

Effects of Structured Exercise Interventions on Menstrual Pain Intensity in Primary Dysmenorrhea: A Systematic Review and Meta-Analysis

Primer Dismenorede Yapılandırılmış Egzersiz Müdahalelerinin Menstrual Ağrı Şiddeti Üzerine Etkileri: Sistematik Derleme ve Meta-Analiz

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<https://doi.org/10.5281/zenodo.23672742>

Received / Gönderim: 02.09.2026

Accepted / Kabul: 18.10.2026

Published / Yayın: 25.10.2026

Volume 3, Issue 3, October, 2026

Cilt 3, Sayı 3, Ekim, 2026

How to Cite This Article

APA 7
Gezer, E. & Gezer, H. (2026). Effects of Structured Exercise Interventions on Menstrual Pain Intensity in Primary Dysmenorrhea: A Systematic Review and Meta-Analysis. *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*, 3(3), 957–981.

Vancouver
Gezer E, Gezer H. Effects of Structured Exercise Interventions on Menstrual Pain Intensity in Primary Dysmenorrhea: A Systematic Review and Meta-Analysis. *International Journal of Health, Exercise, and Sport Sciences (IJOSS)*. 2026;3(3):957-981.

Öz

Primer dismenore, günlük işlevselliği ve yaşam kalitesini olumsuz etkileyebilen menstrual ağrı ile karakterize yaygın bir durumdur. Bu sistematik derleme ve meta-analizin amacı, primer dismenoreli kadınlarda yapılandırılmış egzersiz müdahalelerinin menstrual ağrı şiddeti üzerindeki etkisini değerlendirmektir. Derleme PRISMA 2020 bildirimi doğrultusunda yürütülmüş ve PROSPERO'ya prospektif olarak kaydedilmiştir (CRD420261282619). MEDLINE, PubMed, Science Citation Index, Social Sciences Citation Index ve Scopus veri tabanlarında, yapılandırılmış egzersiz müdahalelerini egzersiz içermeyen kontrol koşullarıyla karşılaştıran randomize kontrollü çalışmalar taranmıştır. Yanıllık riski Cochrane Risk of Bias 2 aracıyla, kanıt kesinliği ise GRADE yaklaşımıyla değerlendirilmiştir. Primer meta-analiz için yeterli nicel veri sağlayan 17 randomize kontrollü çalışma analize dahil edilmiştir. Rastgele etkiler meta-analizinde, yapılandırılmış egzersiz grubunda egzersiz içermeyen kontrol koşullarına kıyasla menstrual ağrı şiddetinin anlamlı düzeyde daha düşük olduğu bulunmuştur (Hedges' $g = -2.18$; %95 GA: -3.02 ila -1.33). Çalışmalar arasında yüksek düzeyde heterojenlik saptanmıştır ($I^2 = 92.4$; $\tau^2 = 2.92$). Tek tek çalışmaların çıkarıldığı ve ek duyarlılık analizleri, havuzlanmış etkinin yönünü değiştirmemiştir. Huni grafiği asimetrisi ve Egger regresyon testi olası küçük çalışma etkilerine işaret etmiştir (intercept = -8.78 ; $p = 0.003$). Metodolojik kaygılar, yüksek tutarsızlık ve olası küçük çalışma etkileri nedeniyle kanıt kesinliği çok düşük olarak değerlendirilmiştir. Yapılandırılmış egzersiz primer dismenoreli kadınlarda menstrual ağrı şiddetini azaltabilir; ancak etkinin büyüklüğü dikkatle yorumlanmalıdır. Optimal egzersiz türü ve dozunu belirlemek için standartlaştırılmış egzersiz protokolleri ve sonuç raporlaması kullanan, metodolojik açıdan güçlü randomize kontrollü çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Primer dismenore; Egzersiz; Menstrual ağrı; Fiziksel aktivite; Meta-analiz; Sistematik derleme

Abstract

Primary dysmenorrhea is a common condition characterized by menstrual pain that may adversely affect daily functioning and quality of life. This systematic review and meta-analysis aimed to evaluate the effect of structured exercise interventions on menstrual pain intensity in women with primary dysmenorrhea. The review was conducted in accordance with PRISMA 2020 and prospectively registered in PROSPERO (CRD420261282619). MEDLINE, PubMed, Science Citation Index, Social Sciences Citation Index, and Scopus were searched for randomized controlled trials comparing structured exercise interventions with non-exercise control conditions. Risk of bias was assessed using the Cochrane Risk of Bias 2 tool, and certainty of evidence was evaluated using the GRADE approach. Seventeen randomized controlled trials provided sufficient quantitative data for the primary meta-analysis. Random-effects meta-analysis showed significantly lower menstrual pain intensity with structured exercise compared with non-exercise control conditions (Hedges' $g = -2.18$, 95% CI -3.02 to -1.33). Substantial between-study heterogeneity was observed ($I^2 = 92.4$; $\tau^2 = 2.92$). Leave-one-out and additional sensitivity analyses did not alter the direction of the pooled effect. Funnel plot asymmetry and Egger's regression test indicated potential small-study effects (intercept = -8.78 , $p = 0.003$). The certainty of evidence was rated as very low because of methodological concerns, substantial inconsistency, and suspected small-study effects. Structured exercise may reduce menstrual pain intensity in women with primary dysmenorrhea; however, the magnitude of benefit should be interpreted cautiously. Further well-designed randomized controlled trials with standardized exercise protocols and outcome reporting are needed to determine the optimal exercise modality and dose.

Keywords: Primary dysmenorrhea; Exercise; Menstrual pain; Physical activity; Meta-analysis; Systematic review

<https://www.ijoss.org/Archive/v3-i3/ijoss-Volume3-issue3-03.pdf>

INTRODUCTION

Primary dysmenorrhea (PD) refers to recurrent menstrual pain occurring without an identifiable pelvic disorder and is particularly common among adolescents and young adult women. Its reported prevalence differs widely across populations, but it remains a frequent menstrual health problem during the reproductive years.

Symptoms are not necessarily limited to pelvic or lower abdominal pain; affected individuals may also experience back pain, fatigue, nausea, headache, diarrhea, and other forms of discomfort. Collectively, these symptoms can disrupt everyday activities, school attendance, physical activity, and overall quality of life (American College of Obstetricians and Gynecologists [ACOG], 2018). The biological mechanisms underlying PD are closely linked to changes in endometrial prostaglandin activity during menstruation. Elevated prostaglandin levels can increase uterine contractions and constrict uterine vessels, thereby limiting local blood flow and contributing to ischemic pain.

Other inflammatory substances, including leukotrienes, may also be involved in the occurrence and intensity of menstrual symptoms. These mechanisms provide the rationale for commonly used pharmacological approaches. Non-steroidal anti-inflammatory drugs (NSAIDs) act mainly by inhibiting prostaglandin synthesis, whereas hormonal treatments can reduce symptoms partly through suppression of ovulation (ACOG, 2018). Non-pharmacological approaches have received increasing attention as additional options for managing PD. Among these approaches, exercise is of particular interest because it can be implemented with relatively few resources and may provide health benefits extending beyond menstrual symptom management.

Research in this area has examined a wide variety of exercise approaches, ranging from aerobic and isometric training to stretching, flexibility, core-stability, relaxation-based exercise, yoga, and programs combining several exercise components. However, the available trials differ considerably in how these interventions are prescribed and delivered, including differences in training intensity, session frequency, program duration, supervision, and outcome assessment. Such variation makes it difficult to determine whether the magnitude of pain improvement is consistent across exercise interventions and remains an important consideration when synthesizing the evidence (Armour et al., 2019; Tsai et al., 2024; Zheng et al., 2024).

Evidence supporting exercise for primary dysmenorrhea has also emerged from earlier systematic reviews. In the Cochrane review conducted by Armour et al. (2019), 12 trials comprising 854 women met the inclusion criteria, while quantitative pooling was possible for 10 of these trials. The review suggested a potentially substantial improvement in menstrual pain with exercise relative to no-exercise conditions. However, confidence in this finding was constrained by limitations in the underlying studies, including small samples and marked heterogeneity. Evidence was also insufficient to draw firm conclusions regarding adverse events and several outcomes other than pain. Recent network meta-analyses have provided a broader comparison of exercise approaches for PD. Tsai et al. (2024) analyzed 29 randomized controlled trials with 1,808 participants and compared six exercise categories, including relaxation,

strength, aerobic, yoga, mixed, and Kegel-based interventions. Their findings generally favored exercise for pain relief, although the estimated benefits varied across exercise types and intervention periods. In another network meta-analysis, Zheng et al. (2024) included 49 studies with 3,129 participants and likewise found improvements in PD-related outcomes across several forms of exercise. Importantly, the relative performance of the interventions differed depending on whether the outcome considered was pain intensity, menstrual symptoms, or duration of pain.

Taken together, previous findings suggest that exercise may be beneficial for PD, but they also highlight substantial diversity within the available evidence. Exercise programs differ not only in modality but also in their duration, frequency, supervision, and overall delivery. Differences in study populations, comparator conditions, and methods used to quantify menstrual pain introduce additional sources of variability. Consequently, pooled estimates may reflect effects derived from clinically and methodologically diverse trials rather than a uniform response to exercise. Interpretation is further complicated by the small samples and methodological concerns reported in parts of the literature, underscoring the importance of considering study quality and certainty of evidence alongside the magnitude of pooled effects (Armour et al., 2019; Tsai et al., 2024; Zheng et al., 2024).

Given the diversity and methodological limitations of the existing literature, a contemporary synthesis is needed to clarify the overall evidence regarding exercise and menstrual pain in primary dysmenorrhea. Accordingly, this systematic review and meta-analysis examined menstrual pain outcomes following structured exercise interventions compared with non-exercise control conditions. The review also considered variation across exercise modalities and examined the stability and credibility of the pooled evidence using sensitivity analyses, risk-of-bias evaluation, and assessment of evidence certainty.

MATERIAL and METHOD

Study Design and Registration

This review followed the PRISMA 2020 reporting framework (Page et al., 2021) and focused on the effects of structured exercise on menstrual pain in women with primary dysmenorrhea relative to non-exercise comparators. Before the review procedures were completed, the protocol was prospectively registered with PROSPERO on 10 January 2026 (CRD420261282619). The registration specified the eligibility criteria, outcomes, and principal methodological procedures in advance. Methodological changes made after registration, where applicable, were documented and reported in the review.

Eligibility Criteria

Eligibility was determined using prespecified PICOS components. Participants had to be women of reproductive age with primary dysmenorrhea, with menstrual pain occurring without an identified pelvic disorder. Studies were not eligible when participants had secondary dysmenorrhea related to a gynecological condition, were pregnant, or when the reported population did not allow primary dysmenorrhea to be distinguished from other causes of menstrual or pelvic pain. The intervention of interest

was a structured exercise program intended for the management of primary dysmenorrhea. Eligible programs could involve aerobic, stretching, yoga, Pilates, resistance or strengthening, core-stability, flexibility, high-intensity interval, or combined exercise approaches. Studies of pharmacological or surgical treatment and passive therapeutic approaches were excluded. Multicomponent interventions were also excluded when the specific contribution of exercise could not be separated from the other treatment components. Comparator groups could receive no intervention, usual care, a wait-list condition, rest, or another condition that did not involve exercise. Trials without an eligible non-exercise comparator were not included. Menstrual pain intensity was the primary outcome and had to be quantified using a validated pain instrument, such as the Visual Analog Scale (VAS), Numeric Pain Scale (NPS), McGill Pain Questionnaire (MPQ), or another validated measure of pain intensity. When a study reported more than one post-intervention assessment, the time point specified by the review protocol and synthesis strategy was used. Eligibility was restricted to randomized controlled trials evaluating exercise-based interventions. Non-randomized and quasi-experimental investigations, observational designs, case series, qualitative research, reviews, and protocols were excluded.

Information Sources and Search Strategy

The literature search was designed to locate randomized controlled trials examining structured exercise for menstrual pain in primary dysmenorrhea. Searches were undertaken in MEDLINE, PubMed, Science Citation Index (SCI), Social Sciences Citation Index (SSCI), and Scopus, as specified in the registered protocol. Electronic searching was supplemented by examining citations both backward and forward from relevant publications to capture potentially eligible reports that might not have been identified through database searching alone. The search framework incorporated three main concepts: primary dysmenorrhea, exercise or physical activity, and randomized controlled trials. Search expressions were adjusted to the indexing conventions and search features of each database. Only published English-language reports were considered, and no publication-date limit was applied. These sources and supplementary search procedures were established in the PROSPERO registration. Terms representing the condition included “primary dysmenorrhea,” “dysmenorrhea,” and “menstrual pain,” while intervention-related terms included “exercise,” “physical activity,” “aerobic exercise,” “stretching,” “yoga,” “Pilates,” “resistance exercise,” “strengthening exercise,” “core stability exercise,” and “flexibility exercise.” Search concepts were connected with the Boolean operators AND and OR, and controlled vocabulary was combined with free-text terminology where supported by the database. Reference lists of eligible articles and pertinent reviews were inspected manually, and forward citation tracking was also undertaken. Retrieved records were subsequently transferred to Zotero, where references were managed and duplicates identified before screening.

Study Selection

Records obtained from the database searches and supplementary citation tracking were collected in Zotero, and duplicate entries were removed before eligibility screening.

The remaining records first underwent title and abstract review using the prespecified inclusion criteria. Reports that appeared potentially relevant, or for which eligibility could not be determined at this stage, were carried forward for full-text evaluation. Full-text eligibility was determined using the predefined PICOS framework. Assessment focused on whether participants had primary dysmenorrhea, allocation was randomized, the intervention met the definition of structured exercise, an appropriate non-exercise comparison condition was available, and menstrual pain intensity was reported as an eligible outcome. Reports were excluded when these requirements were not satisfied, including studies with non-randomized or quasi-experimental designs, ineligible or mixed populations, interventions in which the contribution of exercise could not be evaluated separately, unsuitable comparator conditions, absence of an eligible menstrual pain outcome, or an ineligible publication type. These decisions followed the eligibility framework specified in the prospective registration. For trials containing several study arms, only groups meeting the prespecified intervention and comparator requirements were considered eligible. Reports referring to the same underlying trial were examined together so that participants were not counted more than once. Uncertainty during initial screening was resolved by retaining the record for full-text review rather than excluding it on the basis of limited title or abstract information. The complete sequence from record identification to final inclusion in the systematic review and quantitative synthesis is summarized in the PRISMA 2020 flow diagram (Figure 1).

Data Extraction

A structured extraction framework was used to collect the information required from each eligible report. Study-level information comprised authorship and publication year, study design, participant and sample characteristics, type of exercise, frequency and duration of the intervention, characteristics of the comparison group, the instrument used to measure pain, and the timing of outcome assessment. Quantitative information needed for the meta-analysis was also recorded. For continuous pain outcomes, group sample sizes together with post-intervention means and standard deviations (SDs) were obtained separately for exercise and control conditions whenever these data were reported. Measurements were recorded on the scales originally used by the investigators and were standardized only at the quantitative-synthesis stage. Special handling was required for trials with more than one exercise group. When several eligible intervention arms used the same control group, the relevant exercise groups were combined when appropriate so that participants in the shared comparator were not counted repeatedly in the same pairwise synthesis. For studies presenting several eligible pain measurements, selection followed the prespecified review approach and was not determined by which result reached statistical significance. For the primary analysis, preference was given to pain measurements obtained at completion of the exercise program. Numerical information was not imputed when obtaining or transforming it would have required assumptions unsupported by the original report. A trial could therefore remain eligible for the systematic review even when its results could not be

incorporated reliably into the quantitative analysis; in such cases, the study was retained for narrative consideration where appropriate.

Risk of Bias Assessment

Methodological bias in the included randomized trials was evaluated with the Cochrane Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019), with judgments made for the menstrual pain outcome used in the primary meta-analysis. Evaluation covered all five RoB 2 domains: (1) bias arising from the randomization process, (2) bias due to deviations from intended interventions, (3) bias due to missing outcome data, (4) bias in measurement of the outcome, and (5) bias in selection of the reported result. Judgments for individual domains were assigned as low risk of bias, some concerns, or high risk of bias in accordance with the RoB 2 decision framework, after which an overall judgment was derived for each trial. The inability to blind participants or those delivering the intervention, which is common in exercise trials, was not by itself treated as sufficient reason for a high-risk judgment. For the domain concerning deviations from intended interventions, the assessment instead focused on whether awareness of group assignment could have produced systematic departures from the planned intervention that were capable of influencing the outcome. Outcome measurement required particular consideration because menstrual pain was mainly evaluated through participant-reported measures, including the Visual Analog Scale (VAS), Numeric Pain Scale (NPS), and McGill Pain Questionnaire (MPQ). Accordingly, judgments in this domain took into account whether knowledge of the assigned intervention could plausibly influence participants' subjective ratings of pain. The assessment also considered the completeness of outcome data, differences between the numbers randomized and analyzed, the adequacy of information describing allocation procedures, and inconsistencies in reported outcome information. When methodological reporting did not provide enough evidence to support a low-risk judgment, unreported procedures were not assumed to have been performed adequately. The resulting risk-of-bias assessments informed interpretation of the meta-analytic findings and, where relevant, were examined further in sensitivity analyses.

Statistical Analysis

Menstrual pain intensity was the outcome used for the primary quantitative synthesis. Because the eligible trials quantified pain with different validated measures and numerical ranges, results were placed on a common metric by calculating standardized mean differences (SMDs) as Hedges' g , including the correction for small samples. The direction of the effect was defined so that negative values represented lower post-intervention pain in the exercise group. Effect sizes and their sampling variances were derived from the post-intervention means, standard deviations, and sample sizes reported for the eligible exercise and non-exercise control groups. When several eligible exercise arms from the same randomized trial shared one control group, the intervention arms were combined as appropriate for the primary pairwise comparison to prevent repeated use of the same control participants. Variation among the included trials was expected because exercise programs, intervention frequency and duration, participant

characteristics, and pain measures were not uniform. The overall effect was therefore synthesized under a random-effects model, with between-study variance (τ^2) estimated by restricted maximum likelihood (REML). Pooled effects were accompanied by 95% confidence intervals (CIs). Between-study heterogeneity was characterized using Cochran's Q , τ^2 , and I^2 (Higgins et al., 2003). The I^2 statistic was used to describe the proportion of observed variability attributable to heterogeneity across studies rather than sampling error. Interpretation did not rely solely on numerical cut-offs; the size and direction of individual study effects were also considered in light of the anticipated clinical and methodological diversity of the trials. Stability of the pooled result was investigated through leave-one-out analysis by recalculating the meta-analysis after removing each study in turn. Further sensitivity analyses examined the influence of trials with notable methodological or data-reporting concerns. Hartung–Knapp-adjusted confidence intervals were also obtained where appropriate as an additional check on inference from the random-effects analysis. Trials that otherwise met the review criteria were retained in the qualitative synthesis when an effect size could not be calculated from the available numerical information, but they did not contribute to the corresponding meta-analysis. Missing numerical values were not replaced when doing so would have required assumptions that could not be supported by the original report. When the primary synthesis contained at least 10 studies, possible small-study effects were investigated using a funnel plot together with Egger's regression test (Egger et al., 1997). Funnel plot asymmetry was interpreted with caution because asymmetry can have explanations other than publication bias, particularly when between-study heterogeneity is substantial. Accordingly, these analyses were treated as indicators of potential small-study effects rather than as conclusive evidence that publication bias was present. All statistical analyses were performed in R with the metafor package (Viechtbauer, 2010).

Certainty of Evidence

Confidence in the evidence for menstrual pain intensity was appraised with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) framework (Balshem et al., 2011; Schünemann et al., 2013). As the quantitative evidence was derived from randomized controlled trials, the initial certainty rating was high. Possible downgrading was then considered across the five GRADE domains of risk of bias, inconsistency, indirectness, imprecision, and publication bias. For risk of bias, the RoB 2 judgments of the trials contributing to the pooled estimate were taken into account.

Inconsistency was judged from both the pattern of individual study effects and the extent of statistical heterogeneity, including I^2 and τ^2 . Indirectness was considered in relation to how closely the included populations, exercise programs, comparison conditions, and pain outcomes corresponded to the prespecified review question. Imprecision was examined by considering the width of the confidence interval around the pooled effect together with the amount of information available for that estimate. Potential publication bias was evaluated from the distribution of study effects and, when the number of studies permitted, evidence from funnel plot asymmetry and analyses of small-study effects. After these domains had been considered, the certainty of the

evidence was assigned to one of four levels: high, moderate, low, or very low. The basis for any downgrading decision was recorded and is reported in the GRADE Summary of Findings table (Table 3).

FINDINGS

Study Selection

Records retrieved from the electronic searches and supplementary citation procedures were screened after duplicates had been removed. Title and abstract assessment was followed by full-text examination of records that appeared potentially eligible. At the full-text stage, eligibility was determined according to the prespecified PICOS criteria, including randomized allocation, a population with primary dysmenorrhea, an eligible structured exercise intervention, a non-exercise comparison condition, and measurement of menstrual pain intensity. Full-text exclusions resulted mainly from ineligible study designs or populations, unsuitable comparator conditions, absence of an eligible menstrual pain outcome, or interventions in which the effect attributable specifically to exercise could not be separated. Trials comparing exercise only with an active pharmacological intervention were not eligible when no appropriate non-exercise comparator was available. After eligibility decisions were completed and reports originating from the same trial were reconciled, the qualifying randomized trials were included in the systematic review. Seventeen of these trials contained sufficient group-level numerical information to contribute to the primary meta-analysis of menstrual pain intensity. An otherwise eligible trial was not removed from the systematic review simply because the reported data were insufficient for reliable calculation of a standardized effect size; such evidence was instead considered narratively. This was the case for Kannan et al. (2019a), which satisfied the clinical eligibility requirements but did not report the group-level post-intervention numerical information needed to derive Hedges' g using the prespecified extraction approach. The trial was therefore retained in the systematic review but did not contribute to the primary meta-analysis.

Figure 1 summarizes the complete study-selection pathway in the PRISMA 2020 flow diagram.

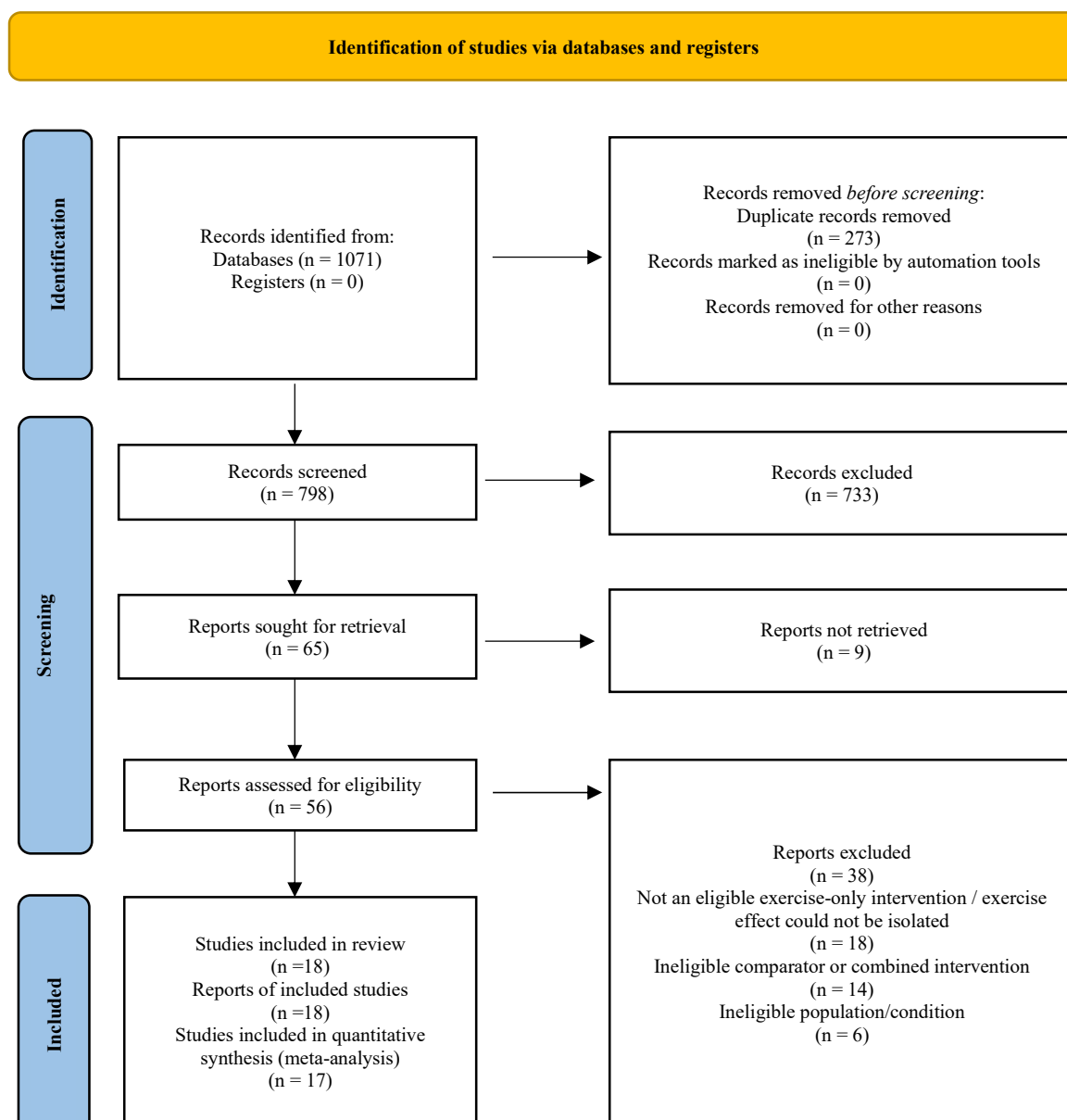


Figure 1. PRISMA 2020 flow diagram of the study identification, screening, eligibility assessment, and inclusion process. Eighteen studies were included in the systematic review, of which 17 randomized controlled trials provided sufficient quantitative data for inclusion in the primary meta-analysis.

Study Characteristics

Considerable variation was observed in the exercise programs evaluated by the randomized trials contributing to the quantitative synthesis. The interventions encompassed aerobic and isometric exercise, stretching or flexibility-based programs, yoga, Pilates, core-stability training, high-intensity interval training, and approaches incorporating more than one exercise component. The way these programs were delivered also differed across studies with respect to session frequency, overall intervention length, supervision, and the timing of outcome evaluation. Participants were predominantly adolescents and young adult women, and many samples were drawn

from university or student populations. Although the included trials generally characterized primary dysmenorrhea as recurrent menstrual pain without identified pelvic pathology, the procedures used to establish diagnosis and determine participant eligibility were not identical across studies. The Visual Analog Scale (VAS) was the most frequently used measure of menstrual pain intensity, with several trials employing other validated pain instruments. Differences in the measurement tools and their scoring ranges necessitated conversion of study effects to a common standardized metric; Hedges' *g* was therefore used in the primary meta-analysis. Multi-arm designs were present in several of the included randomized trials. Azima et al. (2015), for instance, evaluated isometric exercise, massage therapy, and a no-intervention condition within the same trial. Follow-up was completed by 102 participants, distributed equally across the three groups (*n* = 34 per group). Menstrual pain was followed over three consecutive cycles.

In the isometric-exercise group, the mean VAS score changed from 6.58 ± 1.67 at baseline to 4.17 ± 2.12 by the third cycle; at the same assessment point, the no-intervention group had a mean score of 6.67 ± 1.96 .

A three-arm design was also used by Elbandrawy and Elhakk (2021), who evaluated aerobic exercise, isometric exercise, and a control condition, with 35 participants assigned to each arm. The two exercise programs were undertaken three times weekly over an eight-week period, and pain was measured with a VAS. In the primary pairwise synthesis, exercise groups linked to a shared comparator were treated according to the prespecified multi-arm procedure so that the same control participants were not represented more than once.

More broadly, the included interventions differed in program length, ranging from protocols lasting several weeks or menstrual cycles to longer exercise programs. Variation was also evident in exercise type and dose, supervision, participant profiles, and methods of pain assessment, supporting the decision to synthesize the trials using a random-effects model.

Table 1. Characteristics of randomized controlled trials included in the primary quantitative synthesis

Study	Exercise modality	Exercise (n)	Control (n)	Intervention/assessment period	Pain measure	Comparator
Nik Zaid et al., 2022	Isometric exercise	12	12	8 weeks	VAS, 0–10	No-exercise control
Temizkan & Budak, 2025	Aerobic exercise	15	15	Post-intervention	MPQ total pain	Non-exercise control
Elbandrawy & Elhakk, 2021	Aerobic + isometric exercise*	70	35	8 weeks	VAS, 0–10	Control
Azima et al., 2015	Isometric exercise	34	34	Third menstrual cycle	VAS, 0–10	No-intervention control
Shahrjerdi et al., 2019	Core stability exercise	17	17	8 weeks	NPS, 0–100	No-exercise control
Ibrahim et al., 2023	Active stretching*	22	11	4 weeks	VAS, 0–10	No-intervention control
Kirmizigil & Demiralp, 2020	Combined functional exercise	14	14	Post-intervention	Abdominal pain VAS	Control
Yang & Kim, 2016	Yoga	18	18	12 weeks	VAS, 0–10	Non-exercise control
Kirca & Sis Celik, 2023	Yoga	30	30	Post-intervention	VAS, 0–10	Control

Study	Exercise modality	Exercise (n)	Control (n)	Intervention/assessment period	Pain measure	Comparator
Şaşmaz & Aras Bayram, 2024	Online yoga-based exercise	25	25	8 weeks	VAS, 0–10	Control
Mirzaei et al., 2021	Flexibility exercise	20	20	8 weeks	VAS, 0–10	No-intervention control
Kumari et al., 2025	Exercise program	18	18	12 weeks	VAS, 0–10	No-intervention control
Fallah & Mirfeizi, 2018	Stretching exercise	19	21†	8 weeks	VAS, 0–10	No-exercise control
Öztürk et al., 2023	Stretching exercise	22	19	Second menstrual cycle	VAS, 0–10	Control
Song & Kim, 2023	Pilates	15	15	12 weeks	VAS, 0–10	Wait-list control
Huang et al., 2022	Sprint-interval / HIIT exercise	15	15	10 weeks	VAS	Untreated control
Pio-Soria et al., 2025	Interval aerobic cycling	7	10	2-month assessment	VAS	Control

Note. VAS, Visual Analog Scale; NPS, Numeric Pain Scale; MPQ, McGill Pain Questionnaire; HIIT, high-intensity interval training. For multi-arm trials sharing a common control group, eligible exercise arms were combined for the primary quantitative synthesis to avoid double-counting the control group. The control-group sample size reported for Fallah and Mirfeizi differed across sections of the report; the value used in the quantitative extraction table was retained and this study was flagged for sensitivity analysis.

Risk of Bias

RoB 2 evaluation of the 17 randomized trials contributing to the quantitative synthesis showed that methodological concerns were present across the evidence base. Fifteen trials (88.2%) received an overall judgment of some concerns, while the remaining two trials (11.8%) were classified as high risk of bias; none received an overall low-risk judgment. The high-risk classifications applied to Azima et al. (2015) and Shahrjerdi et al. (2019).

At the domain level, D2 (bias due to deviations from intended interventions) and D5 (bias in selection of the reported result) were the most consistently affected domains,

with all 17 trials receiving a judgment of some concerns for each. Figures 2 and 3 provide the study-specific RoB 2 judgments and the overall distribution across domains.

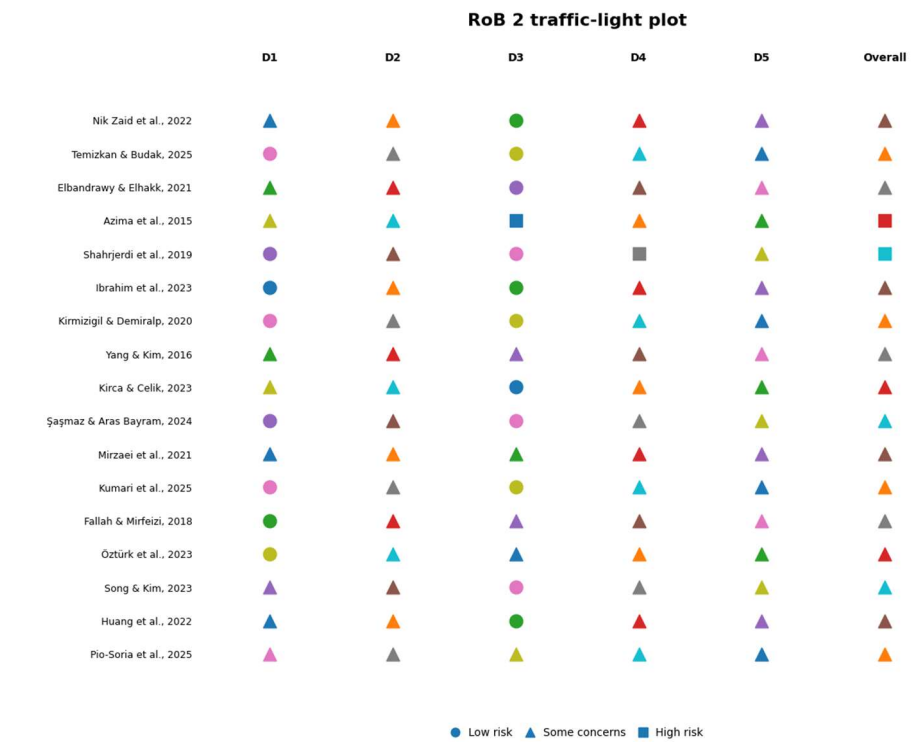
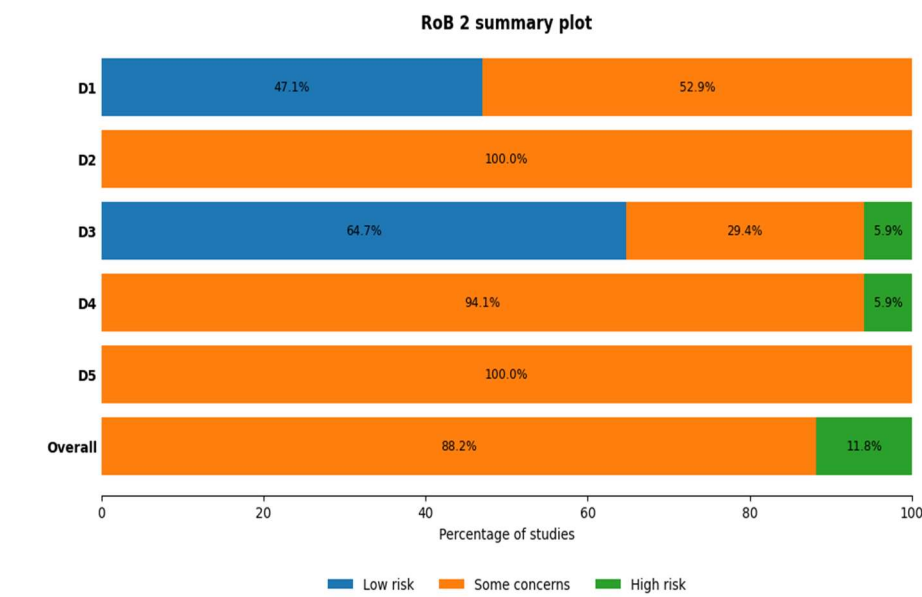


Figure 2. Risk-of-bias assessment of the 17 randomized controlled trials included in the quantitative synthesis using the Cochrane Risk of Bias 2 (RoB 2) tool. D1, bias arising



from the randomization process; D2, bias due to deviations from intended interventions; D3, bias due to missing outcome data; D4, bias in measurement of the outcome; D5, bias in selection of the reported result. Judgments are presented as low risk, some concerns, or high risk of bias.

Figure 3. Summary of risk-of-bias judgments across the 17 randomized controlled trials included in the quantitative synthesis using the Cochrane Risk of Bias 2 (RoB 2) tool. D1, bias arising from the randomization process; D2, bias due to deviations from

intended interventions; D3, bias due to missing outcome data; D4, bias in measurement of the outcome; D5, bias in selection of the reported result. Overall, 15 of 17 trials (88.2%) were judged as having some concerns and 2 of 17 trials (11.8%) as having high risk of bias.

Effect of Exercise on Menstrual Pain Intensity

Data from 17 randomized controlled trials were available for the primary quantitative synthesis of menstrual pain intensity. As pain had been evaluated with different validated instruments and scoring ranges, study results were converted to Hedges' g . Effect estimates were oriented so that negative values represented lower pain intensity with exercise relative to the non-exercise comparator.

Pooling the trials with a random-effects model yielded an overall effect of Hedges' $g = -2.18$ (95% CI -3.02 to -1.33), indicating lower menstrual pain intensity among participants receiving structured exercise interventions. The confidence interval did not include the null value, and the pooled estimate therefore favored exercise.

Marked heterogeneity accompanied this overall effect ($I^2 = 92.4\%$; $\tau^2 = 2.92$). The size of the estimated benefit was therefore far from consistent across trials, and the pooled value should be understood as an average across a diverse group of interventions and study settings rather than as the expected effect of every exercise program.

Although most study-specific estimates were in the direction of lower pain with exercise, their magnitudes differed substantially, ranging from minimal or small between-group differences to very large effects. Such dispersion occurred in the context of differences in exercise modality and dose, program duration, supervision, participant

characteristics, comparator conditions, and approaches to pain measurement. Figure 4 displays the individual study estimates together with the pooled random-effects result.

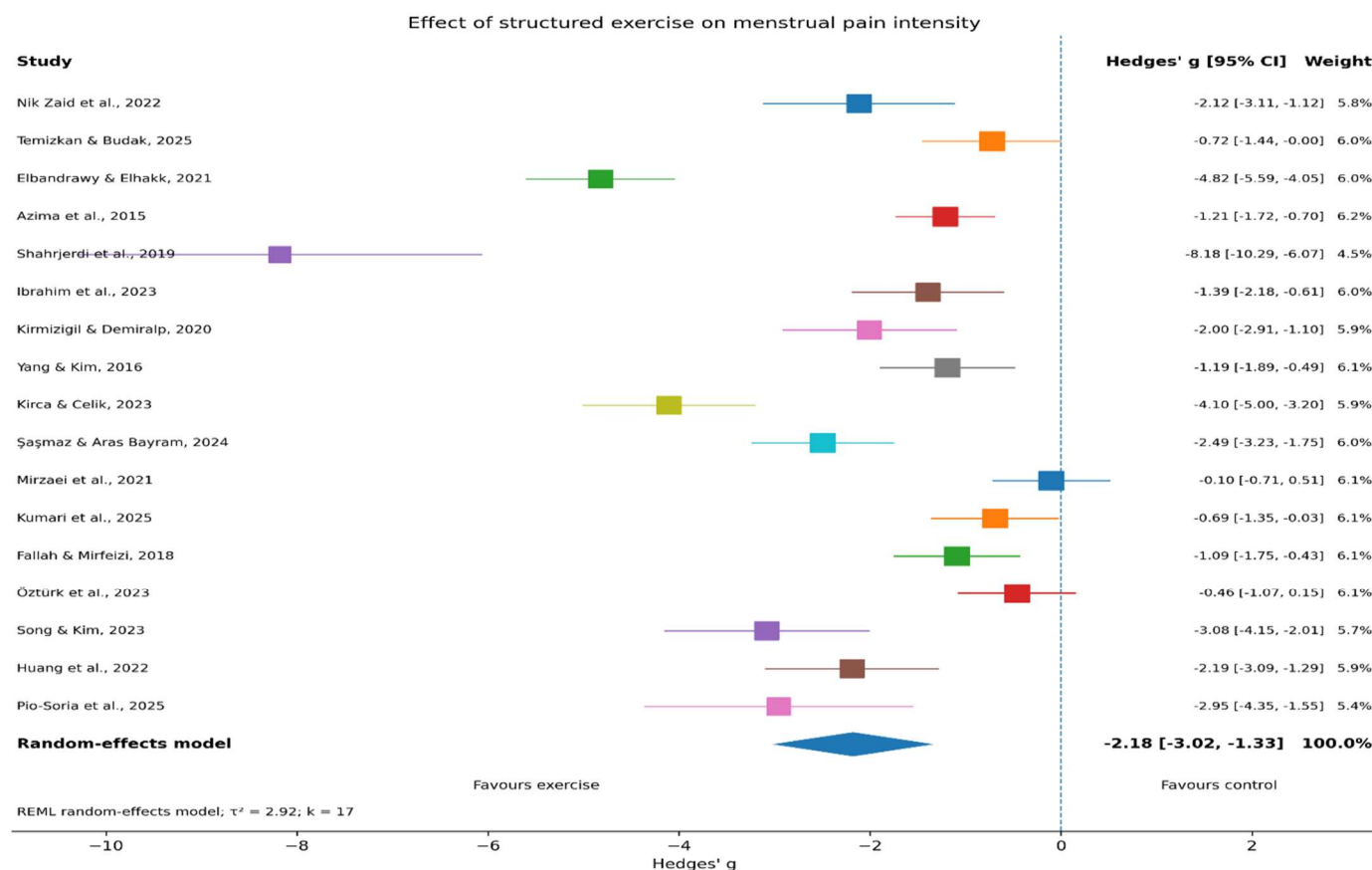


Figure 4. Forest plot of the effect of structured exercise interventions on menstrual pain intensity in women with primary dysmenorrhea. Effect sizes are expressed as Hedges' g with 95% confidence intervals using a random-effects model with restricted maximum likelihood (REML) estimation. Negative values favor exercise. The pooled effect across 17 randomized controlled trials was Hedges' $g = -2.18$ (95% CI -3.02 to -1.33), with substantial between-study heterogeneity ($I^2 = 92.4\%$; $\tau^2 = 2.92$).

Sensitivity Analyses

The sensitivity analyses showed that the overall direction of the primary result was not dependent on any single trial. Across the leave-one-out analyses, pooled Hedges' g values varied between -2.31 and -1.88 , with every recalculated estimate continuing to favor exercise. Removing Shahrjerdi et al. (2019) produced the greatest reduction in the magnitude of the pooled effect, although the result remained in favor of exercise ($g = -1.88$, 95% CI -2.53 to -1.22 ; $I^2 = 91.3\%$; $\tau^2 = 1.61$). When Azima et al. (2015) was removed, the pooled estimate was $g = -2.25$ (95% CI -3.14 to -1.35 ; $I^2 = 92.8\%$; $\tau^2 = 3.12$). Excluding both trials classified as having high overall risk of bias resulted in $g = -1.93$ (95% CI -2.62 to -1.23 ; $I^2 = 91.8\%$; $\tau^2 = 1.71$). The Hartung–Knapp analysis of the full 17-trial dataset retained the same pooled estimate while widening the confidence interval ($g = -2.18$, 95% CI -3.14 to -1.22). Taken together, these analyses indicate that

alternative exclusions and inferential assumptions did not change the direction of the pooled result, although heterogeneity remained substantial.

Table 2. Sensitivity analyses of the effect of exercise on menstrual pain intensity

Analysis	k	Hedges' g	95% CI	I ² (%)	τ^2
Primary REML random-effects analysis	17	-2.18	-3.02 to -1.33	92.4	2.92
Excluding Shahrjerdi et al., 2019	16	-1.88	-2.53 to -1.22	91.3	1.61
Excluding Azima et al., 2015	16	-2.25	-3.14 to -1.35	92.8	3.12
Excluding both high-risk-of-bias studies	15	-1.93	-2.62 to -1.23	91.8	1.71
Hartung–Knapp adjustment, primary dataset	17	-2.18	-3.14 to -1.22	92.4	2.92

Note. CI, confidence interval; REML, restricted maximum likelihood. Negative Hedges' g values favor exercise. Shahrjerdi et al. (2019) and Azima et al. (2015) were the two studies judged to be at high overall risk of bias. The Hartung–Knapp analysis used the same 17-study dataset and REML estimate of between-study variance as the primary analysis.

Small-Study Effects and Publication Bias

The funnel plot displayed a visibly asymmetric distribution of study effects. Egger's regression analysis was consistent with the presence of small-study effects (intercept = -8.78, SE = 2.51, $t = -3.50$, $df = 15$, $p = 0.003$). However, this finding was considered in the context of the pronounced heterogeneity observed in the primary meta-analysis. Funnel plot asymmetry may arise from several sources and was therefore not regarded as proof of publication bias. Rather, the combined funnel plot and regression findings were interpreted as indicating potential small-study effects, while differences in intervention characteristics, sample sizes, methodological quality, and other study-level factors remained plausible contributors to the asymmetric pattern.

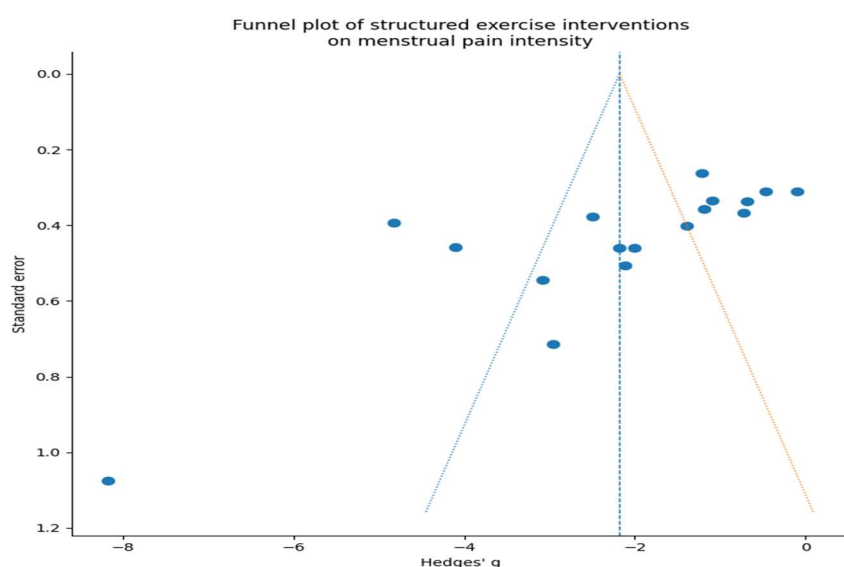


Figure 5. Funnel plot of the effect of structured exercise interventions on menstrual pain intensity. Each point represents one of the 17 randomized controlled trials included in the quantitative synthesis. The vertical dashed line represents the pooled random-effects estimate (Hedges' $g = -2.18$), and the diagonal dotted lines indicate approximate 95% pseudo-confidence limits. Visual inspection suggested funnel plot asymmetry. Egger's regression test provided evidence of small-study effects (intercept = -8.78, SE = 2.51, $t = -3.50$, $df = 15$, $p = 0.003$). Given the substantial between-study heterogeneity,

funnel plot asymmetry should be interpreted cautiously and should not be attributed solely to publication bias.

Certainty of Evidence

Using the GRADE framework, the certainty of evidence for the effect of structured exercise on menstrual pain intensity was judged to be very low. Downgrading for risk of bias reflected methodological concerns across the included evidence, including two trials classified as having high overall risk of bias. Inconsistency warranted further downgrading because substantial unexplained heterogeneity remained across the 17 trials ($I^2 = 92.4\%$; $\tau^2 = 2.92$). No downgrade was applied for indirectness, as the populations, interventions, comparators, and outcome measures were broadly aligned with the review question. Imprecision was also not downgraded because the pooled confidence interval excluded the null value, although the exact magnitude of benefit remained uncertain. Finally, the asymmetric funnel plot and statistically significant Egger test (intercept = -8.78 , $p = 0.003$) raised concern about small-study effects and possible publication bias. Taken together, these considerations resulted in a very low certainty rating, meaning that confidence in the estimated magnitude of the pooled effect is limited and that the true effect could differ substantially from the current estimate.

Table 3. GRADE Summary of Findings for the effect of exercise on menstrual pain intensity

Outcome	Studies	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Effect estimate	Certainty of evidence
Menstrual pain intensity	17 RCTs	Serious ¹	Very serious ²	Not serious	Not serious ³	Strongly suspected ⁴	Hedges' g = -2.18 (95% CI -3.02 to -1.33)	Very low

CI, confidence interval; GRADE, Grading of Recommendations Assessment, Development and Evaluation. Negative Hedges' g values favor exercise.¹Risk of bias was rated as serious because methodological concerns were identified across several trials, including concerns related to the randomization process, deviations from intended interventions, and/or outcome measurement, and two included trials were judged to be at high overall risk of bias. ²Inconsistency was rated as very serious because substantial unexplained between-study heterogeneity was present ($I^2 = 92.4\%$; $\tau^2 = 2.92$), with considerable variation in the magnitude of study-specific effects. ³Imprecision was not downgraded because the 95% confidence interval remained entirely on the side favoring exercise and excluded both the null and effects close to the null. Nevertheless, the width of the confidence interval indicates uncertainty regarding the precise magnitude of the effect. ⁴Publication bias was strongly suspected because funnel plot asymmetry was observed and Egger's regression test indicated small-study effects (intercept = -8.78 , $p = 0.003$). However, because funnel plot asymmetry and small-study effects may also arise

from substantial between-study heterogeneity and other study-level differences, these findings were not considered definitive evidence of publication bias.

DISCUSSION

Principal Findings

The present synthesis indicates that structured exercise is associated with lower menstrual pain intensity in women with primary dysmenorrhea. Across the 17 randomized controlled trials included in the primary meta-analysis, the pooled effect favored exercise and was large in standardized terms (Hedges' $g = -2.18$, 95% CI -3.02 to -1.33). This finding was accompanied, however, by pronounced variation among trial estimates ($I^2 = 92.4\%$; $\tau^2 = 2.92$), showing that the size of the observed benefit was not consistent across the evidence base.

The direction of this finding remained stable under the sensitivity analyses. Re-estimating the pooled effect after individual studies were removed did not change which group was favored, and analyses excluding trials with greater methodological concerns reduced the estimated magnitude without reversing the overall result. The most noticeable attenuation followed removal of Shahrjerdi et al. (2019), a study for which inconsistencies were identified in the reported pain data. Even after its exclusion, the pooled estimate continued to favor exercise, suggesting that the principal finding cannot be attributed solely to one influential trial.

The size of the pooled estimate nevertheless requires cautious interpretation. The contributing trials differed across several clinically relevant features, including the type and dose of exercise, program length, supervision, participant characteristics, and methods used to assess pain. Methodological concerns were also common across the included evidence, while funnel plot asymmetry and the Egger analysis raised the possibility of small-study effects. Thus, the evidence supports a reduction in menstrual pain associated with exercise, but provides considerably less certainty about how large that reduction is likely to be in practice.

Interpretation of the Magnitude and Heterogeneity of the Effect

Although the pooled standardized effect was large, its magnitude should be viewed in the context of the marked variability across trials. Study-specific estimates extended from little or no between-group difference to very large reductions in pain. The high level of heterogeneity therefore indicates that the pooled value summarizes a set of substantially different treatment effects rather than representing a single response that can be expected from exercise in general.

One likely contributor to this variability is the breadth of interventions grouped under structured exercise. The evidence base included aerobic and isometric exercise, stretching, yoga, Pilates, core-stability training, high-intensity interval exercise, and multicomponent programs. These approaches differ in physical demands, targeted muscle groups, training intensity and frequency, and potentially in how they influence pain. Combining them is appropriate for estimating the overall effect of structured

exercise relative to non-exercise conditions, but the resulting pooled estimate should not be taken to mean that the individual modalities are equally effective.

Differences in exercise exposure provide another possible explanation. Program length, number of weekly sessions, duration of individual sessions, supervision, and adherence varied across trials. Delivery also ranged from directly supervised programs to home-based or remotely administered interventions. Consequently, participants may have differed considerably in both the amount of exercise actually performed and their adherence to the prescribed program.

Variation in outcome assessment may also have contributed. VAS was the most common pain measure, but other validated instruments and scoring ranges were used across the included studies. Standardized mean differences allowed these outcomes to be pooled statistically, yet differences in measurement procedures, timing of assessment, and initial pain severity could still influence the study-specific effect estimates.

Study size and methodological quality introduced additional uncertainty. Several trials had small samples, and risk-of-bias concerns were present across most of the evidence base. In addition, the asymmetric funnel plot and significant evidence of small-study effects suggest that effect estimates may have differed systematically according to study size. For these reasons, the large pooled standardized effect should be interpreted as evidence of an overall association favoring exercise rather than as a precise prediction of the amount of pain relief that an individual patient will experience.

Potential Mechanisms Underlying the Effects of Exercise

Several biological and psychological pathways have been proposed to explain why exercise might reduce menstrual pain. Primary dysmenorrhea is closely linked to increased uterine prostaglandin activity, which can intensify myometrial contractions, restrict uterine blood flow, promote ischemia, and activate pain pathways. Inflammatory mediators, including interleukin-6 and tumor necrosis factor- α (TNF- α), have also been implicated and may interact with processes involved in prostaglandin-mediated pain (ACOG, 2018; Kannan et al., 2019b).

One proposed explanation for exercise-induced analgesia involves hormonal and inflammatory modulation. Kannan et al. (2019b) suggested that aerobic exercise could influence progesterone, prostaglandin metabolism, and inflammatory cytokines relevant to dysmenorrhea. Their preliminary observations following high-intensity aerobic exercise included higher progesterone together with reductions in a prostaglandin metabolite and TNF- α relative to no exercise. These observations originated from a small mechanistic investigation, however, and are better regarded as support for a possible pathway than as confirmation of a causal mechanism.

Changes in circulation and endogenous pain regulation provide additional possible explanations. Exercise has been proposed to enhance pelvic blood flow and thereby lessen ischemia associated with excessive uterine contractions. Increased endogenous endorphin activity, relaxation, and other exercise-related analgesic responses may also contribute to altered pain perception. Similar explanations, including improved circulation and endogenous analgesic activity, have been discussed in relation to

stretching and other exercise approaches used for primary dysmenorrhea (Fallah & Mirfeizi, 2018; Kannan et al., 2019b).

Psychological responses to exercise may contribute as well. Reductions in stress or anxiety could influence sympathetic activity and the perception of menstrual pain. Nevertheless, these mechanisms cannot be determined from the present meta-analysis because the included trials primarily evaluated clinical pain outcomes rather than biological or psychological mediators. The current findings therefore demonstrate an association between structured exercise and lower menstrual pain but do not establish the pathway through which that effect occurs (Kannan et al., 2019b; Armour et al., 2019).

Comparison with Previous Evidence

The direction of the present findings is consistent with earlier systematic reviews showing that exercise may alleviate menstrual pain in women with primary dysmenorrhea (Armour et al., 2019; Tsai et al., 2024; Zheng et al., 2024). Armour et al. (2019) reported a reduction in menstrual pain with exercise, although their quantitative synthesis was based on 10 trials and the supporting evidence was judged to be of low certainty. Subsequent network meta-analyses broadened the range of exercise approaches examined and likewise reported beneficial effects, while also demonstrating considerable variation according to exercise modality and intervention characteristics (Tsai et al., 2024; Zheng et al., 2024).

The present review differs from these earlier syntheses in several methodological respects. It incorporates more recent randomized evidence across a broad spectrum of structured exercise approaches, including aerobic and isometric exercise, stretching, yoga, Pilates, core-stability training, and high-intensity interval exercise. Eligibility was also restricted to randomized trials containing an appropriate non-exercise comparator. This criterion allowed the analysis to address specifically whether structured exercise was associated with lower menstrual pain relative to conditions in which exercise was not provided, rather than relying on comparisons between two active exercise approaches.

Another methodological consideration was the treatment of multi-arm trials. When more than one eligible exercise group was compared with a common control condition, intervention arms were handled according to the prespecified approach so that the same control participants did not contribute repeatedly to a single pairwise synthesis. This prevented artificial inflation of statistical precision through duplication of shared comparator data.

The review also examined the credibility and stability of the pooled result through RoB 2 assessment, leave-one-out and additional sensitivity analyses, evaluation of small-study effects, and GRADE appraisal of evidence certainty. Although the pooled estimate remained in favor of exercise across sensitivity analyses, substantial heterogeneity, methodological concerns, and evidence of small-study effects limit confidence in its precise magnitude. Thus, the present findings support the general conclusion of previous

reviews that exercise may reduce menstrual pain while emphasizing greater uncertainty about the size of the benefit than the pooled point estimate alone might suggest.

Clinical Implications

The findings may have practical relevance for the non-pharmacological management of primary dysmenorrhea. Because the direction of the pooled result remained in favor of exercise across the primary and sensitivity analyses, structured exercise may represent a supportive option for women who wish to incorporate non-pharmacological approaches into the management of menstrual pain. This interpretation is generally consistent with previous systematic reviews reporting beneficial effects of exercise in primary dysmenorrhea (Armour et al., 2019; Tsai et al., 2024; Zheng et al., 2024).

The available evidence does not, however, identify one exercise modality as the preferred approach. The included trials examined markedly different forms of exercise, and the present meta-analysis was intended to estimate the overall effect of structured exercise rather than directly compare the relative effectiveness of individual modalities. In the absence of sufficiently robust head-to-head evidence, practical considerations such as individual preference, accessibility, baseline physical capacity, feasibility, and the likelihood of adherence may therefore inform the choice of exercise approach.

Clinical interpretation must also reflect the very low certainty assigned to the evidence. In particular, the large pooled standardized effect should not be understood as a prediction of the degree of pain reduction that every woman with primary dysmenorrhea will experience. The results suggest that exercise may reduce menstrual pain, but the extent of improvement is likely to differ across individuals and exercise programs, and confidence in the precise magnitude of benefit remains limited.

Accordingly, structured exercise is best regarded as a potentially useful supportive component of primary dysmenorrhea management. The present evidence does not justify positioning exercise as a substitute for appropriate medical assessment or for pharmacological treatment when such treatment is clinically indicated.

Strengths and Limitations

Several methodological features strengthen this review. The protocol was registered prospectively in PROSPERO (CRD420261282619), and the quantitative evidence was restricted to randomized trials in which structured exercise could be compared with an eligible non-exercise condition. Shared comparator groups in multi-arm trials were handled without repeatedly counting the same participants, while standardized effect sizes allowed pain outcomes reported on different scales to be synthesized. The stability of the primary result was examined through leave-one-out and additional sensitivity analyses. Interpretation also incorporated RoB 2 judgments, assessment of small-study effects, and GRADE certainty rather than being based on the pooled effect and statistical significance alone.

These strengths should be considered alongside important limitations. Most notably, heterogeneity across the included trials was substantial, reducing confidence in the pooled estimate as a precise representation of the effect expected in a particular setting. Exercise modality, program dose and duration, supervision, participant characteristics,

and procedures for measuring menstrual pain varied considerably. The pooled effect therefore summarizes clinically diverse interventions rather than a uniform treatment approach.

Methodological concerns within the primary studies provide an additional limitation. Most trials received at least some risk-of-bias concerns, and two were judged to have high overall risk of bias. Blinding participants to an exercise intervention was generally impractical, while menstrual pain was predominantly assessed through self-report. In addition, reporting of procedures such as allocation concealment and selective outcome reporting was limited in several trials.

Potential small-study effects must also be considered. Funnel plot asymmetry and Egger's regression were consistent with such effects, although these findings cannot determine their cause. Selective publication is one possible explanation, but genuine between-study heterogeneity and methodological differences between smaller and larger trials could also produce an asymmetric pattern. Publication bias therefore remains a concern rather than a definitive conclusion.

Not every trial meeting the broader eligibility criteria could be incorporated into the primary meta-analysis because sufficiently reliable numerical outcome information was not always available. Such trials were retained in the systematic review and considered narratively where appropriate, but their absence from the pooled calculation may have affected the quantitative estimate.

Finally, the available evidence was insufficient to determine an optimal exercise prescription. Although the findings support structured exercise as a broad intervention category, they do not establish which modality, intensity, frequency, or duration provides the greatest benefit for menstrual pain in primary dysmenorrhea.

Implications for Future Research

Future investigations should move beyond establishing whether exercise is beneficial and examine which forms, doses, and delivery approaches produce the most consistent reductions in menstrual pain. The substantial heterogeneity identified in the present review demonstrates that structured exercise cannot be treated as a uniform intervention. Adequately powered randomized trials directly comparing different exercise modalities would therefore be particularly valuable.

Methodological rigor also requires improvement. Future trials should clearly describe random sequence generation and allocation concealment, register protocols prospectively, prespecify primary outcomes and assessment time points, and report participant attrition transparently. Although blinding participants to exercise is often not feasible, outcome assessment should be blinded whenever the study design permits. Complete reporting of the numbers randomized and analyzed is also important, particularly when pain is assessed across several menstrual cycles or at multiple time points.

More consistent outcome reporting would facilitate comparison and quantitative synthesis across trials. Reports should specify the pain instrument and its scoring range and direction, provide baseline and post-intervention values with appropriate measures of variability and group-specific sample sizes, and identify precisely when pain was

assessed in relation to the menstrual cycle and intervention. Greater completeness in these areas would reduce the likelihood that otherwise eligible trials cannot be incorporated into future meta-analyses.

Exercise interventions themselves should also be described in sufficient detail to permit replication and investigation of dose–response relationships. At a minimum, reports should provide information on exercise frequency, intensity, time, and type, together with overall program duration, supervision, adherence, and adverse events. Improved intervention reporting would make it easier to determine which characteristics of exercise programs are associated with greater or more reproducible benefits.

Further mechanistic research may help clarify how exercise influences dysmenorrhea-related pain. Hormonal, prostaglandin-related, inflammatory, circulatory, endogenous analgesic, and psychological mechanisms have all been proposed, but their relative contributions remain uncertain. Preliminary findings concerning progesterone, prostaglandin metabolites, and inflammatory mediators should therefore be regarded as hypothesis-generating (Kannan et al., 2019b). Randomized studies combining clinical pain outcomes with relevant biological measures could help determine whether changes in these pathways mediate the response to exercise.

Finally, larger multicenter trials with longer follow-up are needed to establish whether benefits persist after supervised exercise has ended. Future studies should also examine outcomes beyond pain intensity, including pain duration, analgesic use, school or work absenteeism, physical functioning, and quality of life.

CONCLUSION

This systematic review and meta-analysis indicates that structured exercise may reduce menstrual pain intensity in women with primary dysmenorrhea when compared with non-exercise control conditions. The pooled effect was in favor of exercise, and its direction remained stable across the sensitivity analyses. Nevertheless, the substantial heterogeneity between trials, methodological concerns within the evidence base, and evidence of small-study effects limit confidence in the precise magnitude of the estimated benefit.

Structured exercise may therefore be considered a potentially useful non-pharmacological component of primary dysmenorrhea management, but the available evidence does not establish an optimal exercise modality, dose, or program. Given the very low certainty of evidence, the magnitude of the pooled effect should be interpreted cautiously. Future adequately powered randomized controlled trials with rigorous methodology, standardized outcome reporting, and clearly specified exercise protocols are needed to clarify the magnitude of benefit and determine whether particular exercise approaches or doses provide more consistent effects on menstrual pain.

Kısaltmalar / Abbreviations

CI: Confidence Interval

GRADE: Grading of Recommendations Assessment, Development and Evaluation

HIIT: High-Intensity Interval Training

MPQ: McGill Pain Questionnaire

NPS: Numeric Pain Scale

NSAIDs: Non-Steroidal Anti-Inflammatory Drugs

PD: Primary Dysmenorrhea

PICOS: Population, Intervention, Comparator, Outcome, and Study Design

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROSPERO: International Prospective Register of Systematic Reviews

RCT: Randomized Controlled Trial

REML: Restricted Maximum Likelihood

RoB 2: Cochrane Risk of Bias 2

SD: Standard Deviation

SMD: Standardized Mean Difference

VAS: Visual Analog Scale

Beyanlar / Declarations

Etik Onay ve Katılım Onayı / Ethics approval and consent to participate

Bu çalışma, daha önce yayımlanmış çalışmalardan elde edilen verilerin kullanıldığı bir sistematik derleme ve meta-analizdir. Araştırma kapsamında yeni katılımcı alınmamış, katılımcılarla doğrudan temas kurulmamış ve bireysel düzeyde tanımlanabilir kişisel veri toplanmamıştır. Bu nedenle etik kurul onayı ve katılımcılardan bilgilendirilmiş onam alınması gerekmemiştir. Çalışmanın hazırlanması ve raporlanması sürecinde bilimsel araştırma ve yayın etiği ilkelerine uyulmuştur. Sistematik derleme protokolü PROSPERO'ya prospektif olarak kaydedilmiştir (CRD420261282619).

This study is a systematic review and meta-analysis based exclusively on data obtained from previously published studies. No new participants were recruited, no direct contact with human participants occurred, and no individually identifiable personal data were collected. Therefore, ethics committee approval and informed consent were not required for this study. The review was conducted and reported in accordance with applicable principles of scientific research and publication ethics. The systematic review protocol was prospectively registered in PROSPERO (CRD420261282619).

Veri Ve Materyal Erişilebilirliği / Availability of data and material

Bu sistematik derleme ve meta-analizde kullanılan veriler yayımlanmış çalışmalardan elde edilmiştir. Meta-analizde kullanılan çıkarılmış veriler ve analizleri destekleyen ilgili materyaller, makul talep üzerine sorumlu yazardan temin edilebilir.

The data used in this systematic review and meta-analysis were extracted from published studies. The extracted data used in the meta-analysis and relevant materials supporting the analyses are available from the corresponding author upon reasonable request.

Çıkar Çatışması / Competing interests

Yazarlar, bu çalışmayla ilgili herhangi bir finansal veya finansal olmayan çıkar çatışması bulunmadığını beyan etmektedirler.

The authors declare no financial or non-financial competing interests related to this study.

Yazar Katkıları / Authors' Contribution Statement

Engin Gezer ve Hatice Gezer; çalışmanın kavramsallaştırılması, sistematik literatür taraması, çalışmaların seçimi, veri çıkarımı, metodolojik değerlendirme, risk-of-bias değerlendirmesi, istatistiksel analiz ve meta-analiz, bulguların yorumlanması ve makalenin hazırlanmasına katkıda bulunmuştur. Her iki yazar da makaleyi eleştirel olarak gözden geçirmiş, makalenin son halini okumuş ve onaylamıştır.

Engin Gezer and Hatice Gezer contributed to the conceptualization of the study, systematic literature search, study selection, data extraction, methodological assessment, risk-of-bias assessment, statistical analysis and meta-analysis, interpretation of the findings, and preparation of the manuscript. Both authors critically reviewed the manuscript and read and approved the final version.

Fon Desteği / Funding

None.

Teşekkür / Acknowledgements

None.

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