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Effects of Pilates in Reducing Depression, Anxiety, and Stress in Pregnant Women: A Systematic Review and Meta Analysis

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Abstract

Pregnancy is often accompanied by significant psychological challenges, including increased risk of depression, anxiety, and stress, which can adversely affect both maternal and fetal outcomes. Non-pharmacological interventions such as Pilates have been proposed as effective strategies to improve mental health during pregnancy. This systematic review and meta-analysis aimed to evaluate the effectiveness of Pilates in reducing depression, anxiety, and stress among pregnant women. Quality assessment was performed using the Cochrane RoB 2.0 tool and meta-analysis was conducted using RevMan 5.4. This study assessed mental illness symptom including depression, anxiety, and stress to evaluate the effect of pilates over periods of 8 to 12 weeks. A search across seven databases identified five articles for analysis, with five low-risk. The meta-analysis shows that pilates interventions, compared to control or usual care, significantly reduced symptoms of depression (SMD: -2.70; 95% CI: -3.27 to -2.13), anxiety (SMD: -1.19; 95% CI: -1.58 to -0.80), and stress (SMD: -6.62; 95% CI: -8.11 to -5.13), all with $p<0.00001$. High heterogeneity was observed for each outcome ($I^2=75–89\%$). This result suggest that pilates can be good exercise to reduce mental illness in pregnant women. Pilates is an effective, safe, and accessible intervention for reducing depression, anxiety, and stress in pregnant women, with additional physical and obstetric benefits. Future research should focus on standardizing intervention protocols, expanding to more diverse and high-risk populations, and assessing long-term outcomes to further inform clinical practice.

Keywords: pilates, pregnant, depression, anxiety, stress.

INTRODUCTION

Pregnancy is a unique physiological state characterized by profound anatomical, hormonal, and psychological changes, requiring significant adaptation from women (Glover, 2014). While many women navigate this period successfully, a substantial proportion experience psychological distress, including depression, anxiety, and stress, which can have far-reaching effects on both maternal and child health (Glover, 2014; Dunkel Schetter & Tanner, 2012; Cantwell, 2021). Mental illnesses such as depression and anxiety are common in pregnancy, with prevalence rates for antenatal depression ranging from 15% to 20% and for anxiety disorders around 15%, with higher rates in low- and middle-income countries (Cantwell, 2021). These conditions are not only under-recognized and underdiagnosed but are also associated with adverse outcomes, including increased risk of preterm birth, low birth weight, impaired fetal neurodevelopment, and even maternal mortality, with suicide remaining a leading cause of maternal death in some settings (Glover, 2014; Dunkel Schetter & Tanner, 2012; Cantwell, 2021).

The threat of mental illness during pregnancy extends beyond the immediate well-being of the mother. Evidence from prospective studies demonstrates that maternal depression, anxiety, and stress during pregnancy can increase the risk for a wide range of adverse outcomes in the child, including emotional and behavioral problems, symptoms of attention deficit hyperactivity disorder, impaired cognitive development, and altered physiological outcomes such as lower birth weight and preterm delivery (Glover, 2014; Dunkel Schetter & Tanner, 2012). These effects are thought to be mediated in part by biological mechanisms such as dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, increased exposure of the fetus to maternal cortisol, and changes in placental function, as well as by epigenetic modifications (Glover, 2014; Dunkel Schetter & Tanner, 2012). Chronic stressors, such as social disadvantage, racism, and poor social support, further compound these risks (O'Hara & Wisner, 2014; Pawluski, 2019; Van den Bergh et al., 2020).

Management of depression, anxiety, and stress in pregnancy involves both pharmacological and non-pharmacological approaches. Antidepressant medications, particularly selective serotonin reuptake inhibitors (SSRIs), are effective but must be prescribed with caution due to potential risks such as fetal malformations and neonatal adaptation syndrome, though recent evidence suggests these risks may be lower than previously thought (Cantwell, 2021). Mood stabilizers like lithium and valproate require careful risk-benefit assessment due to teratogenic potential (Dunkel Schetter & Tanner, 2012; Cantwell, 2021). Non-pharmacological interventions, including cognitive-behavioral therapy (CBT), interpersonal therapy, and various forms of exercise, have demonstrated efficacy in reducing symptoms and improving maternal well-being (Glover, 2014; Farren et al., 2020). Psychological therapies are particularly valuable for women with mild to moderate symptoms or those who prefer to avoid medication.

Among non-pharmacological interventions, Pilates has emerged as a promising option for addressing psychological distress in pregnant women. Pilates is a mind-body exercise method that emphasizes core stability, controlled breathing, and body awareness, and has been adapted for clinical and prenatal use (Biçki & Kartal, 2024; Aktan et al., 2021; Haseli et al., 2024). Randomized controlled trials and systematic reviews have shown that Pilates, when performed regularly during pregnancy (typically two sessions per week for eight weeks), can significantly reduce symptoms of depression, anxiety, and stress. For instance, a study by Aktan et al. (2021) found that pregnant women who participated in clinical Pilates combined with childbirth training experienced lower anxiety levels, less weight gain, and reduced pain during labor compared to those who received only childbirth training or no intervention. Similarly, Biçki and Kartal (2024) demonstrated that Pilates exercises led to a statistically significant reduction in pregnancy-related stress, including aspects related to seeking safety, body image, and social support. Bulguroglu and Bulguroglu (2024) further reported that online Pilates interventions effectively reduced depression, anxiety, and fear of childbirth, with moderate effect sizes, compared to control groups.

The mechanisms by which Pilates exerts these beneficial effects are multifaceted. Physiologically, Pilates may reduce stress by lowering cortisol levels and promoting endorphin release, thereby improving mood and sleep quality. The focus on breathing and relaxation techniques inherent in Pilates helps regulate the autonomic nervous system, reducing sympathetic arousal and enhancing parasympathetic activity, which is associated with reduced anxiety and improved emotional regulation. Psychologically, Pilates enhances body awareness, self-efficacy, and perceived control, all of which are protective against depression and anxiety in pregnancy. Socially, participating in group Pilates sessions can provide peer support and reduce feelings of isolation, further contributing to improved mental health.

METHOD

Study Design

This meta-analysis and systematic review was conducted based on the PRISMA framework and the Cochrane Handbook for Systematic Reviews of Interventions version 6.3, 2022 (Higgins et al., 2019; Sterne et al., 2019).

Search Strategy

The data used in this review were obtained from the PubMed, Scopus, ProQuest, Google Scholar, and Cochrane CENTRAL databases. This literature review includes data collected up to May 13, 2025, using Boolean operators to identify valid and reliable journals according to predetermined criteria (Table 1).

Table 1. Literature search keywords

Database	Keywords.
PubMed, Scopus, ProQuest, Google Scholar, and Cochrane CENTRAL	("Pilates") AND ("Mental illness" OR "Depression" OR "Anxiety" OR "stress") AND ("pregnancy" OR "pregnant")

Study Eligibility Criteria

Inclusion and exclusion criteria were determined to ensure that the data were specific and relevant before the literature search. Inclusion criteria included: 1) Population: pregnant women aged 18–65 years; 2) Intervention: *Pilates*, both online and offline; 3) Comparator: control group with no treatment; 4) Outcome: mental illnesses including depression, anxiety, and stress; and 5) Study design: clinical trials such as randomized controlled trials. Meanwhile, the exclusion criteria consisted of: 1) incomplete text articles; 2) language incompatibility; and 3) incomplete reporting of results. Additionally, articles that were not available online, as well as those focusing on preclinical or *in vivo* research, were excluded. The authors independently assessed each study for eligibility, resolving any disagreements through discussion and mutual agreement. Inclusion criteria were based on the *PICOS* framework, as listed in Table 2.

Table 2. Inclusion criteria based on PICOS

Population	Intervention	Comparison	Outcome	Study Design
Pregnant women 18-65 years	Pilates based on online and offline	Control group who don't have any treatment	Mental illness including depression, anxiety, and stress using several instrument such as DASS-21, HADS-A, HADS-D, HAM-D, CES-D, PSQ-9, PSS, and GAD-7.	Clinical trial such as randomized controlled trial

Abbreviation: DASS-21, Depression Anxiety Stress Scales-21; HADS-A, Hospital Anxiety and Depression Scale – Anxiety subscale; HADS-D, Hospital Anxiety and Depression Scale – Depression subscale; HAM-D, Hamilton Depression Rating Scale; CES-D, Center for Epidemiologic Studies Depression Scale; PHQ-9, Patient Health Questionnaire-9; PSS, Perceived Stress Scale; GAD-7, Generalized Anxiety Disorder-7.

Data Extraction

The data extracted from the studies included in this literature review consisted of: (1) author and year of publication; (2) study characteristics and setting; (3) study population, including sample size and subject type; (4) intervention and control, including duration of administration and follow-up; and (5) study outcomes. Study characteristics were assessed qualitatively by four authors, while other authors double-checked the retrieved data for use in the review.

Quality Assessment and Publication Bias

The risk of bias (RoB) was analyzed using the Revised Tool RoB 2.0, which consists of five domains for studies that are randomized controlled trials (RCTs) (Sterne et al., 2019). The results of the analysis were then recorded in the bias domain file (.xlsx) and uploaded to the ROBVIS website to obtain graphical results.

Quantitative Data Analysis

The data obtained were evaluated as standardized mean difference (SMD) with their respective standard deviations, categorized as continuous data types with 95% confidence

intervals (CI) for analysis. A fixed-effects model was employed to account for similar population characteristics and interventions across studies. The SMD and 95% CI for each study were visually represented in a forest plot, illustrating effect sizes and variability. This plot enabled the identification of heterogeneity among studies when comparing the effectiveness of Pilates and control groups. The main outcomes guiding the reviewers in the statistical analysis were depression, anxiety, and stress, by comparing the mean and standard deviation of follow-up in both groups. The I^2 statistic was used to analyze heterogeneity, with cut-off criteria of 0--25% (not significant), 26--50% (low), 51--75% (medium), and 76--100% (high) (Higgins et al., 2019).

RESULTS AND DISCUSSION

Study selection process and characteristics of the included studies

The database search consisting PubMed, Scopus, ProQuest, Google Scholar, and Cochrane CENTRAL yielded 2000 articles. The articles were exported and followed by duplication removal. The authors screened articles by going through the title and abstracts. Following a screening of titles and abstracts, 1729 studies were removed, and after that 226 studies were excluded. Finally, 5 studies were included for qualitative and quantitative analysis studies with a total 181 participants consisting of an intervention group and a control group (Biçki & Kartal, 2024; Aktan et al., 2021; Bulguroglu & Bulguroglu, 2024; Kim & Hyun, 2022; Yıldırım et al., 2023). The screening and selection process is summarized in the PRISMA schematic diagram in Fig 1. The studies were conducted in Turkey and South Korea with the intervention in the use of pilates while the control used usual care. Outcomes were measured using depression, anxiety, and stress. Detailed characteristics of the included studies and study outcome are listed in Table 3 and Table 4.

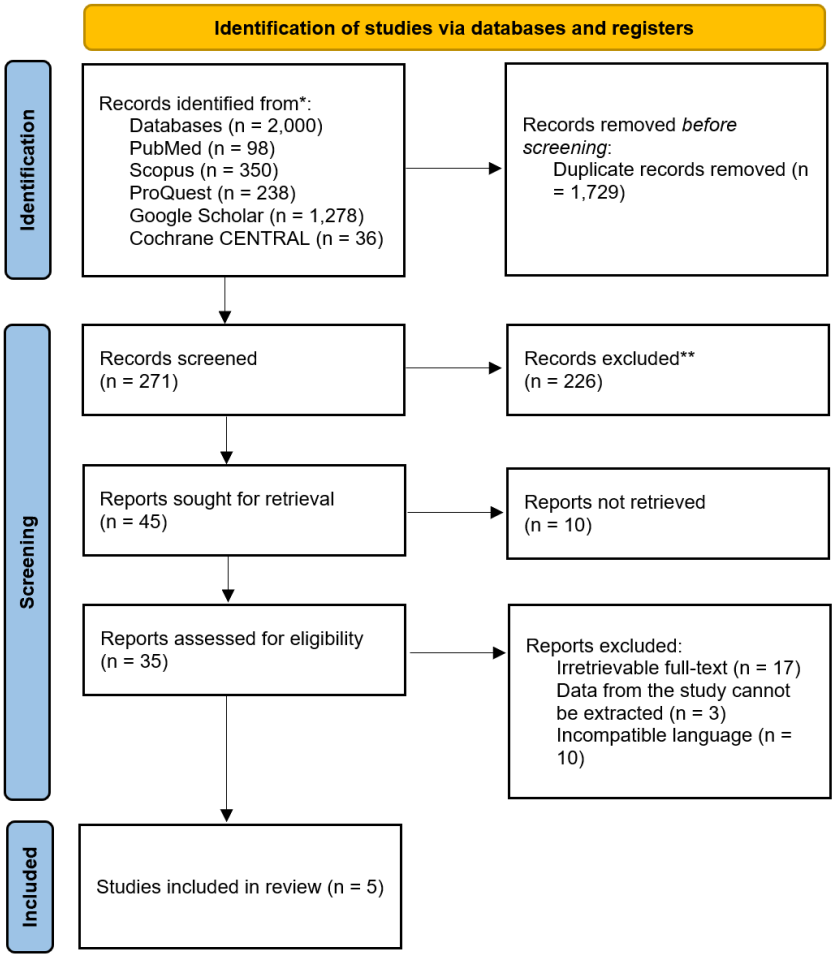

Fig 1. PRISMA schematic diagram for the screening and selection of eligible studies

Quality assessment

Qualitative analysis was performed on all studies, with 5 RCT studies were analyzed using RoB 2.0. The risk of bias (RoB) 2.0 quality assessment was employed to assess the quality of the included randomized controlled trials, where the results are presented in Figure 2 and Figure 3. All studies are of low risk of bias and indicate 100% being low risk. The risk of bias itself assessed five different domains, including the bias arising from the randomization process, bias due to deviations from intended interventions, bias due to missing outcome data, bias in measurements outcome, and bias in the selection of the reported result.

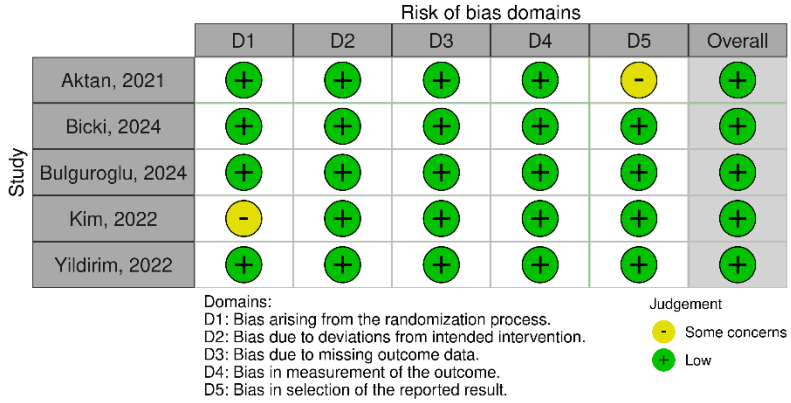

Fig 2 Results of risk of bias quality assessment using the Risk of Bias (RoB) 2.0 for randomized controlled trials included in this systematic review and meta-analysis.

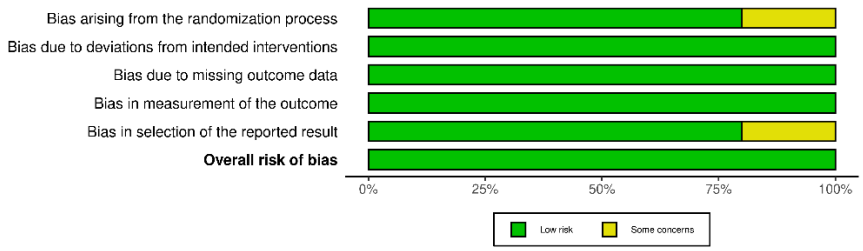

Fig 3 Percentage of the quality assessment according to the five domains using RoB-2 tools from Cochrane.

Depression

Three studies reported depression of pilates vs control group with 100 pregnant patients (Fig 4) (Bulguroglu & Bulguroglu, 2024; Kim & Hyun, 2022; Yıldırım et al., 2023). The result suggests that pilates can reduce depression symptom significantly compared to control group (SMD: -2.70; 95% CI: -3.27 to -2.13; p<0.00001). Heterogeneity among the studies was high and statistically significant (I^2=75%; p=0.02). Thus, it can be concluded that pilates can be the best activities for reducing depression symptom in pregnant patients.

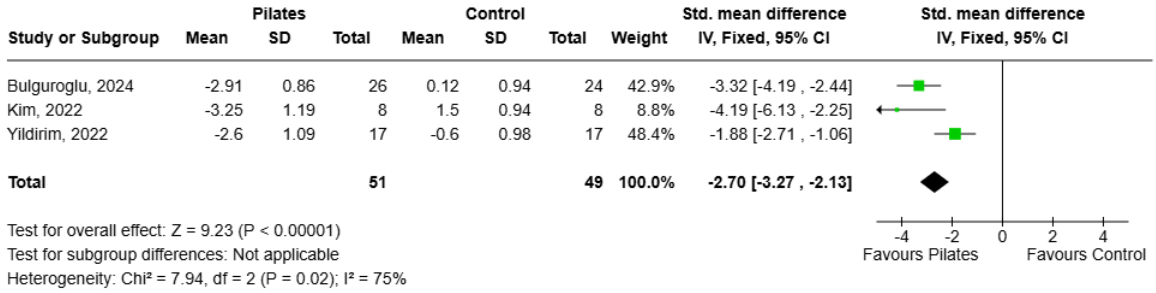

Fig 4. Forest plot of pilates vs control group based on depression.

Anxiety

Three studies reported anxiety of pilates vs control group with 126 pregnant patients (Fig 5) (Aktan et al., 2021; Bulguroglu & Bulguroglu, 2024; Yıldırım et al., 2023). The result suggests that pilates can reduce anxiety symptom significantly compared to control group (SMD: -1.19; 95% CI: -1.58 to -0.80; p<0.00001). Heterogeneity among the studies was high and statistically significant (I^2=75%; p=0.02). Thus, it can be concluded that pilates can be the best activities for reducing anxiety symptom in pregnant patients.

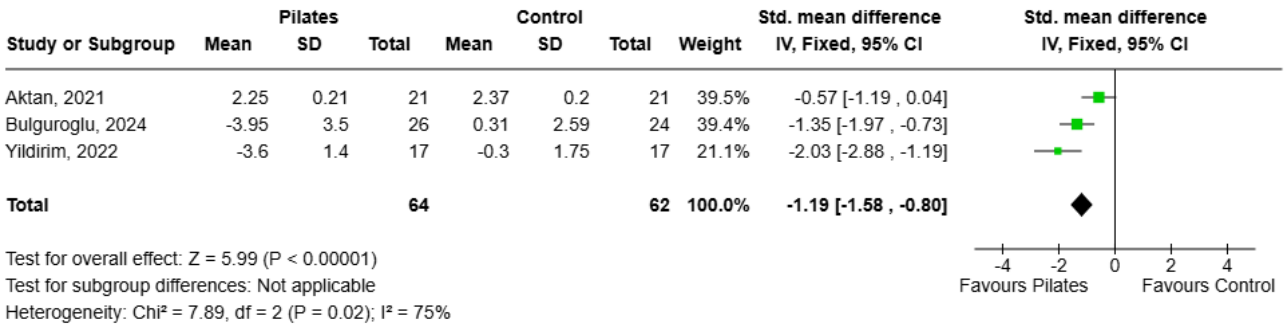

Fig 5. Forest plot of pilates vs control group based on anxiety.

Stress

Two studies reported stress of pilates vs control group with 56 pregnant patients (Fig 6) (Biçki & Kartal, 2024; Kim & Hyun, 2022). The result suggests that pilates can reduce stress symptom significantly compared to control group (SMD: -6.62; 95% CI: -8.11 to -5.13;

p<0.00001). Heterogeneity among the studies was high and statistically significant (I^2=89%; p=0.002). Thus, it can be concluded that pilates can be the best activities for reducing anxiety stress in pregnant patients.

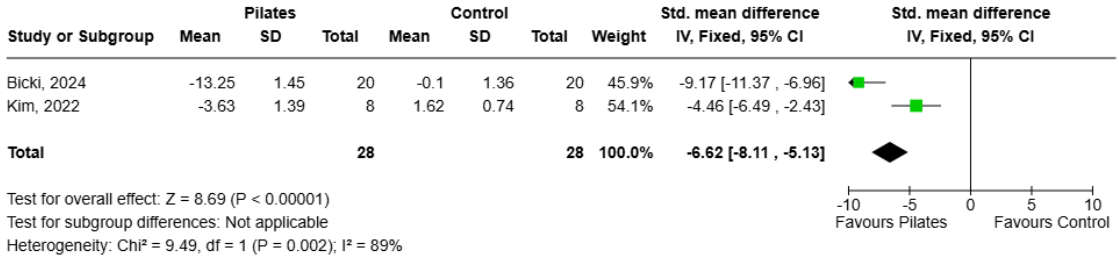

Fig 6. Forest plot of pilates vs control group based on anxiety.

Table 3. Characteristic of the included studies.

No	Author, year	Study Design	Center, Country	Population			Intervention	Control	Duration of treatment	Follow-up
				Gestational Age	Patient	Age				
1	Aktan, 2021(Aktan et al., 2021)	RCT	Single center, Turkey	NA	Intervention: 21 Control: 21	Intervention: 27.52±3.88 Control: 25.5±4.19	Pilates group	Control group	Warm-up phase of 10 mins, the main exercise program for 30-40 mins, and the cooling-down phase of 10 mins, performed for 1 hour a day, 2 days a week for 8 weeks	8 Weeks
2	Bicki, 2024(Bicki & Kartal, 2024)	RCT	Single center, Turkey	1-9 Months	Intervention: 20 Control: 20	Intervention: 28.05 ± 2.81 Control: 28.45 ± 2.39	Pilates group	Control group	Pilates exercises were applied by a physiotherapist for a total of 16 sessions, 2 sessions per week, for 8 weeks. All individuals in the. Pilates group were taught pre-exercise stabilization training and the principles of Pilates. Posture exercises, mat pilates exercises, breathing exercises, and strengthening exercises were varied to suit the pregnant woman and	8 Weeks

No	Author, year	Study Design	Center, Country	Population			Intervention	Control	Duration of treatment	Follow-up
				Gestational Age	Patient	Age				
									applied for 10 repetitions	
3	Bulguroglu, 2024(Bulguroglu & Bulguroglu, 2024)	RCT	Single center, Turkey	Intervention: 17 (14–20) Control: 16 (13–19)	Intervention: 26 Control: 24	Intervention: 27 (25–31) Control: 28 (27–30)	Online pilates group	Control group	One-hour program was arranged as a warm-up, pilates exercises, and a cool-down program. One hour twice a week for eight weeks	8 Weeks
4	Kim, 2022(Kim & Hyun, 2022)	RCT	Single center, Korea	NA	Intervention: 8 Control: 8	Intervention: 39.71 (2.01) Control: 38.14 (1.39)	Pilates group	Control group	Exercise using a real-time remote chat application (ZOOM). The Pilates program consisted of a warm-up, main exercise, and cool-down. It was conducted for eight weeks, twice a week, 50 min a day.	8 Weeks
5	Yildirim, 2022(Yıldırım et al., 2023)	RCT	Single center, Turkey	Intervention: 19.1±3.5 Control: 17.2±1.8	Intervention: 17 Control: 17	Intervention: 30.8±7.0 Control: 28.8±5.6	Pilates group	Control group	Twice a week for 60-min per session for 12 weeks by an experienced Pilates instructor. The exercise program was performed based on traditional Pilates principles, including centering, control, precision, concentration, breath, and flow	12 Weeks

Abbreviation: RCT, Randomized Controlled Trials

Table 4. Outcome of the included studies.

No	Author, year	Depression		Anxiety		Stress	
		Intervention	Control	Intervention	Control	Intervention	Control

1	Aktan, 2021(Aktan et al., 2021)	NA	NA	Mean Change: 2.25±0.21	Mean Change: 2.37±0.20	NA	NA
2	Bicki, 2024(Biçki & Kartal, 2024)	NA	NA	NA	NA	Pre: 50,35 ± 2,90 Post: 37,10 ± 1,88	Pre: 49,35 ± 3,04 Post: 49,25 ± 3,05
3	Bulguroglu, 2024(Bulguroglu & Bulguroglu, 2024)	Pre: 8.23 ± 1.98 Post: 5.32 ± 1.84	Pre: 7.67 ± 1.94 Post: 7.79 ± 1.32	Pre: 35.13 ± 7.66 Post: 31.18 ± 5.84	Pre: 36.62 ± 3.13 Post: 36.93 ± 5.03	NA	NA
4	Kim, 2022(Kim & Hyun, 2022)	Pre: 20.12 ± 2.74 Post: 16.87 ± 2.53	Pre: 20.87 ± 2.16 Post: 22.37 ± 1.93	NA	NA	Pre: 18.50 ± 2.97 Post: 14.87 ± 3.18	Pre: 20.75 ± 1.66 Post: 22.37 ± 1.30
5	Yildirim, 2022(Yıldırım et al., 2023)	Pre: 5.5±2.5 Post: 2.9±2.3	Pre: 5.9±2.2 Post: 5.3±2.2	Pre: 7.4±3.2 Post: 3.8±3.0	Pre: 7.9±4.0 Post: 7.6±3.8	NA	NA

Discussion

The present systematic review and meta-analysis demonstrate that Pilates interventions are effective in reducing depression, anxiety, and stress among pregnant women compared to control groups. The pooled results from five randomized controlled trials (RCTs) involving 181 participants showed significant improvements in all three psychological outcomes: depression (SMD: -2.70; 95% CI: -3.27 to -2.13; $p<0.00001$), anxiety (SMD: -1.19; 95% CI: -1.58 to -0.80; $p<0.00001$), and stress (SMD: -6.62; 95% CI: -8.11 to -5.13; $p<0.00001$). However, high heterogeneity was observed for each outcome ($I^2=75\%$ for depression and anxiety; $I^2=89\%$ for stress), indicating variability in intervention protocols, populations, or measurement tools across studies. The included studies, as detailed in Tables 3 and 4, consistently favored Pilates over control for psychological outcomes, supporting the robustness of these findings.

The meta-analysis found that Pilates significantly reduced depression symptoms in pregnant women compared to controls (SMD: -2.70; 95% CI: -3.27 to -2.13; $p<0.00001$; $I^2=75\%$). These results are consistent with previous studies. Kim et al. (2022) reported that an 8-week online Pilates program led to significant reductions in postpartum depression, sleep disorders, and perceived stress, as well as increased serotonin levels, a biomarker linked to improved mood(Kim & Hyun, 2022). Mazzarino et al. (2022) also observed improved quality of life in pregnant women who participated in Pilates, which is closely related to lower depression scores(Mazzarino et al., 2022). Additionally, a meta-analysis by Fleming and Herring (2018) concluded that Pilates reduces depressive symptoms across various populations, including pregnant women(Fleming & Herring, 2018). The mechanisms underlying these benefits may involve the mind-body focus of Pilates, which enhances body awareness, self-efficacy, and emotional regulation(Hyun et al., 2022).

Pilates was also effective in reducing anxiety symptoms (SMD: -1.19; 95% CI: -1.58 to -0.80; $p<0.00001$; $I^2=75\%$). This aligns with findings from Hyun et al. (2022), where home-based tele-Pilates alleviated insomnia and reduced back pain, both of which are closely linked to anxiety in pregnancy (Hyun et al., 2022)(Hyun et al., 2022; Hyun & Jeon, 2020). Nascimento

et al. (2021) found that Pilates improved glycemic control and reduced anxiety in women with gestational diabetes, suggesting that physiological improvements may contribute to psychological benefits(Do Nascimento et al., 2021). The stress-reducing effects of Pilates, which include breathwork and relaxation, are thought to modulate the autonomic nervous system and lower sympathetic arousal, thus reducing anxiety(Do Nascimento et al., 2021; Hyun et al., 2022).

The effect of Pilates on stress was particularly pronounced (SMD: -6.62; 95% CI: -8.11 to -5.13; $p<0.00001$; $I^2=89\%$). Kim et al. (2022) found that Pilates significantly reduced perceived stress scores, which was correlated with increased serotonin levels(Hyun et al., 2022). Ghandali et al. (2021) demonstrated that Pilates during pregnancy reduced labor pain, shortened the duration of labor, and increased maternal satisfaction, all of which can lower stress levels during pregnancy and childbirth(Ghandali et al., 2021). The group-based or instructor-led nature of Pilates may also provide social support, further buffering against stress. These findings are supported by broader literature, which shows that mind-body interventions like Pilates and yoga are effective for stress reduction in perinatal populations.

A major strength of this review is the rigorous methodology, including the use of PRISMA guidelines, comprehensive database searches, and inclusion of only RCTs with low risk of bias. The consistency of findings across diverse settings (Turkey, South Korea, Australia, Brazil, Spain) and delivery modes (online and in-person) increases confidence in the generalizability of results. However, several limitations should be noted. First, the number of included studies and sample sizes were relatively small, which may limit statistical power and generalizability. Second, high heterogeneity was observed for all outcomes, likely due to differences in intervention protocols (duration, frequency, supervision), participant characteristics (gestational age, baseline mental health, comorbidities), and outcome measures. Third, most studies focused on low-risk pregnancies, so results may not extend to high-risk or multiparous populations. Finally, the lack of long-term follow-up limits conclusions about the sustainability of benefits.

CONCLUSION

This systematic review and meta-analysis provide strong evidence that *Pilates* is an effective intervention for reducing depression, anxiety, and stress in pregnant women. Integrating *Pilates* into prenatal care programs can offer significant psychological and physical benefits for pregnant women, supporting both maternal and fetal health. Future research should focus on standardizing intervention protocols, expanding to more diverse and high-risk populations, and assessing the long-term sustainability of these benefits.

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