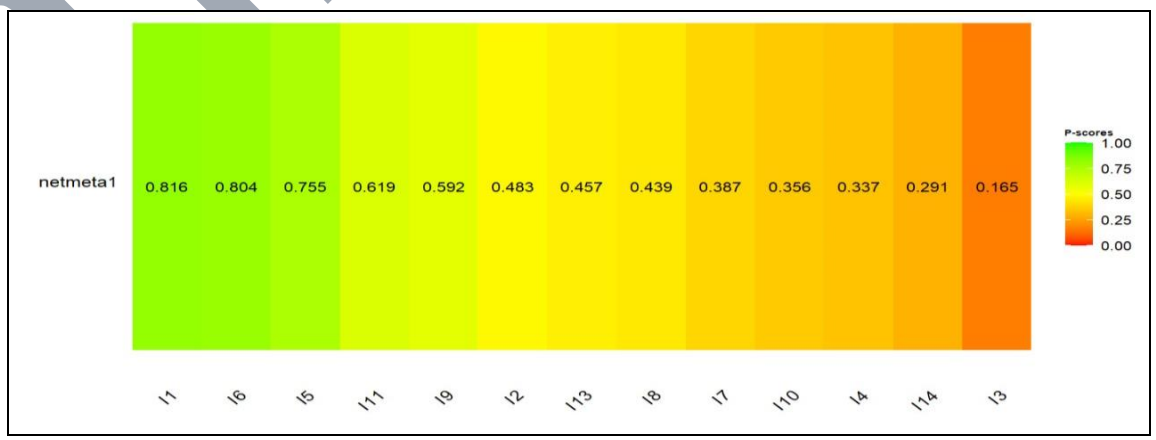


**Figure 4. Ranking of Interventions Based on P-Scores Bias in Meta-Analysis on The Non-Pharmacological Strategies for Postpartum Depression**

***Quality Assessment and Publication Bias***

An assessment using the RoB 2.0 tool identified concerns in Domain 3 ('Bias due to Missing Outcome Data') in the studies by Ling-lin Gao (27), Leung (26), and Lewis (30). These studies lacked clarity in their handling of participant dropouts, casting doubt on the completeness of their reported results. This was attributed to participant attrition during follow-up or withdrawal from the intervention. On the other hand, the other evaluated studies showed a low risk of bias in all domains, so the data were considered appropriate and suitable for use in the analysis. The final results for risk of bias assessment are presented in Figure 5.


**Figure 5. Cohrane Risk of Bias Assessment Summary for Randomized Trials Version 2 (RoB 2.0)**

After assessing the 13 included articles using the Cochrane RoB-ME tool, the researchers raised concerns about the validity of comparisons between the intervention and control groups, as the outcomes were reported using medians and interquartile ranges (IQRs). This occurred in the study which required researchers to conduct manual calculations, raising concerns about bias (32). Consequently, this resulted in an increased risk of bias in the comparisons involving wellness, usual care, and exercise control groups. By contrast, analyses of the risk of bias in other interventions and results of other studies raised no significant concerns, so they are deemed to have high reliability.

***Subgroup Analysis***

Substantial heterogeneity was detected ($I^2$ = 88%), prompting subgroup analyses to explore its potential sources. To investigate heterogeneity, we conducted subgroup analyses by intervention duration (short-term < 8 weeks vs. long-term ≥ 8 weeks), Baseline EPDS severity (mild < 12 vs. moderate-severe ≥ 12), and Geographic region (high-income vs. low/middle-income countries). Random-effects models were used for all subgroups. The subgroup analyses, presented in Table 3, revealed that long-term interventions were associated with a significantly greater reduction in postnatal depressive symptoms (as measured by EPDS) compared to short-term interventions. Similarly, studies enrolling participants with moderate-severe baseline depression showed a larger treatment effect than those which worked with patients with mild baseline symptoms. In contrast, geographic region did not significantly account for the observed heterogeneity.

**Table 3. Subgroup Analyses of Intervention Effects on Edinburgh Postnatal Depression Scale on The Non-Pharmacological Strategies for Postpartum Depression**

| Subgroup | Studies (n) | SMD (95% CI) | $I^2$ | P (subgroup difference) |
|---|---|---|---|---|
| **Intervention Duration** | | | | |
| Short-term (< 8 weeks) | 4 | –1.25 (–2.10, –0.40) | 85% | 0.03 |
| Long-term (≥ 8 weeks) | 9 | –2.10 (–3.05, –1.15) | 90% | |
| **Baseline EPDS Severity** | | | | |
| Mild (< 12) | 2 | –0.80 (–1.50, –0.10) | 75% | 0.01 |
| Moderate-Severe (≥ 12) | 11 | –2.20 (–3.00, –1.40) | 89% | |
| **Geographic Region** | | | | |
| High-income countries | 10 | –1.90 (–2.60, –1.20) | 80% | 0.12 |
| Low/middle-income | 3 | -1.50 (–2.50, –0.50) | 76% | |

SMD: Standardized Mean Difference; EPDS: Edinburgh Postnatal Depression Scale

## Discussion

Current evidence supports non-pharmacological interventions to reduce PPD, but guidelines are limited. This article is the first to use meta-network analysis to compare the effects of different non-pharmacological interventions on PPD, focusing on PPD symptom variables. We were able to visualize the data and identify the best interventions, such as TA-iCBT, iBA, CBT-SFT, and telephone-based interventions, which were more effective than usual interventions. However, the interpretation of these results requires further discussion due to their complexity.

PPD is a multifaceted disorder that affects new mothers emotionally, psychologically and physically. These changes are associated with hyperactivation of brain areas such as the prefrontal cortex, amygdala and insula, which are involved in emotion regulation (33–35). Network meta-analysis studies show that non-pharmacological interventions, especially CBT, are effective in reducing PPD symptoms by changing negative thought patterns and promoting healthy coping (36). Our findings are in line with previous studies, where CBT was the most dominant intervention and was shown to reduce the main symptoms of PPD.

TA-iCBT proved to be the most effective intervention for PPD, specifically designed for young mothers at an affordable cost, incorporating seven multimedia-based CBT modules (text, audio, video) and supported by therapist guidance. CBT with a psychodynamic approach came in second place (MD = 0.01), offering a one-hour postpartum prevention session focusing on education and cognitive-behavioral strategies to reduce the pressure of being the "perfect mother". Meanwhile, iBA provides interactive web-based modules with therapist assistance via email/online messaging, making it a viable option for postpartum mood change management. These three interventions show significant potential in the management of PPD and should be considered as part of a mental health program.

In our study, TA-iCBT showed promising potential in the management of PPD. The successful intervention may adapt to meet the needs of future generations of mothers. Moreover, personalized communication, with an average of 11 text messages, can strengthen the relationship between therapists and mothers. Thus, integrating TA-iCBT in mental health programs is a crucial step to reduce the impact of PPD and improve the well-being of new mothers.

Our findings predominantly reflect evidence from high-income countries (Canada, USA, UK), which may limit their applicability to low and middle income countries. Cultural differences in postpartum practices, mental health stigma, and resource availability could affect intervention feasibility and effectiveness. For example, community-based peer support, a cost-effective strategy, may be more scalable in low and middle income countries than structured psychotherapy. Future trials should prioritize testing adaptable interventions (e.g., task-shifted counseling, digital tools) in diverse settings to ensure global relevance. Furthermore, specific sociodemographic factors, such as socioeconomic status and lack of social support, have been identified as significant correlates of PPD, highlighting the need for accessible interventions (37).

## Limitation

A key limitation of our network meta-analysis is the presence of only one closed loop, which restricts formal consistency checks between direct and indirect evidence. This sparse connectivity may introduce uncertainty in pooled estimates, particularly for interventions compared solely through indirect pathways. While random-effects models and sensitivity analyses were employed to mitigate bias, findings for such interventions should be

interpreted cautiously. Future research should prioritize head-to-head trials to strengthen the network's robustness.

## Conclusion

This network meta-analysis demonstrates that blended care (therapist-supported digital tools) is the most effective non-pharmacological intervention for PPD, particularly when culturally adapted; though, task-shifted counseling shows greater feasibility in low resource settings. Despite these advances, significant gaps remain, including geographic bias (80% of studies were conducted in high income countries) and inconsistent reporting of cost effectiveness and long-term outcomes. Clinicians should prioritize scalable, human-centered approaches like peer support or hybrid models, while researchers must address critical gaps through rigorous trials in low-middle income countries, standardized implementation metrics, and innovative delivery platforms. These findings provide an actionable roadmap for optimizing PPD care globally.

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## Conflict of Interest

None.

## Author's Contribution

Conception and design: Hilmi Amirul Haq, Zainab Khalisah Nurulhaq, Bryan Naufal Abdullah, Siti Wahyuni. Analysis and interpretation of the data: Bryan Naufal Abdullah, Farida Murtiani. Drafting of the article: Hilmi Amirul Haq, Bryan Naufal Abdullah, Siti Wahyuni, Farida Murtiani. Critical revision of the article for important intellectual content: Hilmi Amirul Haq, Siti Wahyuni, Farida Murtiani, Rahmat Saputra. Final approval of the article: Hilmi Amirul Haq, Zainab Khalisah Nurulhaq, Bryan Naufal Abdullah, Farida Murtiani, Rahmat Saputra. Statistical expertise: Bryan Naufal Abdullah, Farida Murtiani. Administrative, technical, or logistic support: Zainab Khalisah Nurulhaq, Siti Wahyuni. Collection and assembly of data: Hilmi Amirul Haq, Zainab Khalisah Nurulhaq, Bryan Naufal Abdullah, Siti Wahyuni

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