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Original Article

Exercise intervention up to 6 months postpartum improves the outcome of Edinburgh postnatal depression scale

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Abstract:
Although exercise-based programs may serve as an alternative therapeutic approach for minimising severe depression in postpartum women, their clinical efficacy must be empirically established. This meta-analysis investigates the effect of exercise intervention on depression in women up to 6 months postpartum. Using relevant keywords, this study searched the following electronic databases: Web of Science, Scopus, PubMed, SPORTDiscus and Google Scholar. Eleven studies met the inclusion criteria, which included 20 trials with Edinburgh Postnatal Depression Score questionnaire score ≥ 10. The eligible studies on exercise intervention for postpartum women were compared in terms of the corresponding usual care, non-intervention and active controls. Estimations using the fixed-effects meta-analysis indicate a significant reduction in postpartum depression scores in the exercise intervention group compared to the control group (overall standardised mean difference = -0.28 [95% CI: −0.38 to −0.18], p<0.001; I^2 = 54.7%). Subgroup analyses revealed that exercise supervision status and exercise intensity considerably influence the effectiveness of interventions in lowering Edinburgh Postnatal Depression Score (supervised group: standardised mean difference = –0.44 [95% CI: −0.65 to −0.22], p<0.001 vs. unsupervised group: standardised mean difference = –0.18 [95% CI: −0.40 to −0.05], p=0.13; low-intensity exercise group: SMD = –0.23 [95% CI: −0.37 to −0.09], p<0.01 vs. moderate-intensity exercise group: standardised mean difference = –0.96 [95% CI: −1.41 to −0.50], p<0.001). Less influence is seen on the timing of exercise intervention (i.e., ≤ 3 months vs. 3 to 6 months). The findings suggest that the current evidence supports exercise intervention as a means for reducing the risk of depression during the first 6 months postpartum. Greater prevention effect is more likely with a supervised exercise program of low to moderate exercise intensity progression.
Key Words*:* **- Meta-analysis, Postpartum, Depression, Mental health, Exercise**

Introduction

Postpartum depression (PPD) is a global mental health issue, annually affecting 13 million women worldwide (Wu et al., 2018). It is defined as a minor or major depression occurring up to one year after childbirth and is estimated to affect 5 to 25% of new mothers (Tonei, 2019). Commonly associated with periodic depressive episodes, PPD may persist over a long period of time. PPD is characterised by emotional lability, guilt, dysphoria, disorientation and suicide thoughts, and has long-lasting detrimental effects on the mother, the infant and the family (Zhou et al., 2022). Various physical, genetic and socioeconomic factors place pregnant and postpartum women at risk of perinatal mental health problems, while buffering factors (e.g., supportive partner) are protective. Time, transportation and access to childcare are the most reported barriers of undertaking psychotherapy during the postpartum period. Therefore, the primary prevention of PPD can help new mothers avoid a lengthy, costly and hard-to-access recovery process (Tonei, 2019).

Postpartum depression has negative consequences on the mother, the new-born and the entire family (Payne & Maguire, 2019). Postpartum depression can also develop into persistent long-term depression, which can raise the likelihood of recurring episodes of depression in later pregnancies (Carter et al., 2018). For instance, women with a history of depressive illness are more likely to develop postpartum depression (Saligheh et al., 2016). The research suggests that the negative effects of postpartum depression may include the mother's low functional status, a greater risk of depression in future, a dysfunctional mother-child attachment relationship, trouble caring for the new-born and an undesirable influence towards her partner (McCurdy et al., 2017). Unfortunately, only a few women with postpartum depression seek treatment (Daley et al., 2007).

Postpartum depression is the most prevalent condition associated with childbirth. The 10-question Edinburgh Postnatal Depression Scale (EPDS) is an effective means for identifying patients at risk of "perinatal" depression (Falana & Carrington, 2019). The EPDS was designed to be a self-reported measure and is usually

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completed in less than five minutes. It may identify the risk of depression in women who may not have previously considered the possibility of PPD. No guidance is currently provided to health practitioners who use the EPDS as a screening instrument. Nonetheless, it is commonly recognised that 10 represents potential depression and > 12 is probable depression (Khanlari et al., 2019). Within the research of treating PPD with psychological and psycho-social treatments, an EPDS score ≥10 is frequently used as an eligibility criteria to indicate depression (Smith-Nielsen et al., 2018).

One potentially promising method for preventing PPD is exercise. Exercise may be described as a planned, systematic, repeated and purposeful action since the aim is the improvement or maintenance of one or more aspects of physical fitness (Asraff et al., 2022; Dasso, 2019). The findings from the meta-analyses, reviews and randomised controlled trials demonstrate encouraging results of exercise in treating and preventing depression in the maternal population. Previous studies have provided compelling evidence regarding exercise in the postpartum period. Exercise was shown to improve blood circulation and strengthen abdominal and spine muscles (Ko et al., 2013), stimulating lactation, accelerating the constriction of the uterus, preventing urogynecological dysfunction, as well as improving the mental and physical condition of mothers (Daley et al., 2007). However, the psychological benefits from exercise training intervention during the first 6 months postpartum are yet to be systematically explored.

Due to the physiological changes during pregnancy and other accompanying discomforts, such as exhaustion and nausea, women also demonstrated reduced behavioural control to be active (Cioffi et al., 2010; Linoby, Azrin, et al., 2020). This sets the stage prior to the postpartum period, which may lead to an increased sedentary behaviour in daily routine.

Postpartum exercise-based interventions may benefit short-term postpartum health in several cohort studies. There is evidence to indicate that exercise intervention has been linked to lower risk of developing depressive episodes (Adachi-Mejia et al., 2010). However, the data from previous studies differ regarding the magnitude of such association (Vargas-Terrones et al., 2021). Thus, the aim of the current study is to systematically evaluate and apply a meta-analytical approach to assess the literature. The effects of exercise intervention during short-term (i.e., up to 6 months) postpartum are examined to change depression outcomes measured via a reliable and validated postnatal depression scale (i.e., EDPS).

Material & methods

Search Strategy and Study Selection

A systematic review and meta-analysis were conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Checklist (Moher et al., 2016). Electronic database searches (PubMed, Web of Science, Scopus, SPORTDiscus and Google Scholar) were conducted up to April 2022 using a combination of keywords: 'postpartum', 'postnatal', 'perinatal', 'puerperium', 'post-pregnancy', 'motherhood', 'after delivery', 'postpartum period', 'aerobic', 'exercise', 'physical exercise', 'physical activity', 'exercise training', 'exercise test', 'exercise therapy', 'exercise movement techniques', 'postpartum exercise', 'postnatal exercise', 'postpartum depression', 'depression', 'depressed', 'postpartum depressed', 'postnatal depression', 'postnatal depressed', 'depressive disorder', 'postpartum depressive disorder' and 'postnatal depressive disorder'. Following the removal of duplicates, a total of 20 trials in 11 studies successfully met the eligibility criteria, which included: research manuscripts written in English; the subjects were physically healthy adult women; the subjects were screened for probable depression using EPDS instrument and received an EDPS score of ≥ 10; and an exercise-based intervention in a community or clinical context (either supervised, unsupervised, coaching-based, motivational, behavioural-oriented, universal, targeted or treatment based) was conducted up to 6 months postpartum (Linoby, Md Yusof, et al., 2020). The identification of potentially eligible articles according to our inclusion and exclusion criteria was accomplished by three authors (I.N., A.L., R.A.L.) in the subsequent steps.

Data Extraction and Quality Assessment

Full articles of potentially relevant studies were retrieved for extensive evaluation using a standardised eligibility form (Poyatos-León et al., 2017). In case of disagreement among reviewers regarding a study's eligibility, a discussion would ensue until a mutual decision is reached. Information was retrieved from each paper, including participant characteristics, study design, exercise characteristics, co-interventions, control group details, postpartum depression assessment score and outcomes of interest.

Evaluation of the quality of each article was performed by three authors (i.e., I.N., A.L., M.N.) using forms adapted from the Cochrane risk of bias tool for intervention studies (Higgins et al., 2011). These assessments consider the quality of exposure and outcome measurements, the representativeness of the study population and the treatment of missing values. For intervention studies, an assessment was conducted on whether: (a) studies were randomised, (b) a randomisation sequence was generated and (c) an analysis on the intention to treat was performed. To calculate the mean quality score of intervention research, studies were converted to a score out of 17. Studies with quality scores lower than 7 (< 25% quintile) are considered to present a "high risk of bias". Those ranging from 7 to 11 represent a "moderate risk of bias", and those with a score greater than or equal to 12 (> 75% quintile) are "low risk of bias".

Statistical Analysis

The effect size of post-interventions was computed, comparing various exercise interventions with all types of control. Subgroup analyses were performed to compare exercise intensity (low vs. moderate intensity), the timing of when the exercise intervention was delivered (≥ 3 months vs. 3 to 6 months) and the exercise supervision status (supervised vs. unsupervised exercise group). The heterogeneity of the treatment effect between studies was statistically evaluated using a Q-test (presence of variation between pooled effect size) and I^2 statistic (degree of heterogeneity). The benchmarks of the I^2 value were interpreted as unimportant/very low heterogeneity (0%–40%), moderate heterogeneity (30%–60%), substantial heterogeneity (50%–90%) and considerable heterogeneity (75%–100%) (Sterne et al., 2011). Estimating the mean summary weighted effect was conducted using fixed-effects model data analyses. The standardised mean difference (SMD) and its 95% confidence interval (CI) were calculated using the Comprehensive Meta-Analysis (CMA; version 3.3.070, Biostat Inc, New Jersey, USA). Forest plot probing was applied to determine any 'patterns' in the data.

Results

Our database search resulted in the identification of 6105 potentially relevant articles. After removing duplicate titles, we were left with 3774 articles. Following a full-text assessment of eligibility criteria outlined earlier, we identified 11 publications describing 19 different trials that fit our criteria for inclusion in the meta-analysis. The main reasons for the exclusion of screened articles include an intervention conducted after 6 months postpartum and an EDPS score of ≤ 9.

Meta-analyses

As shown in Figure 1, the present study found a significant reduction in postpartum depression scores (as evaluated by the EPDS) in favour of exercise intervention rather than the control group. The overall effect size yielded an average standardised mean difference (SMD) of -0.28 (95% CI: −0.38 to −0.18, p<0.001), indicating that exercise intervention provides a small yet significant reduction in depression scores as compared to the control group.

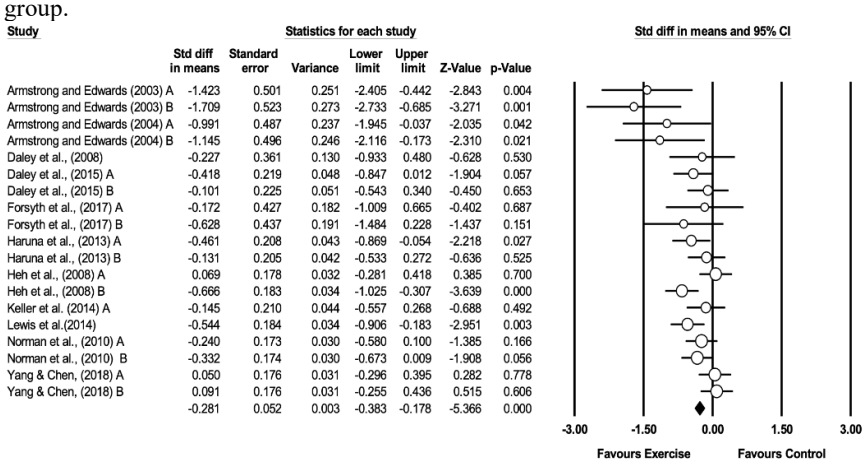

Fig. 1. Forest plot and overall effect size estimates for the effectiveness of exercise-based interventions in ≤ 6 months postpartum assessed via the EDPS score

*Subgrou*p *Analysis*

The timing of when the exercise intervention was delivered during the postpartum period was compared between ≤ 3 months (Armstrong & Edwards, 2003, 2004; Daley et al., 2008; Norman et al., 2010; Yang & Chen, 2018) and 3 to 6 months (Daley et al., 2015; Forsyth et al., 2017; Haruna et al., 2013; Heh et al., 2008; Keller et al., 2014; Lewis et al., 2014). The subgroup analysis revealed that the effect size for the ≤ 3 months group (SMD = –0.45 [95% CI: −0.77 to −0.13], p<0.01) was slightly higher compared to the 3 to 6 months postpartum group (SMD = –0.31 [95% CI: −0.50 to −0.14], p<0.001).

The exercise intensity was also compared between low intensity (Daley et al., 2008; Daley et al., 2015; Haruna et al., 2013; Heh et al., 2008; Keller et al., 2014; Lewis et al., 2014; Norman et al., 2010; Yang & Chen, 2018) and moderate intensity (Armstrong & Edwards, 2003, 2004; Forsyth et al., 2017). The subgroup analysis revealed that the effect size for the moderate-intensity exercise group (SMD = –0.96 [95% CI: −1.41 to −0.50], p<0.001) yielded a substantially greater effect size compared to the low-intensity exercise group (SMD = –0.23 [95% CI: −0.37 to −0.09], p<0.01).

The exercise supervision status was compared between supervised (Armstrong & Edwards, 2003, 2004; Forsyth et al., 2017; Haruna et al., 2013; Keller et al., 2014; Norman et al., 2010) and unsupervised exercise intervention (Daley et al., 2008; Daley et al., 2015; Lewis et al., 2014; Yang & Chen, 2018). The subgroup analysis for the supervised exercise intervention revealed a significant change in the EDPS score. The supervised exercise intervention group (SMD = –0.44 [95% CI: −0.65 to −0.22], p<0.001) had greater effect size than the unsupervised exercise intervention group (SMD = –0.18 [95% CI: −0.40 to −0.05], p=0.13).

Publication Bias

Visual inspection of the funnel plot revealed asymmetrical data, indicating publication bias. The Begg rank correction test and Egger linear regression also found indications of publication bias among the studies that examined the influence of exercise on EDPS scores (Begg, p=0.01; Egger, p=0.01). Since the evidence of bias can be due to inadequate statistical power, the present study applied a non-parametric method, Duval and Tweedie's trim and fill test, and estimated 4 possible missing studies. The estimated effect size of SMD, including the "missing" studies, were not substantially different from our adjusted estimates for missing studies: SMD = 0.23 (95% CI: -0.33 to -0.13). Heterogeneity analysis was conducted to examine the homogeneity status in terms of changes in the EDPS score. A moderate heterogeneity was evident in all included trials ($p<0.001$; I^2 = 54.7%). However, the source of heterogeneity in these three subgroups may be due to related co-variates, such as exercise duration, the intensity of exercise and supervision status.

Study Quality

The study quality was assessed using the Cochrane risk of bias tool for intervention studies. The resulting scores ranged between 8 to 14 out of a total of 17 (mean ± standard deviation: 12.0 ± 2.6, with a median of 12.2). This indicates a global 'low risk of bias' in all eligible studies.

Discussion

This meta-analysis found a statistically significant, moderate treatment effect (SMD = −0.28) of exercise intervention on controlling symptoms of depression in women up to 6 months after childbirth. Overall, the current analysis supports that exercise intervention can help manage postpartum depression levels during the short-term postpartum period of ≤ 6 months.

Regular exercises are well known to provide various benefits. They help manage the feeling of melancholy and improve the mood, enhance cognitive (Nordin et al., 2021) and physical fitness (Linoby, Nurthaqif, et al., 2020), reduce weight (Borg-Stein et al., 2011; Linoby, Jumat, et al., 2020) and manage blood pressure (Jumat et al., 2021). Changes in hormones and body image can positively affect the feeling of self-worth in postpartum women (Airin et al., 2014; Cioffi et al., 2010). Many physiological changes associated with pregnancy continue for more than 20 weeks post-delivery. Since the postpartum period may be challenging for women trying to manage weight and maintain physical activity, these issues must be addressed (Gaston & Cramp, 2011). Introducing exercise intervention is likely to have additional physical and physiological benefits alongside the psychological effect of reducing the symptoms of depression.

The subgroup analyses confirmed that exercise-based interventions for at-risk women with a history of depression or heightened depressive symptoms during <6 months postpartum would be more helpful than general preventative programs. The previous recommendation was a gradual and progressive return to exercise, starting with low to moderate intensity aerobic-based exercises (McCurdy et al., 2017). Continuing postpartum exercise-based activity must be customised since some women may return to being active within days after birth, while others may have medical or physical limitations that make such a return a lengthy process (Borg-Stein et al., 2011).

The current meta-analysis contributes to the literature by providing up-to-date data on the effect of exercise intervention of different intensities (low vs. moderate) on the short-term postpartum period. The subgroup analyses confirmed that intervention using predominantly moderate exercise intensity produced a substantially larger effect size than intervention using only low-intensity exercise. Mücke et al. (2018) validated the current conclusion that those who regularly engage in moderate exercise may have a more favourable physiological and psychological response. Stress hormones, such as catecholamines (i.e., epinephrine and norepinephrine) and cortisol, are strongly influenced by daily physical activity, among other factors. When catecholamine receptors on leukocytes are activated in response to psychological stress, catecholamines and cortisol may promote a cognitive environment that negatively affects the mood, resulting in depressed behaviours (Bozoky & Corwin, 2002). It is believed that the number of changes in catecholamines and cortisol caused by physical exercise may result in mood changes. This may also depend on the intensity of the exercise performed (Goodman, 2004). Although most included studies were classified as lower intensity, the present study found that moderate exercise intensity presents a higher reduction in depression scores. Thus, the current outcomes seem to support intervention that focus on moderate exercise intensity.

The findings of the subgroup analysis in the current study indicate that the timing of exercise intervention (i.e., ≤ 3 months vs. 3 to 6 months postpartum) resulted in a marginal difference in effect size between the subgroups. The ≤ 3 months subgroup yielded a slightly larger effect size than the 3 to 6 months postpartum subgroup. Previous research finds that the development of postpartum depression is typically progressive and insidious during the first 3 months (Heh et al., 2008). Similar periods have been described in several reviews (Brummelte & Galea, 2016; Payne & Maguire, 2019). Women and their families frequently miss the start of postpartum depression. The postpartum transition phase is when women may be at a higher risk for anxious and depressed mood states due to the physical and mental demands of childbirth. This supports the

current finding that exercise intervention during the earlier postpartum period is expected to have a greater impact on reducing postpartum depressive symptoms than exercise programs introduced in the later stage.

The key finding of the current study is that exercise supervision status significantly influences the efficiency of exercise intervention. In the subgroup analysis, supervised exercise intervention revealed a significant change in EDPS score, but not for the unsupervised exercise intervention group (supervised group SMD = –0.44 [95% CI: −0.65 to −0.22], p<0.001 vs. unsupervised group SMD = –0.18 [95% CI: −0.40 to −0.05], p=0.13). Ko et al. (2008) examined the influence of supervised physical exercise on the degree of depression and fatigue in pregnant women. The intervention group demonstrated a significant improvement in lethargy compared to the control group (Ko et al., 2008). Supervised exercise has a more significant impact on depressive symptoms than unsupervised exercise. This suggests that the observed intervention benefit of exercise may likely be attributed to group support. However, the available supervised intervention research greatly adhered to fitness regimens which may be a significant factor (McCurdy et al., 2017). When recommending exercises to women with postpartum depression, acceptability and adherence to exercise regimens are crucial factors to consider.

Several limitations are present in the current study. Potential publication bias is a factor that must be taken seriously since it can easily exaggerate the effect or even simulate a therapeutic effect where none exists. It is impossible to rule out the prospect of publication bias due to the shape of the funnel plot. The asymmetry can be due to inconsistent exercise intervention procedures. Several studies found that most exercise interventions lack structured protocols, such as self-guided exercise intervention with minimum supervision. However, the potential influence of publication bias should be considered when interpreting the results.

Conclusions

The findings of this meta-analysis indicate that exercise intervention during the first 6 months post-delivery is likely to improve depression, as measured by the Edinburgh Postnatal Depression Scale. Estimation using random-effects meta-analysis indicated a significant reduction in postpartum depression scores for the exercise intervention group compared to the control group. Subgroup analyses revealed that exercise supervision status and exercise intensity considerably affect the success of intervention in lowering the EDPS score, with less influence on the timing of intervention. However, the present analyses also suggest that the advantage of exercise intervention depends on the exercise intensity, the timing of exercise intervention and the exercise supervision status. Currently, only a handful of studies had examined the effect of structured exercise intervention on short-term (i.e., after delivery up to 6 months) postpartum depression in women. The lack of adequate replication of certain variables prevents the generalisation of the results achieved in the current study. However, the currently available evidence may support the use of exercise intervention to reduce the risk of postpartum depression during the short-term postpartum period. Greater prevention effect is possible with the implementation of a supervised exercise program of low to moderate exercise intensity progression.

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Conflicts of interest - There is no conflict of interest.

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