

The Effect of Pranayama Yoga Exercise on Erythrocyte Sedimentation Rate (ESR) in Adolescent Girls with Primary Dysmenorrhea

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ARTICLE INFORMATION

Received: 14, May, 2026

Revised: 23, May, 2026

Accepted: 30, May, 2026

KEYWORD

Dysmenorrhea; Yoga pranayama; Erythrocyte sedimentation rate

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DOI

<https://doi.org/10.36456/embrio.v18i1.11519>

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ABSTRACT

Dysmenorrhea is a common menstrual disorder experienced by adolescent girls and may trigger an inflammatory response in the body, as indicated by an increased erythrocyte sedimentation rate (ESR). One non-pharmacological intervention that may help alleviate this condition is yoga pranayama. This study aimed to analyse the effect of yoga pranayama on reducing ESR levels in adolescents with dysmenorrhea. This study used a pre-experimental design with a one-group pretest-posttest approach. The sample consisted of 31 adolescent girls experiencing dysmenorrhea. The yoga pranayama intervention was conducted over 4 weeks, comprising 8 sessions, each lasting 30 minutes. ESR measurements were obtained before and after the intervention using the Westergren method, and the data were analysed using the Wilcoxon signed-rank test. The results showed a decrease in ESR levels after the intervention, with 48.4% of respondents categorised as normal (10–20 mm/h), although 51.6% remained in the high category (>20 mm/h). Statistical analysis indicated a significant difference between pretest and posttest ESR values. This reduction is associated with the relaxation effects of yoga pranayama, which improve tissue oxygenation, enhance blood circulation, and reduce inflammatory responses triggered by increased prostaglandin levels. In conclusion, yoga pranayama is an effective non-pharmacological therapy for reducing ESR in adolescents with dysmenorrhea.

Introduction

Dysmenorrhea is one of the most common menstrual disorders experienced by adolescent girls and often causes pain and discomfort that can interfere with daily activities, school attendance, and quality of life. Primary dysmenorrhea is primarily associated with increased prostaglandin production, particularly prostaglandin F2 α (PGF2 α) and prostaglandin E2 (PGE2), which induce excessive myometrial contractions and vasoconstriction of the uterine blood vessels. These conditions may reduce blood flow and oxygen supply to the uterine tissues, resulting in hypoxia and ischemia that contribute to menstrual pain (Barcikowska et al., 2020). In addition to hormonal factors, the occurrence and severity of dysmenorrhea may also be influenced by psychological and physiological conditions among adolescents, including stress levels, sleep quality, physical activity, and nutritional status. These factors may affect pain perception and the body's physiological response to menstruation, resulting in variations in the severity of dysmenorrhea symptoms among individuals (Aprilia et al., 2022). The inflammatory processes associated with menstruation may also be accompanied by alterations in the erythrocyte

sedimentation rate (ESR), a nonspecific haematological marker influenced by changes in plasma proteins and erythrocyte aggregation (Tishkowski & Zubair, 2025).

The prevalence of dysmenorrhea is relatively high across different countries. A systematic review reported that the prevalence of dysmenorrhea varies considerably across populations and studies, owing to differences in definitions, severity criteria, and research methods (MacGregor et al., 2023). Globally, approximately 40–70% of women of reproductive age experience dysmenorrhea, with around 10% experiencing severe pain that significantly interferes with daily activities, while approximately 70–90% of dysmenorrhea cases occur during adolescence (Meinawati, 2021). In Indonesia, particularly in East Java, the 2021 Adolescent Reproductive Health Survey reported that 4,653 adolescents experienced dysmenorrhea, with 90.25% having primary dysmenorrhea and 9.75% having secondary dysmenorrhea (Christiana et al., 2023). The high prevalence of dysmenorrhea among adolescents highlights the importance of appropriate management to minimise its impact on daily activities, learning participation, and quality of life.

Management of dysmenorrhea can be approached through both pharmacological and non-pharmacological methods. Pharmacological treatment, particularly nonsteroidal anti-inflammatory drugs (NSAIDs), is commonly used to relieve menstrual pain by inhibiting prostaglandin synthesis and reducing uterine contractions (Itani et al., 2022). However, concerns regarding potential adverse effects associated with pharmacological treatment have increased interest in non-pharmacological approaches that are safer, accessible, and easier to implement among adolescents. Various non-pharmacological methods, including warm compresses, light exercise, acupressure, aromatherapy, and yoga, have been reported to help reduce menstrual pain by promoting relaxation, improving blood circulation, and stimulating endogenous pain-relieving mechanisms (Swandari, 2021). Therefore, the development of simple and practical non-pharmacological interventions may provide an important alternative for adolescent girls experiencing dysmenorrhea.

One potential non-pharmacological intervention is yoga pranayama, a breathing practice focused on controlled breath regulation to promote relaxation and physiological balance. Regular breathing exercises may enhance relaxation, regulate the balance of the autonomic nervous system, and support tissue circulation and oxygenation. Slow and deep breathing may increase oxygenation and promote parasympathetic activity, thereby contributing to physiological relaxation and pain reduction (Kurt & Yayla, 2025). Pranayama has also been reported to be beneficial in managing pain and promoting relaxation among individuals experiencing menstrual-related symptoms (Widiastini et al., 2023). In addition to its potential effects on pain, yoga and pranayama may influence physiological and haematological parameters. Previous research has shown that regular yoga and pranayama practice can produce positive changes in haematological parameters, including a significant reduction in ESR, suggesting a potential influence on systemic inflammatory responses (Raju et al., 2024).

The potential relationship between dysmenorrhea and ESR provides an important physiological basis for investigating yoga pranayama as a non-pharmacological intervention. Increased prostaglandin activity during primary dysmenorrhea is associated with uterine vasoconstriction, excessive myometrial

contractions, hypoxia, and ischemia, which contribute to menstrual pain (Barcikowska et al., 2020). At the same time, inflammatory processes may affect erythrocyte aggregation and sedimentation, thereby altering ESR values (Tishkowski & Zubair, 2025). Through controlled breathing and relaxation, yoga pranayama may promote parasympathetic activity, improve circulation and tissue oxygenation, and potentially modulate physiological responses associated with dysmenorrhea. Thus, the observed reduction in ESR following yoga pranayama may reflect changes in physiological conditions accompanying the intervention. However, ESR remains a non-specific marker and should not be interpreted as a direct or specific measure of inflammation.

A preliminary study conducted at SMPN 1 Sidoarjo revealed that, among 43 eighth-grade female students, 31 met the research criteria and experienced dysmenorrhea that interfered with their learning activities. This finding highlights the need for effective, practical, and accessible interventions that can be implemented in the school setting. Although previous studies have demonstrated the benefits of yoga and pranayama for pain reduction and physiological improvement, research specifically examining the effect of yoga pranayama on ESR among adolescent girls with primary dysmenorrhea remains limited. Therefore, this study aims to analyse the effect of yoga pranayama exercises on erythrocyte sedimentation rate (ESR) in adolescent girls with primary dysmenorrhea.

Method

This study employed a quantitative research design with a one-group pretest–posttest approach. Conducted at SMPN 1 Sidoarjo from April to May 2026, the study involved 43 eighth-grade female students experiencing dysmenorrhea. Utilising a purposive sampling technique based on predetermined criteria, a sample of 31 adolescent students with dysmenorrhea was selected. These participants met specific inclusion and exclusion criteria, which included obtaining parental consent, experiencing primary dysmenorrhea, and not consuming any medications, among others.

The intervention consisted of pranayama yoga exercises performed over four weeks, totalling eight sessions, with each session lasting 30 minutes under the researcher's direct supervision. Measurements of the erythrocyte sedimentation rate (ESR) and pain intensity were conducted before and after the intervention at the Sidoarjo Public Health Centre (Puskesmas Sidoarjo). The students were escorted to the health centre during working hours, where blood samples were collected by health centre staff, with the researcher accompanying them. Blood samples of 2–3 mL were drawn via venipuncture from the antecubital fossa. The ESR was measured using the Westergren method, while pain intensity was assessed using the Numeric Rating Scale (NRS).

Data analysis was conducted using univariate and bivariate approaches. The Wilcoxon signed-rank test was utilised to evaluate the differences in ESR values before and after the intervention. This study obtained ethical clearance issued by the Ethical Review Committee of the Faculty of Health Sciences, Universitas Adi Buana Surabaya, under certificate number 004/Ad.2/KEPK-FIKes/V/2026.

Result

Table 1 Presents the Frequency Distribution of Respondent Characteristics

Category	f	%
Age		
10-13 Years	0	0
14-16 Years	31	100
17-19 Years	0	0
Menstrual Volume		
Pad change <2 times/day (hypomenorrhea)	1	3,2
Pad change 3–4 times/day (normal)	30	96,8
Pad change >4 times/day (menorrhagia)	0	0
Dysmenorrhea Pain Scale		
Scale 0	0	0
Scale 1–3	0	0
Scale 4–6	17	54,8
Scale 7-9	14	45,2
Scale 10	0	0
IMT (z-score)		
Underweight (thinness)	2	6,5
Normal	26	83,9
Overweight	1	3,2
Obese	2	6,5

Source: primary data, 2026

Based on Table 1, all respondents were aged 14–16 years (100%), indicating that the age variable was homogeneous and did not confound the results. This homogeneity is advantageous as it minimises biological variations that may influence the menstrual cycle and pain perception. Almost all respondents had a normal menstrual volume (96.8%), suggesting relatively stable menstrual conditions and supporting the study findings. However, this homogeneity also limits comparative analysis across different menstrual volume groups. Regarding dysmenorrhea pain characteristics, the majority of respondents were categorised as experiencing moderate pain (54.8%), while the rest experienced severe pain. This indicates variability in baseline conditions, which may influence the response to the intervention, as respondents with higher pain intensity may have greater potential for improvement. Additionally, the subjective nature of pain assessment may introduce potential bias. Regarding Body Mass Index (BMI), most respondents were in the normal range (83.9%). However, a small proportion were classified as underweight, overweight, and obese. These conditions may act as confounding factors, particularly obesity, which is associated with increased systemic inflammation and hormonal imbalance that can exacerbate menstrual pain. Therefore, these factors should be considered when interpreting the study results as part of its limitations (Harahap et al., 2021).

Table 2 Presents the Distribution of The Frequency of Yoga Pranayama Practice and its Relationship with Erythrocyte Sedimentation Rate (ESR)

Category	f	%
Yoga Pranayama Practice Frequency		
Regular	28	90,3
Irregular	3	9,7
Total	31	100%

Source: primary data, 2026

Based on Table 2, the majority of respondents (28; 90.3%) performed yoga pranayama regularly, while the remaining 3 (9.7%) were categorised as irregular.

Table 3 Presents the Specific Data on Erythrocyte Sedimentation Rate (ESR) Levels Before and After the Yoga Pranayama Intervention

Category	f	%	Sig. (Shapiro-Wilk)
ESR Pre-test			0,003
0-9 mm/hour (low)	0	0	
10-20 mm/hour (normal)	0	0	
>20 mm/hour (high)	31	100	
ESR Post-test			0,052
0-9 mm/hour (low)	0	0	
10-20 mm/hour (normal)	15	48,4	
>20 mm/hour (high)	16	51,6	
Pre-test			0,016
Mild pain (1-3)	0	0	
Moderate pain (4-6)	17	54,8	
Severe pain (7-9)	14	45,2	
Extreme pain (10)	0	0	
Post-test			0,003
Mild pain (1-3)	10	32,3	
Moderate pain (4-6)	19	61,3	
Severe pain (7-9)	2	6,5	
Extreme pain (10)	0	0	

Source: Saphiro Wilk

Based on Table 3, all respondents had erythrocyte sedimentation rate (ESR) levels >20 mm/hour (100%) prior to the intervention, indicating high ESR. After 4 weeks of yoga pranayama (twice a week, 30 minutes per session), a decrease in ESR levels was observed. A total of 48.4% of respondents showed a reduction to the normal category (10–20 mm/hour), while 51.6% remained in the high category, although a decrease was still evident.

In addition, a reduction in the intensity of menstrual pain was observed. Initially, most respondents experienced moderate pain (54.8%) or severe pain (45.2%). After the intervention, the distribution shifted to mild pain (32.3%), moderate pain (61.3%), and severe pain (6.5%), indicating an overall improvement in pain levels. The Shapiro–Wilk normality test indicated that some data were not normally distributed ($p < 0.05$); therefore, a non-parametric statistical test was applied, as it is more appropriate for the data characteristics.

Table 4 Presents the Results of the Wilcoxon Signed-Rank Test.

Variable	Z	p-value (Asymp. Sig. 2-tailed)	Interpretation
ESR level	-6.848	0.000	Significant
Pain Scale	-6,450	0.000	Significant

Source: Wilcoxon Signed-rank Test

Based on Table 4, the results of the Wilcoxon Signed-Rank Test showed that the significance value (Asymp. Sig. 2-tailed) was less than 0.05 ($p < 0.05$), indicating a statistically significant difference between the pretest and posttest values. The use of the Wilcoxon test in this study was appropriate given the non-normal distribution of the data, which made non-parametric analysis more suitable for comparing paired observations. The analysis results showed changes in values for the majority of respondents after the intervention, as reflected in the differences between pretest and posttest measurements. Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted, indicating that the intervention had a significant effect on the variables studied.

Discussion

Previous research has demonstrated that yoga pranayama significantly helps reduce pain levels during the active phase of the first stage of labour in primiparous women. Following the intervention, the majority of the women reported a decrease in pain intensity. Statistically, yoga pranayama significantly reduces labour pain during the active phase of the first stage (Widiastini et al., 2023). Furthermore, the routine practice of yoga pranayama has been shown to significantly reduce the erythrocyte sedimentation rate (ESR), indicating a decrease in the body's inflammatory processes. Although yoga pranayama is widely used as a complementary therapy, a systematic review indicates that prior studies have provided only limited in-depth investigations into the correlation between yoga pranayama practice and changes in haematological parameters, particularly the erythrocyte sedimentation rate (ESR) (Raju, 2024).

This study transitions from subjective pain indicators to objective biochemical measures by examining the effect of Yoga Pranayama on the Erythrocyte Sedimentation Rate (ESR) in female adolescents aged 14–16 years with primary dysmenorrhea. This area remains under-investigated in prior research. The research interest stems from the high prevalence of dysmenorrhea, which significantly disrupts adolescents' daily activities and productivity, alongside the clinical success of the study in demonstrating that this yoga breathing technique is not merely suggestive but effectively enhances tissue oxygenation to reduce ESR levels. Consequently, Yoga Pranayama serves as a safe, practical, cost-effective, and side-effect-free complementary alternative therapy compared to analgesic medications.

Before the yoga pranayama intervention, all respondents had elevated erythrocyte sedimentation rate (ESR) levels (>20 mm/h), indicating active inflammation associated with dysmenorrhea. This condition can be explained by increased prostaglandin production, which triggers excessive uterine contractions and systemic inflammatory responses. In addition, respondents' pain may contribute to physiological stress, elevating stress hormones such as cortisol and adrenaline. These hormonal changes can stimulate the production of pro-inflammatory cytokines, which, in turn, promote erythrocyte aggregation (rouleaux formation), thereby accelerating sedimentation. (Chopra et al., 2023).

After approximately 4 weeks of yoga pranayama intervention, a reduction in ESR levels was observed in a considerable proportion of respondents, with nearly half reaching the normal range. This finding indicates an improvement in inflammatory status. Physiologically, pranayama breathing techniques, characterised by slow, controlled breathing, activate the parasympathetic nervous system while suppressing sympathetic activity (Djalilova et al, 2019). This shift reduces stress hormone levels, particularly cortisol, thereby decreasing the production of pro-inflammatory cytokines such as IL-6 and TNF- α . Furthermore, improved tissue oxygenation and enhanced blood circulation contribute to reduced inflammation. Therefore, yoga pranayama helps lower ESR levels, an indicator of inflammation, in adolescents with dysmenorrhea (Chopra et al., 2023).

Before the intervention, the distribution of pain intensity showed that none of the respondents experienced mild pain (0%). The majority of respondents were categorised as having moderate pain, with 17 respondents (54.8%), while the remaining 14 respondents (45.2%) experienced severe pain.

This indicates that most respondents experienced relatively high levels of pain during dysmenorrhea, which could interfere with daily activities and reflects a substantial baseline condition prior to the intervention.

After the intervention, changes in pain distribution were observed. A total of 10 respondents (32.3%) reported mild pain, 19 respondents (61.3%) reported moderate pain, and only 2 respondents (6.5%) reported severe pain. These findings demonstrate a shift toward lower pain intensity, with a notable reduction in the number of respondents experiencing severe pain compared with the pre-intervention condition.

Based on the pre- and post-intervention comparison, it can be concluded that pain intensity decreased among respondents following the treatment. This improvement is reflected by the emergence of the mild pain category and the substantial decrease in severe pain cases. These results suggest that the intervention helped alleviate dysmenorrhea, thereby enhancing respondents' comfort and daily functioning.

The results of the Wilcoxon Signed-Rank Test for both pain and erythrocyte sedimentation rate (ESR) showed p -values < 0.05 , indicating statistically significant differences between pre- and post-intervention conditions. This finding demonstrates that both pain intensity and ESR levels decreased following the yoga pranayama intervention. Therefore, the intervention was shown to significantly reduce dysmenorrhea pain and lower inflammatory markers among the respondents.

From a pathophysiological perspective, dysmenorrhea is characterised by increased production of prostaglandins, which trigger excessive uterine contractions, vasoconstriction, and tissue ischemia, ultimately stimulating an inflammatory response. This process elevates plasma protein levels, such as fibrinogen and globulin, which promote erythrocyte aggregation and accelerate sedimentation, thereby increasing ESR as an indicator of inflammation (Jayawardena et al., 2020).

In contrast, yoga pranayama exerts physiological effects by activating the parasympathetic nervous system and suppressing sympathetic activity, thereby eliciting a relaxation response. Controlled breathing techniques help reduce stress hormones such as cortisol, enhance tissue oxygenation, and decrease the production of inflammatory mediators. The reduction in inflammatory response leads to decreased plasma protein levels, thereby slowing erythrocyte sedimentation and lowering ESR values. Thus, yoga pranayama is not only effective in alleviating dysmenorrhea pain but also helps reduce inflammation through physiological mechanisms (Anisa, 2023).

This study has several limitations that should be considered when interpreting the results. First, confounding variables such as diet, stress levels, and physical activity were not optimally controlled, which may introduce bias to the internal validity of the findings. Second, the small sample size limits the statistical power and the generalizability of the results to a broader population. Additionally, the use of Erythrocyte Sedimentation Rate (ESR) as a sole indicator is non-specific, as it was not supplemented by more precise inflammatory markers such as CRP, IL-6, or TNF- α . Finally, variations in participants' adherence to the yoga pranayama practice pose a potential source of bias in the intervention's efficacy.

Conclusion

Based on laboratory results from the Westergren method, all respondents initially had elevated erythrocyte sedimentation rates (ESR) during dysmenorrhea. However, following the yoga pranayama intervention, the mean ESR values decreased significantly from pre-test to post-test. This decline was consistent with the improvement in respondents' pain scores: prior to the intervention, the majority of respondents experienced moderate pain, while the remainder experienced severe pain; after the intervention, a mild pain category emerged. The number of sufferers with severe pain decreased drastically. Statistically, the Wilcoxon Signed Rank Test yielded a significance value demonstrating that yoga pranayama has a significant effect on reducing ESR levels and pain intensity in adolescent girls with dysmenorrhea. Therefore, these findings should be interpreted with caution, and future research is recommended to strictly control for confounding variables, employ larger sample sizes, include specific inflammatory biomarkers, and implement a more structured adherence-monitoring system.

Based on these findings, it is recommended that adolescent girls consider yoga pranayama as a safe, natural, and alternative non-pharmacological therapy for relieving menstrual pain. School healthcare providers are also encouraged to integrate this relaxation exercise into adolescent reproductive health education programs and conduct early preventive screenings. Furthermore, educational institutions can utilise the results of this study as an academic reference in adolescent midwifery care courses. For future researchers, it is suggested to increase the sample size, extend the intervention duration, and investigate long-term effects and comparisons with other therapies.

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