



The effects of pilates on mental health outcomes: A meta-analysis of controlled trials

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ABSTRACT

Objective: This meta-analysis estimated the population effect size for Pilates effects on mental health outcomes. **Data sources:** Articles published prior to August 2017 were located with searches of Pubmed, Medline, Cinahl, SportDiscus, Science Direct, PsychINFO, Web of Science, and Cochrane Controlled Trial Register using combinations of: Pilates, Pilates method, mental health, anxiety, and depression.

Study selection: Eight English-language publications that included allocation to a Pilates intervention or non-active control and a measure of anxiety and/or depressive symptoms at baseline and after the Pilates intervention were selected.

Data extraction: Participant and intervention characteristics, anxiety and depressive symptoms and other mental health outcomes, including feelings of energy and fatigue and quality of life, were extracted. Hedges' *d* effect sizes were computed, study quality was assessed, and random effects models estimated sampling error and population variance.

Data synthesis: Pilates resulted in significant, large, heterogeneous reductions in depressive ($\Delta = 1.27$, 95%CI: 0.44, 2.09; $z = 3.02$, $p \leq 0.003$; $N = 6$, $n = 261$) and anxiety symptoms ($\Delta = 1.29$, 95%CI: 0.24, 2.33; $z = 2.40$, $p \leq 0.02$; $N = 5$, $n = 231$) and feelings of fatigue ($\Delta = 0.93$, 95%CI: 0.21, 1.66; $z = 2.52$, $p \leq 0.012$; $N = 3$, $n = 161$), and increases in feelings of energy ($\Delta = 1.49$, 95%CI: 0.67, 2.30; $z = 3.57$, $p < 0.001$; $N = 2$, $n = 116$).

Conclusions: Though this review included a small number of controlled trials with small sample sizes and non-active control conditions of variable quality, the available evidence reviewed here supports that Pilates improves mental health outcomes. Rigorously designed randomized controlled trials, including those that compare Pilates to other empirically-supported therapies, are needed to better understand Pilates' clinical effectiveness and plausible mechanisms of effects.

1. Introduction

Population-based and experimental evidence supports the mental health benefits of exercise¹ among otherwise healthy adults,^{2,3} chronically-ill patients^{4,5} and adults with anxiety and depressive disorders.^{6,7} Mental health benefits have been supported for traditional modes of exercise, including aerobic exercise training.^{2,4,5} Emerging evidence has also supported the positive effects of other non-traditional forms of exercise, including yoga,⁸ tai chi and qigong.⁹ However, a paucity of evidence exists on the mental health benefits of these non-traditional modes of exercise.

Pilates, an alternative form of exercise, has been relatively understudied. Its developer, Joseph Pilates, posited that the method may provide a valuable tool for every individual, regardless of age, gender,

capacity or ability to utilise to enhance both physical and mental states.¹⁰ This exercise system is described as low-to-moderate intensity, predominantly floor based mind-body exercise, and addresses core stability, muscular strength, flexibility, breathing and posture.¹¹

Recent systematic reviews support positive effects of Pilates on flexibility, dynamic balance and muscular endurance in healthy populations,¹² and back pain,^{13–15} quality of life, fall prevention, physical fitness and mood states in older populations.^{16,17} In contrast, limited evidence is available regarding mental health benefits. Pilates has been shown to improve depression and mood in elderly and college-aged populations,^{18,19} and sleep quality and quality of life in college students,²⁰ middle-aged,²¹ sedentary,²² and elderly populations.²³ However, no systematic review of controlled trials of the effects of Pilates on anxiety and depressive symptoms has been conducted. Thus, the key

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objective of this systematic review and meta-analysis was to quantify the overall population effect of Pilates on depression and/or anxiety symptoms. A secondary objective was to quantify the overall effect of Pilates on other related mental health outcomes, including feelings of energy and fatigue and dimensions of health-related quality of life (HRQoL) also reported in the included studies.

2. Methods

The systematic review and meta-analysis reported here was conducted according to PRISMA guidelines.²⁴

2.1. Data sources and searches

Articles published prior to August 2017 were identified using the following electronic databases: PubMed, Medline, Cinahl, SportDiscus, Science Direct, PsycINFO, Web of Science and the Cochrane Controlled Trials Register using combinations of – “Pilates”, “Pilates method”, “mental health”, “anxiety”, “depression”, and “controlled trials”. Reference lists of the included studies and available systematic reviews were manually reviewed.

2.2. Study selection/inclusion criteria

Inclusion criteria were (1) peer reviewed publication available in English, (2) allocation to a Pilates intervention or non-active control that lacked exercise training, (3) a depression and/or anxiety symptom outcome measured at baseline and during and/or after the intervention. Excluded studies (1) included Pilates as one part of a multi-component intervention but not include the additional component in the comparison condition, or (2) compared Pilates with an active treatment (pharmacotherapy or exercise). Fig. 1 provides a flowchart of study selection, and Table 1 provides a summary of the included trials.

2.3. Data extraction and quality assessment

The authors extracted data from the included articles. Study quality was assessed using the PEDro checklist.²⁵ This scale has been applied in two recent Pilates systematic reviews,^{12,16} which reported overall low levels of quality for the included studies. Criterion one (eligibility) relates to external validity and is not used in the calculated total PEDro score. A PEDro score of 5 is applied to distinguish between high and low quality.²⁵ Table 2 presents the results of study quality assessment.

2.4. Effect size calculation

Hedges’ *d* effect sizes were calculated by subtracting the mean change in the comparison condition from the mean change in the Pilates condition and dividing by the pooled standard deviation of baseline scores.²⁶ Effect sizes were adjusted for small sample size bias and calculated such that larger improvements in the investigated mental health outcomes (depressive symptoms, anxiety symptoms, feelings of fatigue, feelings of energy, mental health dimensions of HRQoL, Overall HRQoL) resulted in the reported positive effect sizes.²⁶

2.5. Data synthesis and analysis

Using an SPSS macro (SPSS *MeanES*, SPSS 22.0, IBM Corp., Aramont, NY), random effects models were used to aggregate mean effect size delta (Δ).^{26,27} Heterogeneity was examined with the *Q* statistic, percent of observed variance accounted for by sampling error,²⁶ and I^2 , calculated to exam degrees of inconsistency, with low, moderate and high levels indicated if I^2 was 25%, 50%, 75%, across the identified studies.²⁸ Heterogeneity was indicated if Q_{Total} reached a significance level of $p \leq 0.05$ and/or the sampling error accounted for less than 75% of the observed variance.²⁶ Publication bias was addressed by inspection of a funnel plot²⁹ and quantified with rank correlation and

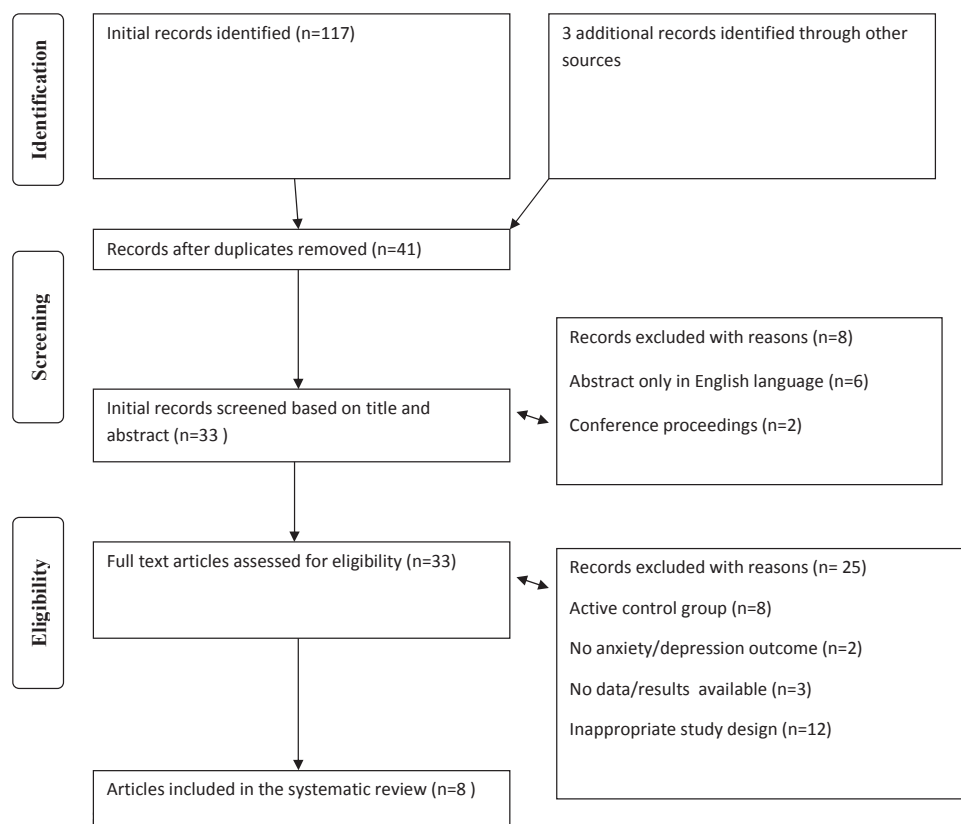


Fig. 1. Meta-Analysis Flow Chart.

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