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Comparative Effects of Aerobic and Core Strengthening Exercises on Primary Dysmenorrhea among Adolescents Girls

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ABSTRACT

Primary dysmenorrhea is one of the most common gynecological complaints among adolescent girls and may interfere with daily and school activities. Exercise-based intervention, including aerobic exercise and core strengthening exercise, can reduce menstrual pain as non-pharmacological management. This study aimed to compare the effects of aerobic exercise and core strengthening exercise on primary dysmenorrhea among adolescent girls. A randomized pre-test and post-test-controlled trial was used. The research was conducted at SMP Muhammadiyah 2 Gamping, Sleman, Indonesia involving 34 adolescent girls aged 10-17 years with primary dysmenorrhea. Participants were randomly assigned using simple randomization into an aerobic exercise group (n=17) and a core strengthening exercise group (n=17). Pain intensity was measured using the Visual Analog Scale (VAS) before and after a three-week intervention performed three times weekly, with 30-minute sessions. The mean VAS score in the aerobic exercise group decreased from 6.00 ± 2.09 to 3.00 ± 1.86, while the core strengthening group decreased from 7.18 ± 1.94 to 4.53 ± 1.84. The reduction in pain intensity was greater in the aerobic group (3.00 points) than in the core strengthening group (3.00 points vs. 2.65 points; Mean difference −1.53; 95% CI −2.75 to −0.31; p=0.020). Both interventions significantly reduced primary dysmenorrhea pain intensity (p<0.001) with a significant difference between groups p=0.020. Aerobic exercise may provide greater benefits in school-based menstrual health programs for adolescent's girls.

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INTRODUCTION

Dysmenorrhea is one of the most common reproductive health problems among adolescent girls and can substantially affects daily activities, school attendance, academic performance, and quality of life. According to the World Health Organization (WHO), adolescents represent a vulnerable population in reproductive health issues.(1) Globally, the prevalence of primary dysmenorrhea among adolescents has been reported to range from 50% to 90%, indicating that menstrual pain is a widespread health concern in this population.(2),(3) Adolescence is characterized by hormonal fluctuations and reproductive maturation. These physiological changes may influence menstrual pain perception and response to physical activity. Dysmenorrhea has also been associated with school

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absenteeism, decreased concentration during learning, and reduced quality of life among adolescents.(4) Recent evidence indicates that physical activity may play an important role in the prevention and management of dysmenorrhea among adolescents.(5)(6)(7) These findings indicate that dysmenorrhea remains a relevant public health concern that requires effective and accessible management strategies, particularly for adolescent populations.

Primary dysmenorrhea occurs in the absence of pelvic pathology and is primarily associated with excessive prostaglandin production, which increases uterine contractions and contributes to ischemic menstrual pain.(8) Adolescents with dysmenorrhea have been reported to have higher concentrations of prostaglandin F2α (PGF2α) than individuals without menstrual pain, supporting the involvement of inflammatory mediators in pathophysiology of menstrual pain.(9) Elevated prostaglandin concentrations may increase inflammatory responses, stronger uterine contractions, and greater pain severity during menstruation.(10),(11) Excessive myometrial contractions can further reduce uterine blood flow and aggravate ischemic pain, which contributes to greater pain severity in primary dysmenorrhea.(12) Understanding these mechanisms provides a physiological rationale for interventions that may improve circulation and modulate pain responses.

Pharmacological treatments, particularly non-steroidal anti-inflammatory drugs (NSAIDs), are commonly used to relieve menstrual pain.(4) However, long-term use of analgesics may cause side effects, and some adolescents experience limited access to medication or low adherence to pharmacological treatment. Therefore, interventions targeting inflammatory pathways and improving uterine blood circulation are considered essential in reducing menstrual pain (8). Understanding this physiological mechanism provides a scientific basis for implementing exercise-based interventions as a non-pharmacological approach to dysmenorrhea management. Building on this evidence, structured exercise has emerged as one of the most promising non-pharmacological approaches for primary dysmenorrhea. Aerobic exercise has been shown to significantly reduce dysmenorrhea by improving blood circulation and stimulating endorphin release.(13),(14),(15) Recent systematic reviews and meta-analyses have also reported beneficial effects of exercise, particularly aerobic exercise, on pain intensity in primary dysmenorrhea.(16),(17) Core strengthening exercises improve lumbopelvic stability and reduce abdominal muscle tension, which may decrease menstrual pain.(18), (19) Additional evidence suggests that combining core exercises with breathing techniques can further reduce dysmenorrhea intensity.(20) These findings support the potential role of structured exercise programs in managing menstrual pain among adolescents.

Although both aerobic and core strengthening exercises have been associated with reductions in dysmenorrhea intensity, most previous studies have examined these interventions independently. Direct head-to-head comparisons between aerobic and core strengthening exercises remain limited, particularly among adolescent girls. Furthermore, differences in exercise intensity, duration, and study design across previous research make it difficult to determine which type of exercise provides superior benefits. This lack of comparative evidence highlights a research gap in identifying the most effective non-pharmacological intervention for adolescents experiencing primary dysmenorrhea. Comparing aerobic and core strengthening exercises is also clinically meaningful because both interventions are relatively low-cost, easy to implement in school-based health programs, and may differ in adolescents' preferences and feasibility for regular practice.(14),(16),(18) This evidence gap is clinically relevant because both exercise modalities are relatively low-cost and potentially feasible for implementation in school-based health programs, while their physiological mechanisms and practical requirements differ.

Therefore, this study aimed to compare the effects of aerobic exercise and core strengthening exercises on dysmenorrhea among adolescents. We hypothesized that aerobic exercise may provide greater reduction in dysmenorrhea intensity due to its systemic effects on circulation and endorphin release.(14),(16) By directly evaluating these

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two commonly recommended exercise modalities within the same study design, this research seeks to clarify their relative effectiveness in reducing menstrual pain and to determine which intervention is more practical and beneficial for adolescent populations.(19)

METHOD

This study employed a randomized controlled experimental design with a pretest and posttest two-group approach. The study was conducted at SMP Muhammadiyah 2 Gamping, Yogyakarta, Indonesia, from 6 to 29 January 2026. The target population comprised adolescent girls with primary dysmenorrhea. A total of 88 adolescent girls were initially screened for eligibility. Based on the inclusion and exclusion criteria, 34 participants met the eligibility requirements and were included in the study. The inclusion criteria were adolescent girls aged 10–17 years who experienced primary dysmenorrhea, had a baseline pain intensity score of ≥3 on the Visual Analog Scale (VAS), and were willing to participate in the study. Primary dysmenorrhea was determined based on participants' self-reported menstrual pain without diagnosed pelvic pathology. Participants with secondary dysmenorrhea or diagnosed gynecological disorders were excluded from the study. The required sample size was calculated using OpenEpi software. The calculation parameters, including the assumed effect size, significance level, statistical power, and allowance for potential attrition, should be reported to ensure reproducibility. Eligible participants were recruited using purposive sampling because the study targeted a specific population of adolescent girls with primary dysmenorrhea within a single school setting. After eligibility screening and enrollment, participants were randomly allocated to one of two intervention groups: an aerobic exercise group (n=17) or a core strengthening exercise group (n=17). The use of purposive sampling for participant recruitment and simple randomization for group allocation was intended to distinguish participant selection from intervention allocation. Participants were randomly allocated to the aerobic exercise or core strengthening exercise group using a simple lottery method. Identical folded papers labelled "A" (aerobic exercise) and "C" (core strengthening exercise) were placed in a container, and each participant drew one paper to determine group assignment. The person responsible for preparing the allocation papers and the procedure used to ensure allocation concealment should be specified. Because of the nature of the exercise interventions, participants and intervention providers could not be blinded to group assignment.

Both exercise interventions were conducted in a face-to-face setting and were directly supervised by the researcher to ensure proper exercise technique and adherence to the intervention protocol. The aerobic exercise intervention was performed three times per week for three consecutive weeks. Each session lasted 30 minutes, consisting of 5 minutes of warm-up, 20 minutes of moderate-intensity aerobic movements, and 5 minutes of cool-down. Moderate intensity was defined as approximately 60–70% of the estimated maximum heart rate (HRmax).(13) The core strengthening exercise group performed pelvic bridging, plank, cat and camel, and curl-up exercises. Each movement was performed for approximately 30 seconds per repetition with 10 repetitions per exercise and two sets, with a 30-second rest period between sets. The active core strengthening exercises lasted approximately 20 minutes. However, similar to the aerobic exercise group, the total session duration was maintained at 30 minutes including warm-up and cool-down.(18) Blinding was not applied in this study because participants were aware of the exercise interventions they received. The participant recruitment, eligibility assessment, randomization, allocation, intervention, and analysis processes are presented in Figure 1.

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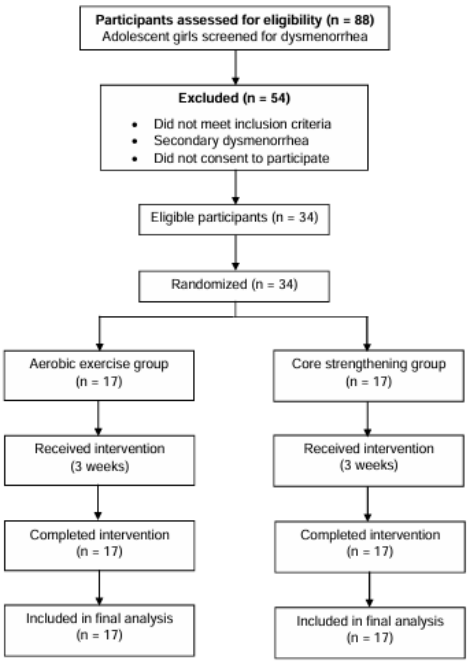

Figure 1. CONSORT flow diagram of participant recruitment, eligibility assessment, randomization, allocation, follow-up, and analysis in the aerobic exercise and core strengthening groups

The primary outcome was change in dysmenorrhea pain intensity, assessed using the Visual Analog Scale (VAS), ranging from 0 (no pain) to 10 cm (worst pain imaginable), which is a valid and reliable instrument for pain assessment.(21) Pain intensity were obtained based on participants' self-reported recall of menstrual pain experienced during their most recent menstrual cycle before the intervention (pre-test) and during the menstrual cycle following the three-week intervention period (post-test).

Data normality was assessed using the Shapiro-Wilk test, and homogeneity of variance was evaluated using Levene's test. Within-group differences were analyzed using the Wilcoxon Signed Rank Test and Paired Sample T-Test, while between-group differences were analyzed using the Mann-Whitney U Test because at least one post-intervention dataset did not meet the assumption of normality. Statistical analysis was performed using SPSS 25 software, and statistical significance was set at $p<0.05$.

This study was conducted in accordance with ethical principles for health research involving human participants. Ethical clearance for this study was obtained from the Poltekkes Kemenkes Yogyakarta Ethics Committee (No. DP.0403/e-KEPK.1/1278/2025). The study was declared ethically appropriate to be conducted in accordance with health research standards. Written informed consent was obtained from all participants and their parents or legal guardians prior to data collection.

RESULTS

A total of 34 adolescent girls were enrolled and randomly allocated into two groups: the aerobic exercise group (n = 17) and the core strengthening exercise group (n = 17). All participants completed the three-week intervention and were included in the final analysis.

Demographic Characteristics

The demographic characteristics of the participants are presented in Table 1. The majority of participants in both groups were aged 10–14 years. The aerobic exercise group had a BMI range from 15.61–30.39 kg/m², while the core strengthening group ranged from 13.70–

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32.89 kg/m². Physical activity levels were predominantly categorized as light activity in both groups.

Table 1. Demographic Characteristics of Participants

Characteristics	Aerobic Exercise (n=17)	Core Strengthening Exercise (n=17)
Age (years)	12–15	13–16
BMI (kg/m²)	15.61–30.39	13.70–32.89
Physical Activity		
Light	9 (52.9%)	9 (52.9%)
Moderate	6 (35.3%)	7 (41.2%)
Heavy	2 (11.8%)	1 (5.9%)

Baseline comparison using the Mann–Whitney U test showed no statistically significant difference in pre-intervention VAS scores between groups (p = 0.098), indicating that both groups were comparable prior to the intervention.

Changes in Dysmenorrhea Intensity

Changes in VAS scores before and after the three-week intervention are presented in Table 2 and Figure 2. The aerobic exercise group showed a decrease in mean VAS score from 6.00 ± 2.09 at pretest to 3.00 ± 1.86 at posttest, corresponding to a mean reduction of 3.00 points. The core strengthening exercise group showed a decrease from 7.18 ± 1.94 to 4.53 ± 1.84, corresponding to a mean reduction of 2.65 points.

Table 2. Comparison of VAS Scores Before and After the Intervention

Group	Pretest Mean ± SD	Posttest Mean ± SD	Mean Reduction	Within-Group Test	95% CI	Effect size	p-value
Aerobic Exercise	6.00 ± 2.09	3.00 ± 1.86	3.00	Wilcoxon Signed Rank Test	-	r = 0.89	<0.001
Core Strengthening Exercise	7.18 ± 1.94	4.53 ± 1.84	2.65	Paired Sample t-test	2.10 - 3.19	d = 2.50	<0.001

Both groups demonstrated statistically significant reductions in VAS scores following the intervention. In the aerobic exercise group, the Wilcoxon signed-rank test showed a significant reduction in pain intensity ($Z = -3.666$, $p < 0.001$), with an effect size of $r = 0.89$. In the core strengthening exercise group, the paired-samples *t*-test also showed a significant reduction in VAS scores ($p < 0.001$), with a Cohen's d of 2.50.

Figure 2 illustrates the changes in mean VAS scores from pretest to posttest in the two intervention groups.

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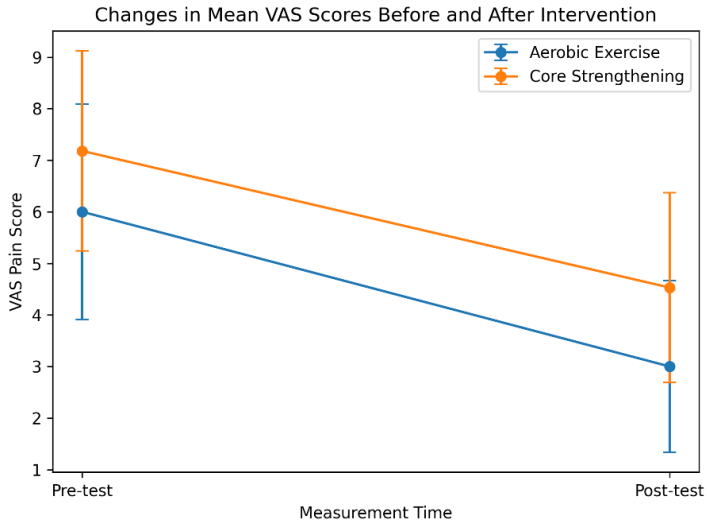

Figure 2. Changes in mean VAS scores before and after the intervention in the aerobic exercise and core strengthening exercise groups.

Normality and Homogeneity Testing

The Shapiro–Wilk test showed that pre-test data in both groups were normally distributed ($p > 0.05$). However, post-test data in the aerobic exercise group were not normally distributed ($p = 0.039$). Therefore, the Wilcoxon Signed Rank Test was used for the aerobic exercise group, while the paired sample t-test was used for the core strengthening group. Levene's test indicated that the variance between groups was homogeneous for both pre-test and post-test data ($p > 0.05$).

Between-Group Comparison

The between-group comparison is presented in Table 3. The Mann–Whitney U test showed a statistically significant difference in posttest VAS scores between the aerobic exercise and core strengthening exercise groups ($U = 78.0$, $p = 0.020$). The mean difference in posttest VAS scores was −1.53 points (95% CI, −2.75 to −0.31), indicating a lower post-intervention pain score in the aerobic exercise group.

Table 3. Between-Group Comparison of Posttest VAS Scores

Comparison	Mean Difference	95% CI	Test	p-value
Aerobic Exercise vs Core Strengthening Exercise (posttest)	-1.53	-2.75 to -0.31	Mann–Whitney U test	0.020

The results showed a statistically significant difference in post-intervention VAS scores between the aerobic exercise and core strengthening groups ($U = 78.0$, $p = 0.020$). The mean difference in post-intervention pain scores between groups was −1.53 points (95% CI −2.75 to −0.31), indicating greater pain reduction in the aerobic exercise group. These findings indicate that aerobic exercise resulted in a greater reduction in dysmenorrhea intensity compared with core strengthening exercise.

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DISCUSSION

The present study demonstrated that both aerobic exercise and core strengthening exercises significantly reduced dysmenorrhea intensity among adolescents girls. However, aerobic exercise produced a greater reduction in pain intensity than core strengthening exercises. Specifically, the aerobic exercise group showed a mean reduction of 3.00 points in VAS score, representing approximately a 50% decrease from baseline pain intensity, while the core strengthening group demonstrated a 2.65-point reduction. This level of reduction is considered clinically meaningful, as previous pain research suggests that a decrease of 2 points or approximately 30% on the VAS scale represents a clinically important improvement in pain perception. Therefore, the results of this study indicate that both exercise interventions provide meaningful benefits for menstrual pain management among adolescents.

Importantly, this study contributes to the existing literature by directly comparing two structured exercise modalities within the same adolescent population, which has been identified as a research gap in previous studies. This comparison provides clearer evidence regarding the relative effectiveness of different exercise interventions for dysmenorrhea management.(16),(22)

Effect of Aerobic Exercise on Dysmenorrhea

Aerobic exercise significantly reduced dysmenorrhea intensity, with a mean reduction of 3.00 points on the VAS. The findings of this study demonstrate that aerobic exercise significantly reduces dysmenorrhea intensity among adolescents. The magnitude of pain reduction observed in this study indicates that aerobic exercise provides clinically meaningful improvement in menstrual pain management.

Several physiological mechanisms may explain this effect. Aerobic exercise increases improvements in uterine blood circulation and oxygen supply, which reduce ischemic pain caused by excessive prostaglandin production. Elevated prostaglandin levels increase uterine contractility and are considered a major cause of primary dysmenorrhea.(4),(8) Aerobic exercise may also reduce inflammatory mediators and stimulate the release of β-endorphins, which increase pain tolerance and decrease pain perception. Improved systemic circulation during aerobic exercise may further reduce uterine ischemia and improve oxygen delivery to reproductive tissues. These findings are consistent with several previous studies reporting that aerobic exercise significantly reduces primary dysmenorrhea intensity.(13),(23) In addition, recent systematic reviews and meta-analyses have concluded that aerobic exercise is one of the most effective non-pharmacological interventions for dysmenorrhea management.(14),(16) These mechanisms provide a plausible explanation for the substantial reduction in pain observed in the aerobic exercise group.

However, previous studies have reported inconsistent findings. Differences in exercise intensity, intervention duration, participant characteristics, and adherence may partly explain these variations. Cultural factors, lifestyle patterns, and adherence to exercise programs may also influence the effectiveness of exercise-based interventions. Previous studies have also indicated that differences in physical activity levels and lifestyle patterns among adolescents may influence the severity of dysmenorrhea.(6),(7) Despite these variations, the overall evidence suggests that regular aerobic exercise provides important physiological benefits that contribute to menstrual pain reduction.

Effect of Core Strengthening Exercises on Dysmenorrhea

Core strengthening exercises also significantly reduced dysmenorrhea intensity, with a mean VAS reduction of 2.65 points. Strengthening the abdominal and lumbopelvic muscles may improve postural stability, neuromuscular control, and pelvic support, which can reduce mechanical stress in the pelvic region during menstruation.

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Previous studies have shown that stretching and core-based exercise interventions can reduce symptoms of primary dysmenorrhea.(18),(19) In addition, some studies suggest that combining core strengthening exercises with relaxation or breathing techniques may enhance pain reduction outcomes.(20) The present findings therefore support core strengthening as a potentially useful non-pharmacological option for adolescents experiencing dysmenorrhea.

The mechanism may differ from that of aerobic exercise. Core strengthening targets the abdominal and lumbopelvic musculature and may improve postural stability, neuromuscular control, and pelvic support. These effects may reduce musculoskeletal tension and alter pain perception during menstruation. Although the reduction observed in the present study was statistically significant, the magnitude of improvement was smaller compared with aerobic exercise. This may be explained by the underlying physiological mechanisms of dysmenorrhea. Primary dysmenorrhea is primarily associated with uterine ischemia caused by prostaglandin-induced hypercontractility of the myometrium, which represents a vascular and biochemical process.(4),(8) Aerobic exercise directly influences these mechanisms by improving circulation and modulating inflammatory mediators. One possible explanation is that core strengthening exercises mainly target musculoskeletal stability and mechanical support, which may indirectly influence pain perception rather than addressing the primary biochemical cause of dysmenorrhea.

This interpretation should be considered cautiously because the present study did not measure prostaglandin concentrations, inflammatory markers, uterine blood flow, or other physiological outcomes. Consequently, the proposed mechanisms remain plausible explanations rather than directly demonstrated pathways. Future studies incorporating objective physiological measures are needed to determine whether differences in biological responses explain the observed differences between exercise modalities.

Comparison Between Aerobic and Core Strengthening Exercises

The principal contribution of this study is the direct comparison of aerobic and core strengthening exercise within the same randomized adolescent cohort. The between-group analysis demonstrated a statistically significant difference in post-intervention VAS scores, with a mean difference of −1.53 points (95% CI −2.75 to −0.31; p = 0.020), favoring aerobic exercise. This finding suggests that aerobic exercise may provide greater pain relief than core strengthening exercise when delivered under the intervention conditions used in this study. This finding highlights the importance of selecting exercise modalities that address the underlying pathophysiology of primary dysmenorrhea. Since dysmenorrhea is primarily driven by prostaglandin-mediated uterine ischemia, interventions that improve systemic circulation and inflammatory regulation, such as aerobic exercise, may provide greater therapeutic benefit.

The superiority of aerobic exercise may be related to its broader physiological effects. Aerobic activity simultaneously engages cardiovascular, metabolic, and neurophysiological systems and may influence circulation, inflammatory regulation, and endogenous pain modulation. In contrast, core strengthening primarily emphasizes muscular stability and lumbopelvic control. Although both mechanisms may contribute to pain reduction, aerobic exercise may more directly influence physiological processes associated with primary dysmenorrhea, particularly those related to circulation and systemic pain modulation.

The findings are broadly consistent with previous evidence indicating that aerobic exercise can produce substantial reductions in dysmenorrhea intensity and that exercise modality may influence treatment effectiveness.(16), (22), (24) However, differences across studies in exercise dose, participant characteristics, outcome measurement, and intervention duration make direct comparisons difficult. The present study therefore adds comparative evidence rather than establishing that aerobic exercise is universally superior

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to all forms of core-based exercise. Further adequately powered randomized trials are needed to determine whether the observed difference is reproducible across different adolescent populations and intervention protocols.

Practical and Clinical Implications

The findings of this study have several practical implications for adolescent health programs. Aerobic exercise may be recommended as a simple and accessible non-pharmacological intervention for managing primary dysmenorrhea in adolescents. Health workers, school nurses, and midwives involved in adolescent reproductive health programs may consider encouraging regular aerobic exercise sessions of approximately 30 minutes as a first-line non-pharmacological strategy for menstrual pain management before pharmacological treatment is considered. Schools may also play an important role in supporting adolescent reproductive health by integrating structured physical activity programs, particularly aerobic exercise, into school-based health promotion initiatives. These findings may inform policymakers and public health practitioners in developing school-based menstrual health programs that promote safe and effective lifestyle interventions for dysmenorrhea management.(1)

Strengths of the Study

This study has several strengths. First, it provides a direct head-to-head comparison between aerobic exercise and core strengthening exercises within the same adolescent population, which allows a clearer evaluation of the relative effectiveness of these two exercise modalities in reducing dysmenorrhea intensity. Second, the exercise interventions were conducted under direct supervision by the researcher, ensuring that participants performed the exercises correctly and adhered to the intervention protocol. Third, the study applied a standardized pain assessment using the Visual Analog Scale (VAS) and appropriate statistical analyses to evaluate changes in pain intensity following the interventions.

Study Limitations

Despite these strengths, several limitations should be considered when interpreting the findings of this study. First, the sample size was relatively small (n = 34), which may limit the generalizability of the results to broader adolescent populations. Second, the intervention period was relatively short (three weeks), which may not fully capture the long-term effects of exercise interventions on dysmenorrhea. Third, the study did not control for other forms of physical activity performed by participants outside the intervention sessions, which may have influenced pain outcomes. Additionally, biological markers such as prostaglandin levels or inflammatory mediators were not measured, which could have provided further insight into the physiological mechanisms underlying pain reduction. Fourth, participants and the researcher were not blinded to group allocation because the nature of the exercise interventions made blinding impractical. This may have introduced performance or reporting bias, particularly because pain intensity was assessed using a self-reported outcome. Fifth, physical activity performed outside the intervention sessions was not controlled, which may have influenced pain outcomes. Finally, the study did not assess prostaglandin levels, inflammatory biomarkers, uterine perfusion, medication use, or other physiological and behavioral factors that could help explain the mechanisms underlying the observed effects.

Implications for Future Research

Future studies should use larger, multicenter randomized controlled trials with longer follow-up periods to determine whether the benefits of aerobic and core strengthening exercises are sustained across multiple menstrual cycles. Research should also examine whether

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intervention dose, including exercise frequency, intensity, and duration, modifies treatment effectiveness. Comparative studies incorporating objective biomarkers, such as prostaglandin and inflammatory mediator levels, may clarify the physiological mechanisms underlying differences between exercise modalities. In addition, future research could evaluate combined aerobic and core strengthening programs to determine whether multimodal exercise provides greater benefits than either modality alone. Outcomes such as quality of life, school attendance, analgesic use, adherence, and cost-effectiveness should also be considered to determine the broader clinical and public health value of exercise-based dysmenorrhea management.

CONCLUSION

Both aerobic and core strengthening exercises significantly reduce pain intensity among adolescent girls with primary dysmenorrhea. However, aerobic exercise produced significantly greater pain reduction than core strengthening exercises, indicating that it may represent the more effective non-pharmacological intervention. This head-to-head comparison provides new comparative evidence supporting the preferential use of aerobic exercise in school-based menstrual health programs. Nevertheless, the findings should be interpreted considering the relatively small sample size and short intervention period. Future multicenter randomized controlled trials with longer follow-up and objective physiological biomarkers are warranted to confirm these findings and evaluate the long-term effectiveness of exercise-based interventions for primary dysmenorrhea.

AUTHOR CREDIT STATEMENT

NNM contributed to the study conception and design, data collection, data analysis, and manuscript drafting. **SK** and **MAI** contributed to research supervision, methodological guidance, data interpretation, and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

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DECLARATION OF COMPETING INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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