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Effect Of Exercise On Primary Dysmenorrhea Among College Students

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Declaration of Conflict of Interest
The authors wish to declare that there are no potential conflicts of interest that could partially or fully prejudice the research report.

Abstract

Introduction: Primary dysmenorrhea is a prevalent menstrual disorder among college students and significantly interferes with academic performance and quality of life. While analgesics remain the most commonly used treatment, increasing attention has been directed toward non-pharmacological approaches such as exercise.

Aim: This study assessed the comparative effectiveness of exercise and analgesics, in pain management among college students with primary dysmenorrhea.

Methodology: A quasi-experimental study design was employed involving college students diagnosed with primary dysmenorrhea. Participants were assigned into one of three groups: Group 1, Group 2 and Group 3. Baseline pain intensity was measured using the Visual Analogue Scale (VAS). Following the intervention period, post-intervention pain scores were reassessed. Data were analyzed using paired t-tests and one-way analysis of variance (ANOVA) with post-hoc comparisons.

Results: Baseline pain scores were comparable across groups, with mean pre-intervention VAS scores of 8.7 ± 1.3 in Group 1, 8.6 ± 1.4 in Group 2, and 8.8 ± 1.3 in Group 3 ($p = 0.595$). Post-intervention pain intensity significantly decreased in all groups. Group 1 showed the greatest reduction, with mean VAS decreasing from 8.7 ± 1.3 to 4.1 ± 0.9. Group 2 decreased from 8.6 ± 1.4 to 4.8 ± 1.2, while Group 3 decreased from 8.8 ± 1.3 to 5.7 ± 1.5. One-way ANOVA revealed a significant difference in post-intervention pain scores among the groups ($F = 45.67$, $p < 0.001$, $\eta^2 = 0.24$).

Conclusion: The combination of exercise and analgesics produced the greatest pain reduction, followed by exercise alone, while analgesics alone were least effective. Exercise represents a safe, cost-effective, and clinically valuable intervention for managing primary dysmenorrhea among college students.

Keywords: Dysmenorrhea, Analgesics, Exercise, Prevalent, Students

Introduction

Dysmenorrhea is one of the leading causes of gynecological consultation worldwide, with a global prevalence ranging from 15.8% to 91.5% among adolescents [1]. Reports from the World Health Organization indicate that between 16.8% and 81% of women experience dysmenorrhea, with 45% to 95% of women of childbearing age affected [2,3]. It is therefore one of the most common menstrual disorders and has significant implications for physical, psychological, and social wellbeing. Dysmenorrhea negatively impacts academic performance, daily functioning, sleep quality, and concentration, often leading to social withdrawal and reduced self-confidence. Despite its high prevalence, many adolescents and young women do not seek medical care, instead resorting to self-medication, resulting in suboptimal management [4,5].

Dysmenorrhea follows a cyclic pattern and is typically most severe during the first day of menstruation, lasting up to 72 hours. Cultural perceptions and the belief that menstrual pain is a normal part of womanhood contribute to underreporting and delayed care-seeking behavior [6-9]. Healthcare professionals therefore play an essential role in identifying affected individuals, providing appropriate education, and recommending effective management strategies, including non-pharmacological interventions such as exercise [10].

Primary dysmenorrhea is characterized by spasmodic, cramp-like lower abdominal pain that may radiate to the lower back and thighs [11]. The pain ranges from mild to severe and occurs in the absence of identifiable pelvic pathology. It is commonly accompanied by systemic symptoms such as nausea, vomiting, headache, fatigue, bloating, dizziness, and diarrhea, further impairing daily functioning [12,13]. Symptoms usually begin 6–12 months after menarche, coinciding with the establishment of ovulatory cycles [14].

The pathophysiology of primary dysmenorrhea is primarily linked to hormonal fluctuations during the menstrual cycle. Following ovulation, increased progesterone levels stimulate the production of prostaglandin $F_{2\alpha}$ within the endometrium. Elevated prostaglandin levels result in excessive uterine contractions, reduced uterine blood flow, and ischemic pain [15,16]. Leukotrienes and vasopressin further contribute to uterine hypercontractility and pain perception [11]. Psychological factors such as stress and anxiety may intensify pain sensitivity and are associated with increased symptom severity [17]. Although primary dysmenorrhea often improves with age or childbirth, it may persist for several years in some women [18,19].

Current management strategies primarily involve nonsteroidal anti-inflammatory drugs (NSAIDs) and hormonal therapies [20,21]. While effective for many individuals, approximately one-quarter of affected women continue to experience persistent pain. Additionally, cultural differences and concerns regarding side effects may influence medication use, leading many women to rely on over-the-counter analgesics and self-care measures rather than seeking professional medical advice [21]. These limitations highlight the need for complementary, non-pharmacological interventions.

Physical exercise has been increasingly recognized as a beneficial therapeutic option. Regular physical activity has been shown to reduce stress, exert antinociceptive effects, and decrease prostaglandin levels associated with primary dysmenorrhea [22,23]. Exercise has long been recommended in clinical practice guidelines, including those of ACOG, and has been associated with improvements in pain severity, mental health, and overall quality of life [24,25]. Furthermore, it represents a low-cost intervention with minimal adverse effects.

However, although exercise is widely recommended, comparative evidence evaluating the effectiveness of exercise alone, analgesics alone, and their combined use among college students remains limited. Therefore, this study aimed to assess the comparative effectiveness of exercise, analgesics, and combination therapy in reducing pain intensity among college students with primary dysmenorrhea.

Methodology

Research Design

A quantitative research approach was adopted using a quasi-experimental pre-test and post-test design.
Participants were divided into three groups:

- Group 1: Combined exercise and analgesic group
- Group 2: Exercise-only group
- Group 3: Analgesic-only group

Pain intensity was measured before the intervention (pre-test) and after the intervention (post-test) in all three groups to determine the effect of the interventions.
The study was conducted at Delta State University, Abraka, Delta State.

The total duration of the study was two months. The exercise training was conducted three days per week, once daily, for eight weeks. The study was carried out at a 95% confidence level.

Study Area

The study was conducted among female college students attending Delta State University, Abraka. The institution

provides a diverse population of young women from different academic disciplines, making it suitable for assessing the effect of exercise on primary dysmenorrhea. The study environment included lecture halls, hostels, and designated exercise areas within the campus.

Population and Sampling
The target population comprised female college students aged 18–25 years who experienced primary dysmenorrhea. A purposive sampling technique was used to select participants who met the inclusion criteria.

Inclusion Criteria
- Females with regular menstrual cycles
- Females aged 18–25 years
- Females willing to participate
- Females who experienced pain before or during menstruation

Exclusion Criteria
- Females regularly practicing yoga or structured exercise
- Females diagnosed with polycystic ovarian disease (PCOD) and on treatment
- Females with secondary dysmenorrhea (e.g., fibroid, cervical stenosis)
- Females who did not experience menstrual pain
- Females with irregular menstrual cycles
- Females with cardiovascular health conditions

The sample size was calculated using the formula:

$n_0 = Z^2pq / d^2$

Where:
Z = standard normal deviation at 95% confidence level (1.96)
p = estimated prevalence of primary dysmenorrhea among college students
q = 1 − p
d = margin of error

Pain reduction was calculated by subtracting the post-intervention VAS score from the pre-intervention VAS score.

Mean Pain Reduction = Pre-intervention VAS − Post-intervention VAS
Percentage pain reduction was calculated as:
(Mean Pain Reduction ÷ Pre-intervention VAS) × 100

Sampling Technique
A multistage sampling technique was employed.
First, eligible participants were selected using purposive sampling based on the inclusion criteria.

Second, participants were randomly assigned into the three study groups (Group 1, Group 2, and Group 3) to minimize selection bias.

Research Instruments
Data were collected using a structured, self-administered questionnaire consisting of the following sections:
- Sociodemographic characteristics
- Menstrual history and dysmenorrhea characteristics
- Exercise participation pattern

Pain intensity was measured using the Visual Analogue Scale (VAS), ranging from 0 (no pain) to 10 (worst possible pain).

The Menstrual Symptom Questionnaire (MSQ) was used to assess the frequency and severity of dysmenorrhea symptoms and their impact on daily activities.

Anthropometric measurements such as height and weight were obtained using standardized measuring instruments.

Validity of the Instrument
Content and face validity of the questionnaire were established through review by experts in nursing, physiotherapy, and reproductive health. Their suggestions were incorporated to ensure that the instrument adequately measured variables related to dysmenorrhea and exercise intervention.

Reliability of the Instrument
Reliability was determined using a test–retest method during a pilot study conducted among a similar population not included in the main study.

The Visual Analogue Scale (VAS) demonstrated high reliability with an Intraclass Correlation Coefficient (ICC) of 0.99 (95% CI: 0.989–0.992), indicating excellent consistency.

Data Collection Procedure
The study was conducted over two menstrual cycles.

Baseline Assessment (Pre-Test)
Participants completed the VAS and MSQ during their first menstrual cycle to establish baseline pain intensity and symptom severity.

Intervention Phase
During the second menstrual cycle, participants in:
- Group 1 received both structured exercise and analgesics
- Group 2 participated in structured exercise only
- Group 3 received analgesics only

The exercise program consisted of aerobic and stretching exercises performed three times per week for 30 minutes per session over eight weeks.

Post-Intervention Assessment (Post-Test)
At the end of the intervention period, participants completed the VAS and MSQ again to assess changes in pain intensity and symptom severity.

Data Analysis
Data were analyzed using descriptive and inferential statistics.
Descriptive statistics such as mean and standard deviation were used to summarize demographic characteristics and baseline measurements.
Inferential statistics included:
- Paired t-tests to compare pre-test and post-test scores within each group
- One-way analysis of variance (ANOVA) to compare differences among the three groupsStatistical significance was set at $p < 0.05$.

Ethical Considerations
Ethical approval was obtained from the institutional ethical committee of Delta State University (Approval No: RCB/FBMC/DELSU/25/757).

The study was explained to all participants, and informed consent was obtained before data collection. Confidentiality and anonymity were maintained throughout the study. This study is not a clinical trial therefore, clinical trial registration and number are not applicable. In addition, no funding was sought or received.

Limitations of the Study
- Self-reporting bias
- Relatively small sample size
- Variations in adherence to the exercise regimen

Result
This section presents the analysis and interpretation of data collected to assess the effect of exercise among college students with primary dysmenorrhea.

The primary objective was to evaluate changes in pain intensity among the three intervention groups: combined exercise and analgesic, exercise only, and analgesic only. Pain levels were measured before (pre-test) and after (post-test) the intervention period.

Data were analyzed using descriptive and inferential statistical methods, including paired sample t-tests and one-way analysis of variance (ANOVA), to determine the statistical significance of observed differences. All statistical analyses were conducted at a 95% confidence level ($p < 0.05$), and results are presented accordingly.

Variable	Category	Group 1 Analgesic plus Exercise n equals 100	Group 2 Exercise Only n equals 100	Group 3 Analgesic Only n equals 100	Total Frequency n equals 300	Percentage
Age of Menarche (Years)	9 to 10	20	20	20	60	20.0
	11 to 12	52	50	51	153	51.0
	13 to 14	28	30	29	87	29.0
Height (m)	Below 1.50	16	17	16	49	16.3
	1.50 to 1.60	65	62	64	191	63.7
	Above 1.60	19	21	20	60	20.0
Current Age (Years)	18 to 20	55	60	58	173	57.7
	21 to 23	33	30	34	97	32.3
	24 to 25	12	10	10	30	10.0
Weight (kg)	Below 50	14	13	14	41	13.7
	50 to 65	70	68	69	207	69.0
	Above 65	16	19	17	52	17.3

Table 1: Demographic Characteristics using Descriptive Statistics to interpret the Effect of Exercise among College Student with Primary Dysmenorrhea

Statistical Interpretation

The distribution of demographic variables across the three study groups showed a high level of similarity, indicating that the groups were comparable at baseline. Most respondents attained menarche between 11 and 12 years, accounting for 51.0 percent of the total sample, with nearly equal frequencies across all groups. Height distribution was also comparable, as the majority of participants fell within the 1.50 to 1.60 m category, representing 63.7 percent of the respondents. In terms of current age, over half of the participants were aged 18 to 20 years, while about one third were within the 21 to 23 year range, with minimal variation across groups. Similarly, body weight was predominantly within the 50 to 65 kg category, comprising 69.0 percent of the sample, and was evenly distributed among the three groups. Overall, the close similarity in age of menarche, height, current age, and weight suggested homogeneity of the study groups. This indicated that these demographic characteristics were unlikely to confound the assessment of the effect of exercise on primary dysmenorrhea, thereby strengthening the validity of comparisons made between the intervention groups.

Variable	Category	Group 1 Analgesic plus Exercise n equals 100	Group 2 Exercise Only n equals 100	Group 3 Analgesic Only n equals 100	Total Frequency n equals 300	Percentage
Menstrual Cycle Length (Days)	3 to 4	60	58	59	177	59.0
	5 to 6	40	42	41	123	41.0
Duration of Menstrual Pain (Days)	1 to 2	67	66	67	200	66.7
	3 to 4	33	34	33	100	33.3
Drug History	NSAIDs	30	0	35	65	21.7
	Paracetamol	15	0	15	30	10.0
	Other Drugs	10	0	10	20	6.7
	No Drug History	45	100	40	185	61.6
Sanitary Pads Used per Day	10 or less	63	61	63	187	62.3
	More than 10	37	39	37	113	37.7

Table 2: Demographic Characteristics using Descriptive Statistics to interpret the Effect of Exercise among College Student with Primary Dysmenorrhea

Statistical Interpretation

The menstrual cycle length and duration of menstrual pain were similar across all groups, with most participants reporting 3–4 day cycles (59.0%) and 1–2 days of pain (66.7%), indicating baseline homogeneity in menstrual characteristics. Drug history varied by group, with Group 2 (Exercise only) having no prior drug use, while Groups 1 and 3 had participants with NSAIDs, paracetamol, or other drugs, reflecting differences in prior pharmacological exposure. Sanitary pad usage was consistent across groups, with most participants using 10 or fewer pads per day (62.3%), suggesting uniform menstrual flow and minimizing its potential influence on pain assessment. Overall, the groups were largely comparable in menstrual characteristics, except for drug history, which aligned with the study design and allowed assessment of exercise effects independently.

Descriptive Statistics (Mean and SD)

This section provides the mean, standard deviation (SD), and range for each variable across the three groups (Group 1: Analgesic + Exercise; Group 2: Exercise Only; Group 3: Analgesic Only):

Variable	Group 1	Group 2 (n=100)	Group 3 (n=100)
Age of Menarche (years)	11.9 ± 1.6	11.6 ± 1.5	11.8 ± 1.6
Height (cm)	1.56 ± 0.08	1.54 ± 0.07	1.55 ± 0.08
Current Age (years)	20.6 ± 1.8	19.9 ± 1.9	20.5 ± 1.9
Weight (kg)	59.2 ± 8.4	55.1 ± 9.2	57.3 ± 9.0
Menstrual Cycle Length (days)	4.4 ± 0.9	4.3 ± 0.9	4.4 ± 0.9
Duration of Menstrual Pain (days)	2.1 ± 0.9	2.0 ± 0.8	2.1 ± 0.9
No. of Pads Used/Day	10.2 ± 1.8	9.8 ± 1.7	10.1 ± 1.9
Pre-VAS (0–10)	8.7 ± 1.3	8.6 ± 1.4	8.8 ± 1.3
Post-VAS (0–10)	4.1 ± 0.9	4.8 ± 1.2	5.7 ± 1.5

Table 3: Descriptive Statistics (Mean ± SD) (n = 100)

Statistical Interpretation

The mean values and standard deviations indicated that the three groups were largely comparable at baseline. Age of menarche, height, current age, weight, menstrual cycle length, duration of menstrual pain, and sanitary pad usage showed minimal variation across groups, reflecting homogeneity in demographic and menstrual characteristics. Pre-intervention VAS scores were similarly high across groups (8.6–8.8), confirming comparable baseline pain severity. Post-intervention VAS scores showed a reduction in all groups, with Group 1 (Analgesic plus Exercise) demonstrating the greatest decrease (mean 4.1), followed by Group 2 (Exercise only, 4.8) and Group 3 (Analgesic only, 5.7). This suggested that exercise, alone or combined with analgesics, effectively reduced menstrual pain more than analgesics alone.

Inferential Statistics

Source	SS	df	MS	F	p	η^2
Between Groups	1.72	2	0.86	0.52	.595	.003
Within Groups	491.30	297	1.65			
Total	493.02	299				
No significant differences between groups (all p >. 05).						

Table 4: Research Question 1, Effect of Primary Dysmenorrhea Among Young Women (Baseline Pain Comparison)

Statistical Interpretation

This one-way ANOVA assessed baseline pain severity (pre-intervention VAS scores) among the three groups: Group 1 (Analgesic + Exercise), Group 2 (Exercise only), and Group 3 (Analgesic only). The result revealed no statistically significant difference in baseline pain levels among the groups ($F(2, 297) = 0.52$, $p = 0.595$). The effect size ($\eta^2 = 0.003$) indicates that only 0.3% of the variance in baseline pain scores was explained by group differences, which is negligible. This confirms that all groups were equivalent in terms of initial pain severity, strengthening the internal validity for evaluating intervention effects in subsequent analyses.

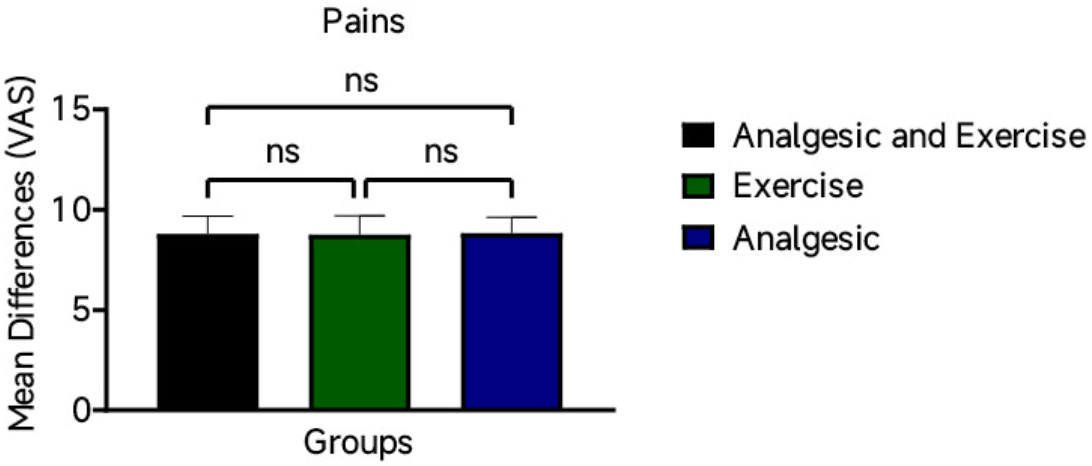

Figure 1: Pre-Intervention Pains

Data were expressed as Mean ± SD, n=100, nsp<0.0001 is No significant when compared to Exercise, and Analgesic.

Group	n	Mean ± SD	t	df	p	Cohen's d
Exercise (G2)	100	4.8 ± 1.2	4.685	198	<0.0001****	0.74
Analgesic (G3)	100	5.7 ± 1.5				

Table 5: Research Question 2: Exercise vs. Analgesics on Pain Reduction (Post-VAS)

Statistical Interpretation

An independent samples t-test compared post-intervention pain scores between Group 2 (Exercise only) and Group 3 (Analgesic only). The result showed a statistically significant difference in pain reduction ($t(198) = 4.685$, $p < 0.0001$), with the exercise group reporting significantly lower pain scores. The effect size (Cohen's $d = 0.74$) is considered medium to large, suggesting that exercise alone had a substantially greater impact on pain reduction compared to analgesics alone. This finding underscores the efficacy of physical activity as a non-pharmacological treatment for dysmenorrhea.

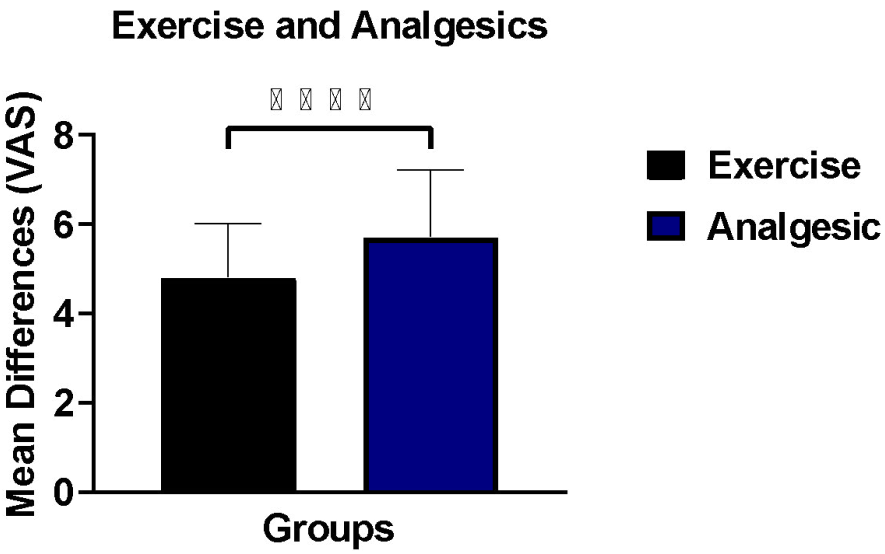

Figure 2: Post-Intervention Pains among Exercise and Analgesics Groups

Data were expressed as Mean ± SD, n=100, ****p<0.0001 is significant when compared to Analgesic.

Time	Mean ± SD	t	df	p	f
Pre	8.7 ± 1.3	29.09	198	<0.0001****	2.086
Post	4.1 ± 0.9				

Table 6: Research Question 3: Pre- vs. Post-VAS in Group 1 (Analgesic + Exercise)

Statistical Interpretation

For Group 1, a paired t-test showed a highly significant reduction in pain from pre- to post-intervention ($t(198) = 29.09$, $p < 0.0001$). The effect size ($f = 2.086$) indicates a very large treatment effect, confirming the superiority of combining exercise with analgesics for managing primary dysmenorrhea. The sharp drop in pain scores (from 8.7 to 4.1) reflects a clinically meaningful improvement.

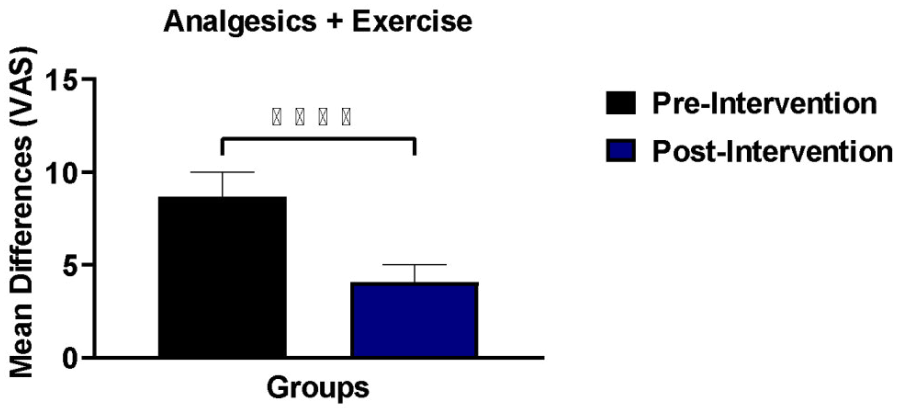

Figure 3: Pre and Post-Intervention Pains in Analgesics and Exercise Groups

Data were expressed as Mean ± SD, n=100, ****p<0.0001 is significant when compared to Post-Intervention.

Time	Mean ± SD	t	df	p	f	95% CI
Pre	8.6 ± 1.4	20.61	198	<0.0001****	1.361	[8.9, 5.0]
Post	4.8 ± 1.2					

Table 7: Safety/Efficacy of Exercise (Pre- vs. Post-VAS in Group 2)

Statistical Interpretation

In Group 2, a significant reduction in pain scores was also observed ($t(198) = 20.61$, $p < 0.0001$). The effect size ($f = 1.361$) is large, suggesting that exercise alone is highly effective in managing dysmenorrhea symptoms. The 95% confidence interval for the difference in means indicates a strong and reliable improvement, further supporting exercise as a standalone intervention.

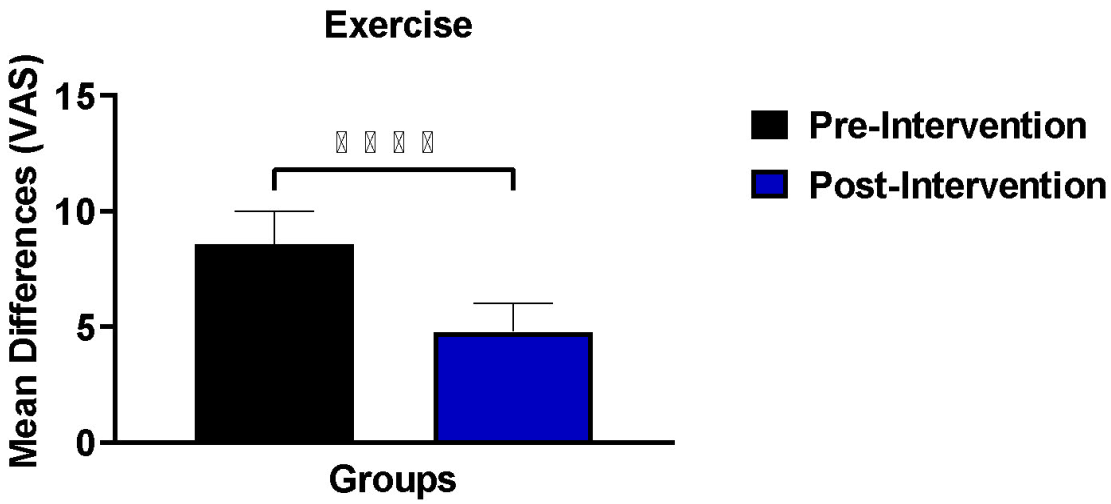

Figure 4: Pre and Post-Intervention Pains in Exercise Groups

Data were expressed as Mean ± SD, n=100, ****p<0.0001 is significant when compared to Post-Intervention.

Time	Mean ± SD	t	df	p	f
Pre	8.8 ± 1.3	15.62	198	<0.0001****	1.331
Post	5.7 ± 1.5				

Table 8. Pre- vs. Post-VAS in Group 3

Statistical Interpretation

Group 3 also demonstrated a statistically significant reduction in pain ($t(198) = 15.62$, $p < 0.0001$), though the effect size ($f = 1.331$) is slightly smaller than that of the exercise group. Despite a clear reduction in pain, analgesics alone were less effective compared to the other interventions, especially when juxtaposed with the combination therapy (Group 1).

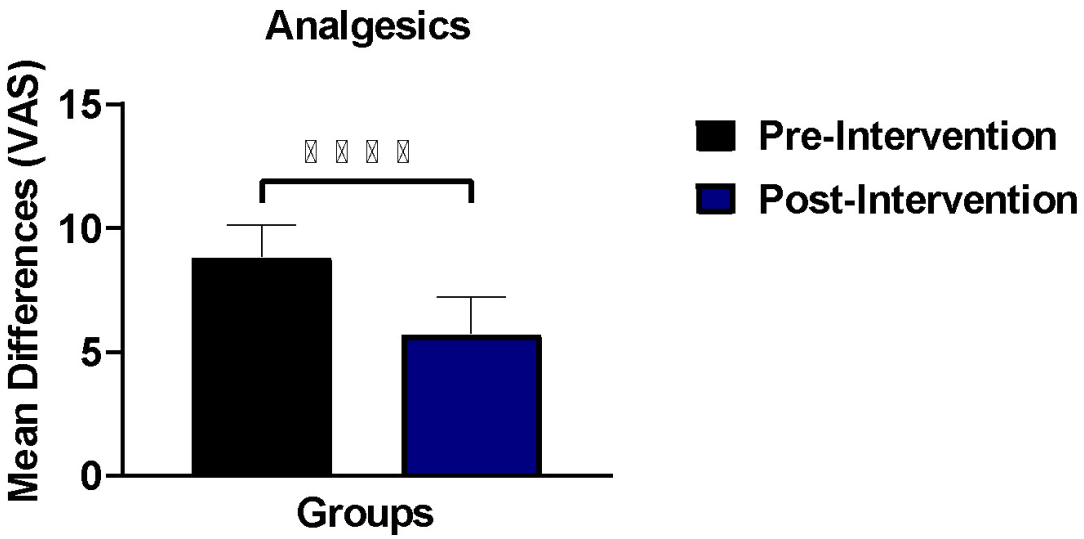

Figure 5: Pre and Post-Intervention Pains in Analgesics Groups

Data were expressed as Mean ± SD, n=100, ****p<0.0001 is significant when compared to Post-Intervention.

Group	n	Mean ± SD	F	df	p	η^2	Post-Hoc (Tukey HSD)
G1: Analgesic + Exercise	100	4.1 ± 0.9	45.67	2, 297	<0.0001	0.24	G1 < G2, G1 < G3, G2 < G3
G2: Exercise Only	100	4.8 ± 1.2					
G3: Analgesic Only	100	5.7 ± 1.5					

Table 9: One-Way ANOVA Comparing All Three Groups (Post-Intervention VAS Scores)

Statistical Interpretation

The post-intervention comparison of pain scores across all three groups using one-way ANOVA revealed a statistically significant difference ($F(2, 297) = 45.67$, $p < 0.0001$). The effect size ($\eta^2 = 0.24$) is large, indicating that 24% of the variance in post-treatment pain scores is attributable to the treatment type. Tukey's post-hoc test confirmed that Group 1 experienced significantly lower pain than both Groups 2 and 3, while Group 2 also had significantly less pain than Group 3. This clearly establishes the combination of exercise and analgesics as the most effective strategy, with exercise alone being superior to analgesics alone.

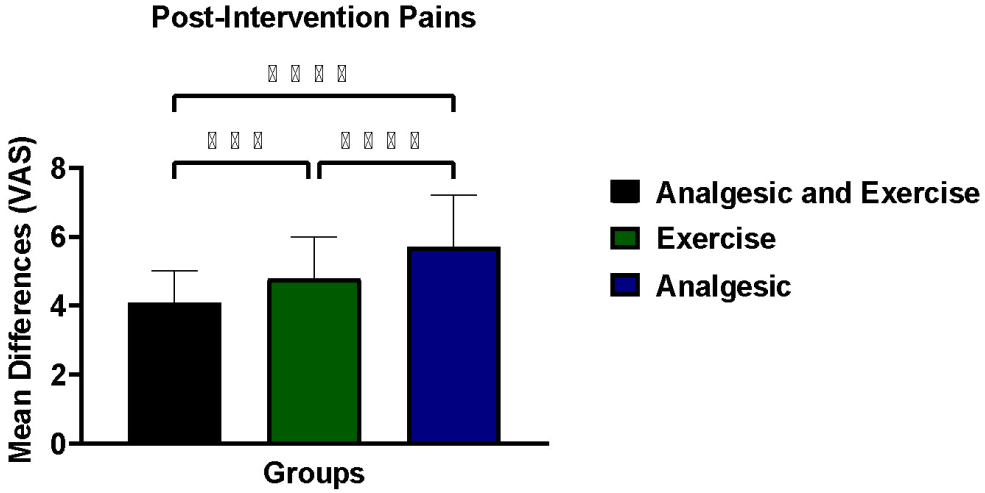

Figure 6: Post-Intervention Pains Among Groups

Data were expressed as Mean ± SD, n=100, ****p<0.0001 is significant when compared to Exercise, and Analgesic.

Discussion

The findings of this study provide compelling evidence regarding the comparative effectiveness of exercise, analgesics, and their combination in managing primary dysmenorrhea among college students. Primary dysmenorrhea remains one of the most debilitating menstrual disorders among young women, often impairing academic concentration, physical performance, and overall well-being. This study contributes to the growing body of evidence supporting non-pharmacologic interventions, particularly exercise, in alleviating menstrual pain.

Baseline homogeneity across the three groups strengthens the internal validity of this study. Demographic variables such as age, age at menarche, body weight, height, and menstrual cycle characteristics were uniformly distributed (Table 1 and Table 2), minimizing confounding influences. The one-way ANOVA of baseline VAS scores (Table 4) revealed no statistically significant difference among the groups ($p = 0.595$) with a negligible effect size ($\eta^2 = 0.003$), confirming group equivalence. Such baseline similarity is essential in quasi-experimental studies assessing pain outcomes, given that pain perception is influenced by physiological and psychosocial factors [12]. Additionally, the similarity in menarcheal age aligns with studies linking variations in menarche to dysmenorrhea severity [26,27]. while uniformity in body mass is consistent with evidence suggesting that both low and high BMI may influence pain perception through hormonal metabolism differences [28].

A critical finding of this study is the significant pain reduction observed in the exercise-only group (Table 3). The reduction in mean pain scores from 8.6 to 4.8 demonstrates both statistical and clinical significance. This supports previous findings that aerobic activity reduces prostaglandin levels and uterine contractions, thereby minimizing dysmenorrheic pain [29,30]. Exercise may exert its analgesic effect through enhanced pelvic blood flow, reduction of uterine ischemia, release of endogenous opioids such as beta-endorphins, and stress modulation [31,32]. These mechanisms collectively explain the substantial improvement observed among participants who engaged in structured physical activity. The result also aligns with global public health data emphasizing the protective role of regular physical activity against menstrual and reproductive health disorders [33,34].

Although the analgesic-only group (Table 8) experienced a statistically significant reduction in pain (from 8.8 to 5.7), the magnitude of improvement was comparatively smaller. NSAIDs reduce menstrual pain primarily through cyclooxygenase inhibition, thereby decreasing prostaglandin synthesis [35]. Exercise-induced analgesia has been linked to hormonal regulation, reduced cortisol levels, and improved psychological well-being, all of which contribute to enhanced pain coping capacity [36,37]. However, pharmacologic monotherapy may not adequately address the psychosomatic and lifestyle-related contributors to menstrual discomfort [21]. emphasize the importance of holistic approaches in adolescent and young adult populations, noting limitations associated with exclusive reliance on analgesics, including side effects and reduced long-term compliance [38].

The most pronounced pain reduction was observed in the combined intervention group (Group 1). As shown in Table 6, participants receiving both exercise and analgesics demonstrated the greatest decrease in pain, supported by a very large effect size ($f = 2.086$). This suggests a synergistic interaction between pharmacologic and physical modalities. While analgesics suppress prostaglandin-mediated uterine contractions, exercise enhances oxygen delivery to uterine tissues, mitigates ischemic pain, and improves psychological well-being through neurotransmitter modulation. These findings are consistent with Kannan and Claydon [36]. who reported superior outcomes with multimodal therapy compared to single-modality interventions.

Between-group comparison using one-way ANOVA (Table 9) revealed a statistically significant difference in post-intervention pain scores ($F = 45.67$, $\eta^2 = 0.24$), indicating that approximately 24% of the variance in pain reduction was attributable to intervention type. Tukey's post-hoc analysis confirmed the hierarchy of effectiveness: combined intervention, exercise only, and analgesic only. Such a large explained variance is notable in behavioral health research and supports theoretical models such as the ischemia-hypoxia model and pain-gate theory, which suggest that physical activity modulates nociceptive signaling and improves tissue oxygenation [40,41].

Beyond physiological mechanisms, exercise confers psychological benefits including reduced stress, improved mood, and enhanced self-efficacy. Young women with dysmenorrhea often report higher levels of anxiety and depressive symptoms [28]. In this context, exercise serves as both a physiological and psychological intervention. The physiological mechanism underlying the exercise induced benefits may be related to the inflammatory and/or immunologic pathway. Studies have shown that physical exercise modulates immunocytes dynamics and the inflammatory milieu [42,43]. These multidimensional benefits may explain why exercise alone outperformed analgesic monotherapy in this study.

Overall, the findings challenge the exclusive reliance on pharmacologic treatment and support integrative approaches that incorporate structured physical activity. Particularly in low-resource settings, exercise represents a cost-effective, accessible, and sustainable strategy for managing primary dysmenorrhea without pharmacologic side effects.

Conclusion

This study demonstrates that exercise, analgesics, and their combination significantly reduce pain associated with primary dysmenorrhea among college students, with the combined intervention producing the greatest improvement. Exercise alone proved more effective than analgesics alone, highlighting its strong therapeutic value as a safe and non-pharmacologic intervention. The confirmed baseline equivalence across groups strengthens the validity of these findings. Collectively, the results support a shift from pharmacologic monotherapy toward integrative and lifestyle-based management strategies in the treatment of primary dysmenorrhea.

Recommendations

Regular structured exercise should be promoted as a first-line, non-pharmacological strategy for managing primary dysmenorrhea among young women, particularly within college settings. Health practitioners should consider combining exercise with analgesics when enhanced or rapid pain relief is required, while educating patients on the limitations of sole pharmacologic therapy. Incorporating menstrual health education and supervised exercise programs into campus health services may improve pain outcomes and reduce medication dependence. Future research with longer follow-up periods and diverse populations is recommended to further establish optimal exercise protocols and strengthen evidence for integrative dysmenorrhea management strategies.

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