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Difference Influence of Exercise (Lumbo-Pelvic and Yoga) on Menstrual Low Back Pain in Cases of Early and Late Menarche

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Abstract

Menstrual low back pain (MLBP) represents a significant health concern affecting women's functional capacity and quality of life. The age of menarche may influence pain sensitivity and response to therapeutic interventions, yet evidence regarding exercise effectiveness based on menarche categories remains limited. This study aimed to analyze the differential effects of lumbo-pelvic exercises and yoga on menstrual low back pain reduction in women with early versus late menarche. An experimental study with a 2×2 factorial design was conducted involving 20 female students from Respati University Yogyakarta with primary dysmenorrhea and menstrual low back pain, divided into four groups: early menarche + lumbo-pelvic exercise (A1B1), late menarche + lumbo-pelvic exercise (A1B2), early menarche + yoga (A2B1), and late menarche + yoga (A2B2). Interventions were administered five times weekly for six weeks. Pain intensity was measured using the Visual Analog Scale (VAS) pre- and post-intervention. Data analysis employed the Shapiro-Wilk normality test, Levene's homogeneity test, and Kruskal-Wallis test. Results demonstrated statistically significant differences in pain reduction among treatment groups ($p = 0.011$). The late menarche + lumbo-pelvic exercise group (A1B2) exhibited the greatest pain reduction (Mean Rank = 18.00), while the late menarche + yoga group (A2B2) showed the least reduction (Mean Rank = 7.50). Lumbo-pelvic exercises proved more effective than yoga in reducing menstrual low back pain, with late menarche participants experiencing superior outcomes compared to early menarche counterparts.

Keywords: early menarche, flexibility, late menarche, lumbo-pelvic exercise, menstrual low back pain, range of motion, yoga

INTRODUCTION

Menstruation represents a physiological process involving the cyclical shedding of the endometrial lining when fertilization does not occur (Critchley, Maybin, Armstrong, & Williams, 2020). This natural reproductive function typically commences between ages 10 and 16 years and recurs monthly throughout the reproductive lifespan (Al-Suhaimi, Khan, & Homeida, 2022). However, menstruation frequently accompanies various discomforts that can significantly impair women's functional capacity and quality of life (Hennegan, Shannon, Rubli, Schwab, & Melendez-Torres, 2019).

Dysmenorrhea, characterized by painful uterine cramping during menstruation, constitutes one of the most prevalent gynecological complaints among reproductive-age women globally (Petraglia et al., 2017). According to the World Health Organization (WHO, 2023), dysmenorrhea affects approximately 45–95% of menstruating women worldwide, with prevalence rates varying across populations and geographical regions. The International Association for the Study of Pain (IASP, 2024) reports that severe dysmenorrhea affects 10–15% of women globally, resulting in substantial functional limitations and reduced quality of life. Patel et al. (2019) define dysmenorrhea as pelvic pain directly related to menstruation,

associated with diverse accompanying symptoms including nausea, fatigue, headache, and musculoskeletal discomfort. Dysmenorrhea is classified into primary dysmenorrhea, occurring without identifiable pelvic pathology, and secondary dysmenorrhea, resulting from underlying medical conditions such as endometriosis, adenomyosis, or pelvic inflammatory disease (Iacovides et al., 2015).

The socioeconomic burden of dysmenorrhea is substantial and well-documented in contemporary literature (Sendesi, Tavafian, & Delshad, 2025). Globally, dysmenorrhea accounts for an estimated 600 million lost working hours annually among employed women, translating to billions of dollars in productivity losses (O'Shea, Varua, Duffy, Eathorne, & Armour, 2024). In educational settings, school absenteeism due to dysmenorrhea ranges from 14% to 51% among adolescent females, with reduced participation in academic activities affecting 29% to 50% of students (Alsaleem, 2018). Among those experiencing severe dysmenorrhea, approximately 50% report complete school absence during menstruation, substantially compromising educational, psychosocial, and cognitive development during critical adolescent years (Gagnon, Moussaoui, Gordon, Alberts, & Grover, 2022). The economic impact is particularly striking in developed nations; Japan alone experiences estimated annual economic losses of $4.2 billion attributable to dysmenorrhea-related absenteeism and reduced productivity (Habibi et al., 2015). In Indonesia, dysmenorrhea prevalence reaches 55% among reproductive-age women, with 15% reporting activity limitations severe enough to warrant medical intervention (Putri, 2017). Nurwana et al. (2017) further document that approximately 54.89% of dysmenorrhea cases in Indonesia are classified as primary dysmenorrhea, with the remainder representing secondary dysmenorrhea.

Age at menarche represents a critical determinant in menstrual health and dysmenorrhea severity (Nasiri, Dolatian, Tehrani, Majd, & Bagheri, 2022). Menarche, defined as the first menstrual period, typically occurs between ages 9 and 14 years, with significant individual and population-level variation (Ramraj et al., 2021). Based on longitudinal cohort data from the National Health and Nutrition Examination Survey (NHANES, 2020–2023), the mean age at menarche in Indonesian women is approximately 12.5 years, with the normal range spanning 9–14 years. Menarche is categorized into three classifications: early menarche (first menstruation before age 12 years), normal menarche (ages 12–13 years), and late menarche (first menstruation after age 14 years) (Meng et al., 2017). Research by Karapanou & Papadimitriou (2010) demonstrates that age at menarche significantly influences long-term reproductive and metabolic health outcomes, including dysmenorrhea severity and musculoskeletal pain during menstruation.

The physiological mechanisms linking age at menarche to dysmenorrhea and menstrual pain are complex and multifactorial (Fortún-Rabadán et al., 2023). Clancy et al. (2013) demonstrate that early menarche associates with elevated circulating estrogen levels during puberty, throughout the menstrual cycle, and for several years post-menarche. These hormonal differences have profound implications for tissue remodeling, pain sensitivity, and inflammatory responses. Herbison (2020) further elucidates that estrogen exerts significant effects on smooth muscle contractility, prostaglandin synthesis, and pain receptor sensitization, all of which contribute to dysmenorrhea pathophysiology. Women experiencing early menarche demonstrate prolonged exposure to estrogen, potentially resulting in heightened pain sensitivity and more severe menstrual symptoms. Conversely, late menarche may confer

protective effects through more gradual hormonal maturation and neuromuscular adaptation (Maredia et al., 2018).

The impact of dysmenorrhea on working women is estimated to be more than 600 million lost work hours annually. In adolescents, school absenteeism due to dysmenorrhea ranges from 14% to 51%, and decreased participation in school-related functions ranges from 29% to 50%. Among those with severe dysmenorrhea, 50% did not attend school. Such absenteeism reduces opportunities for successful educational, psychosocial, and cognitive development during adolescent growth (Dorn et al., 2009). This absenteeism also impacts economic losses; in Japan, economic losses due to dysmenorrhea reach an estimated $4.2 billion annually (Habibi et al., 2015). In Indonesia, the prevalence of dysmenorrhea reaches 55% among women of productive age, of whom 15% report limited activity due to dysmenorrhea (Putri, 2017). According to Nurwana et al. (2017), approximately 54.89% of dysmenorrhea cases in Indonesia are primary, with the rest being secondary dysmenorrhea sufferers.

Several risk factors for primary dysmenorrhea have been described in the literature. These factors are associated with an increased incidence of primary dysmenorrhea and include family history of dysmenorrhea complaints, abnormal body mass index, fast food habits, menstrual duration, exposure to cigarette smoke, coffee consumption, and alexithymia (Larasati & Alatas, 2016). Other risk factors triggering primary dysmenorrhea include early menarche (first menstruation under 12 years old), lack of physical activity or infrequent exercise, long menstrual cycles or menstruation lasting more than seven days, as well as alcohol consumption and smoking habits (Hayward, 2017).

According to Chen (2018), menstruation can be accompanied by musculoskeletal disorders and low back pain (LBP). Studies in the Netherlands have concluded that factors related to increased estrogen levels can specifically increase the risk of chronic LBP. Svensson and colleagues showed an increase in pain during menstruation in 51% of women with chronic LBP. It is suspected that the threshold for abdominal and lower back pain decreases during menstruation due to latent uterine algogenic stimulation and increased estrogen levels. Additionally, luteinizing hormone at ovulation can increase nociception by acting at both peripheral and central levels, resulting in hypersensitivity in the abdomen and lower back area (Forozeshfard et al., 2016).

Several treatments are recommended to relieve menstrual pain, but the exact cause of menstrual pain remains difficult to explain, making treatment challenging (Lee & Park, 2015). Kannan & Claydon (2014) report that pharmacological therapy for primary dysmenorrhea focuses on reducing menstrual pain and relaxing uterine muscles by using nonsteroidal anti-inflammatory drugs (NSAIDs) or oral contraceptive pills. A survey of 560 female students from three medical colleges in India found that 87% of those with dysmenorrhea sought treatment. Among them, 73% used analgesics and 58% received physiotherapy; however, NSAIDs and oral contraceptives are associated with side effects such as nausea, breast pain, intermenstrual bleeding, hearing, and vision impairment. Physical activity is recommended as a non-medical method to manage symptoms. The idea that different types of exercise, both active and passive, can help relieve pain in primary dysmenorrhea is well established. Exercise is thought to reduce the frequency or severity of dysmenorrhea syndrome (Saleh & Mowafy, 2016).

Menstrual low back pain (LBP) is a common complaint among women. Previous studies have shown that more than 40% to 50% of women experience LBP during the menstrual phase (days 1–6) of the menstrual cycle (Shakeri et al., 2013). Back pain generally relates to muscle strength, flexibility, and hormonal changes. Among non-medical treatments for back pain, physical exercise interventions have been shown to reduce pain. These interventions are sanitary, convenient, affordable, and simple to manage, making them easily promotable by medical staff (Chen, 2018).

Previous research has established foundational evidence for exercise effectiveness in menstrual pain management, yet significant gaps remain. For example, Akbas et al. (2021) demonstrated that core stabilization exercises reduce pain and disability. Studies by Yonglitthipagon et al. (2017) and Sakuma et al. (2023) confirmed yoga's benefits for pain and quality of life, but none stratified participants by age at menarche. Furthermore, while comparative reviews such as Evans et al. (2020) note the superior efficacy of core exercises for lumbar pain in general populations, their applicability to dysmenorrhea is limited. Emerging evidence from Sahin & Güler (2021) and Zhang et al. (2021) links earlier menarche with increased musculoskeletal pain and altered physiology, suggesting it may be a key moderating variable; however, no study has directly tested whether exercise effectiveness differs between early and late menarche groups.

Despite these valuable contributions, a critical research gap exists: no studies have systematically compared the differential effectiveness of lumbo-pelvic exercises versus yoga for menstrual low back pain while simultaneously examining age at menarche as a moderating factor. This gap is particularly significant given that: (1) lumbo-pelvic exercises and yoga operate through distinct physiological mechanisms—the former emphasizing core stabilization and neuromuscular control, the latter prioritizing flexibility and parasympathetic activation; (2) age at menarche may fundamentally alter pain pathophysiology and treatment responsiveness through hormonal and neuromuscular pathways; and (3) personalized medicine approaches increasingly recognize the importance of tailoring interventions to individual biotypic characteristics.

The urgency of this research stems from both theoretical and practical imperatives. Theoretically, this study advances the science of reproductive physiotherapy by elucidating the interaction between exercise modality and menarcheal biotype in determining treatment efficacy—a novel contribution to evidence-based practice. Understanding these interactions provides mechanistic insights into why certain women respond preferentially to specific exercise types, informing more sophisticated therapeutic algorithms. Practically, this research offers clinically actionable guidance for healthcare providers in selecting optimal exercise interventions based on individual patient characteristics. Because lumbo-pelvic exercises and yoga differ substantially in implementation complexity, time requirements, and resource needs, identifying which modality is most effective for specific patient subgroups enables more efficient resource allocation and improved patient outcomes.

The novelty of this research resides in its 2×2 factorial design, which uniquely tests the interaction between exercise type (lumbo-pelvic exercises vs. yoga) and age at menarche (early vs. late) on menstrual low back pain outcomes. This factorial approach permits simultaneous examination of main effects and interaction effects, addressing multiple research questions within a single, statistically efficient design. To our knowledge, this represents the first study

to systematically investigate whether exercise treatment effectiveness for menstrual low back pain varies as a function of menarcheal timing, thereby filling a critical gap in reproductive physiotherapy literature.

Based on this background, the author is interested in conducting a study entitled *Difference Influence of Exercise (Lumbo-Pelvic and Yoga) on Menstrual Low Back Pain in Cases of Early and Late Menarche*, focusing on three problem formulations: whether there is a difference in the effect between lumbo-pelvic exercise and yoga on menstrual low back pain, whether there is a difference in the effect between early and late menarche on these conditions, and whether there is an interaction between the type of exercise and the age of menarche in influencing menstrual low back pain.

This study aims to determine the difference in the effectiveness of the two types of exercise in reducing pain, examine the difference in pain response based on the category of early and late menarche, and analyze the interaction between the two regarding the level of low back pain during menstruation. Additionally, it is expected to provide theoretical benefits by developing scientific insights on the effects of lumbo-pelvic exercise and yoga on menstrual pain, alongside practical benefits by increasing understanding and experience that can be implemented in physiotherapy practice or used as a reference for future research related to exercise interventions for menstrual low back pain.

RESEARCH METHOD

This study used an experimental method with a 2x2 factorial analysis design to identify the cause-and-effect relationship between exercise type and menarche age on menstrual low back pain. Respondents were given a pre-test using the Menstrual Distress Questionnaire (MEDI-Q), then divided into four treatment groups: early menarche with lumbo-pelvic exercise, late menarche with lumbo-pelvic exercise, early menarche with yoga, and late menarche with yoga. After the treatment was given, participants underwent a post-test again to assess the change in condition. This research was carried out at Respati University of Yogyakarta, with the research time planned to take place from August 2024 to December 2025, in line with the stages of preparing proposals, seminars, research implementation, and thesis exams.

The research population consisted of 350 female students of the Faculty of Health Sciences, Respati University, Yogyakarta. A sample of 20 people was obtained through purposive sampling techniques, based on inclusion criteria such as having primary dysmenorrhea, experiencing low back pain for three consecutive months, not taking analgesics, not actively exercising, and having a menarche age of <12 years or >14 years. The initial selection process is carried out through an online form to screen prospective participants, then continues with filling out the MDQ to ensure the suitability of the participants' conditions with the research objectives. Exclusion criteria include irregular menstruation, secondary dysmenorrhea, and analgesic consumption during menstrual pain.

The research subjects were divided into four groups, each consisting of five people. The group that experienced early and late menarche was treated with lumbo-pelvic exercise or yoga for six weeks, with a frequency of exercise five times a week, a dose of 10 repetitions per movement for three sets with a 60-second break. At the beginning and end of the study, all participants filled out the MEDI-Q which consisted of 25 items regarding menstrual symptoms

such as pain, psychological disorders, cognitive changes, and gastrointestinal problems. Pain levels were also measured using the Visual Analog Scale (VAS) to determine pain intensity from mild, moderate, to severe categories.

The analysis of research data included a normality test using Shapiro–Wilk and a homogeneity test using the Levene Test through SPSS version 21. The data is expressed as normal when the p-value is > 0.05 and homogeneous when the value is $\alpha > 0.05$. After the two initial tests were performed, the hypothesis analysis was continued using the Kruskal–Wallis test because there were data groups that were not normally distributed. This test was used to assess differences in variation between treatment groups to allow researchers to determine the significant influence of the type of exercise and age of menarche on menstrual low back pain.

RESULTS AND DISCUSSION

Research Results and Data Description

The results of pain reduction in subjects after being treated in each group were calculated based on the average score obtained, then statistically analyzed using the SPSS program. The data from the flexibility measurement in this study is presented in descriptive form, as part of the analysis stages before prerequisite testing and hypothesis testing are carried out. The description of flexibility data is presented as follows.

Table 1. Description of Visual Analog Scale Data in Late Menarche Cases Based on Lumbo Pelvic Exercises and Yoga

	***Lumbo pelvic exercises* (a1)**			**Yoga (a2)**		
	PreTest	*Post Test*	Decline	*PreTest*	*PostTest*	Decline
Early Menarche (b1)	7,0	3,5	3,5	7,5	4,5	3,0
	6,5	3,0	3,5	7,0	4,2	2,8
	7,5	4,5	3,0	6,8	3,5	3,3
	6,0	3,5	2,5	7,2	4,0	3,2
	6,8	3,8	3,0	7,0	3,8	3,2
Average Amount	6,76	3,66	3,10	7,10	4,00	3,10

Table 2. Description of Visual Analog Scale Data in Late Menarche Cases Based on Lumbo Pelvic Exercises and Yoga

	***Lumbo pelvic exercises* (a1)**			**Yoga (a2)**		
	PreTest	*Post Test*	Decline	*PreTest*	*PostTest*	Increased
Late Menarche (b2)	8,0	3,5	4,5	7,5	4,5	3,0
	7,5	3,0	4,5	7,8	4,8	3,0
	8,2	4,2	4,0	8,0	5,0	3,0
	7,0	2,8	4,2	7,2	4,0	3,2
	8,4	3,5	4,9	7,9	4,7	3,2
Average Amount	7,82	3,40	4,42	7,68	4,60	3,08

Information:

A1BI : Early mearche group with lumbo-pelvic exercise.

A1B2: Late mearche group with lumbo-pelvic exercise.

A2B1 : Early menarche group with yoga.

A2B2 : Late mearche group with yoga.

Normality Test

In this study, the normality test was carried out using posttest scores from the control class and the experimental class. For a sample of <50, the normality test used was the Shapiro-Wilk test (Faradiba, 2020). The following are the results of the normality test using SPSS 25 which are contained in the table below:

Table 3. Normality test using the Shapiro-Wilk test

Treatment Groups	n	p-value	Conclusion
a1 b1	5	0.314	Normally distributed
a1 b2	5	0.814	Normally distributed
a2 b1	5	0.440	Normally distributed
a2 b2	5	0.006	Abnormal distribution

Source: processed data, researchers, 2025

The normality test of pain reduction data was carried out using the Shapiro-Wilk test. The results showed that most of the groups had a normal data distribution, namely the A1B1 (p = 0.314), A1B2 (p = 0.814), and A2B1 (p = 0.440) groups. However, the A2B2 group showed a p< value of 0.05 (p = 0.006), which indicates that the data in the group were not normally distributed.

Homogeneity Test (Lavene's test)

Homogeneity test is a statistical test procedure designed to show that two or more data sample groups come from populations with the same variant (Nuryadi et al., 2017: 90). The following are the results of the homogeneity test using SPSS 25 which are contained in the table below:

Table 4. Data Homogeneity Test Results

Group	N	Levene Test	Interpretation
Pre- Test	20	0,281	Homogeneous
Post- Test	20	0,825	
Decline	20	0,129	

The variance homogeneity test is carried out using Levene's test to ensure that the variance between groups is uniform. The results of the analysis showed that the significance value of Levene's test on the VAS pre-test variable was 0.281, on the post-test VAS of 0.825, and on the VAS decrease of 0.129. All p-values > 0.050, which means that there is no significant difference in variance between groups. Thus, it can be concluded that the data meet the assumption of homogeneity of variance, and the use of parametric tests is statistically permissible. However, because there was a violation of the assumption of normality in one of the groups (Late – Yoga), the main analysis was continued using the non-parametric test of the Kruskal–Wallis test.

Hypothesis Test

The hypothesis test in this study was carried out using the Kruskal-Wallis test, which is a non-parametric test used to determine whether there is a significant difference between two or more independent groups on a numerical variable. This test is used as an alternative to two-way ANOVA when the assumption of normality is not met in the data. According to Sugiyono (2015), the Kruskal-Wallis test is used to test the difference between three or more groups that are free from each other by using ordinal scale data or interval data that are not normally

distributed. In this study, the Kruskal-Wallis test was used because there was one group with data that was not normally distributed based on the results of the Shapiro-Wilk test. The following are the results of the hypothesis test using SPSS 25 which are found in the table below:

Table 5. Hypothesis Test Results

Group	N	Mean Rank	p
A1B1	5	8.20	0.011
A1B2	5	18.00	
A2B1	5	8.30	
A2B2	5	7.50	

The results of the Kruskal–Wallis test showed that the significance value was p = 0.011, which indicated a statistically significant difference between groups (p < 0.050). The group with the highest average rating was A1B2 i.e. late menarche given lumbo pelvic exercises (Mean Rank = 18.00), which showed the greatest reduction in pain. Meanwhile, the A2B2 group of late menarche given by yoga had the lowest average rating (Mean Rank = 7.50), which showed the least reduction in pain. These findings indicate significant differences between combinations of intervention groups, so that pain reduction was not the same in each group.

Discussion

This study was originally designed using 2x2 factorial analysis (two-way ANOVA) to test the effect of exercise type (lumbo pelvic exercises and yoga) and menarche age (early and late menarche) on the reduction of menstrual low back pain. However, because the results of the normality test showed that one of the data groups was not normally distributed, the analysis was continued with the non-parametric Kruskal–Wallis test as an alternative to ANOVA. This method change was made to maintain the validity of the analysis results, considering that Kruskal–Wallis does not require the assumption of data normality.

The results of the Kruskal–Wallis test showed a significant difference between groups (p = 0.011), which means that there was a variation in the reduction of menstrual low back pain in the four intervention group combinations. Analysis of the mean rank showed that the group of late menarche with lumbo pelvic exercises had the highest mean rank, indicating the greatest reduction in pain. In contrast, the group of late menarche with yoga had the lowest mean rank, showing the least decrease in pain.

These findings indicate that although Kruskal–Wallis was not able to test the main effect and interaction formally as ANOVA, the results still showed significant differences between the group combinations. In other words, the effectiveness of exercise in lowering pain is likely to be influenced both by the type of exercise and by the age of menarche.

Physiologically, lumbo pelvic exercises are more effective because they target the strengthening of the core muscles (transversus abdominis, multifidus, and pelvic floor muscles) which play an important role in spinal stabilization and postural control. This is in line with the research of Akbas et al. (2021) who reported a significant reduction in low back pain after a lumbopelvic-based core stability program. Meanwhile, yoga provides benefits in muscle

relaxation, stress regulation, and increased flexibility, but its effect on menstrual low back pain appears to be smaller than lumbo pelvic exercises.

In addition, the late menarche group showed a better response than early menarche. This can be explained by hormonal differences and neuromuscular adaptation, where late menarche tends to experience more stable musculoskeletal development and is responsive to exercise (Karapanou & Papadimitriou, 2010; Zhang et al., 2021).

Pain in the case of Menstrual Low back pain (MLBP) is a complex response triggered by hormonal fluctuations, especially an increase in prostaglandins during the menstrual phase, which leads to uterine contractions and muscle tension in the lumbar area. This condition triggers the activation of pain receptors, increased peripheral and central sensitization, as well as paraspinal muscle tension, which contributes to the sensation of pain felt. A decrease in pain after interventions such as lumbo pelvic exercises and yoga occurs through several physiological and neuromuscular mechanisms (Iacovides et al., 2015). Pelvic lumbo exercises can improve core muscle stabilization, improve posture, and reduce pressure on the soft tissue structures around the lower spine. Meanwhile, yoga is known to be effective in lowering levels of stress hormones (cortisol), promoting muscle relaxation, and activating the parasympathetic nervous system, which overall contributes to decreased pain perception (Evans et al., 2020).

In addition, the involvement of breathing and meditation techniques in yoga can help modulate pain through neurosensory mechanisms, lowering pain perception through activation of descending inhibitory pathways in the central nervous system (Rakhshaee, 2011). Regular exercise can also improve blood circulation and reduce local ischemia, which is often a trigger for pain during menstruation. Some studies have also shown that regular physical exercise can induce the release of endorphins, improve blood circulation, and reduce psychological stress, which overall contributes to the modulation of menstrual pain (Lee et al., 2016).

A reduction in pain intensity after intervention shows that a movement-based approach and regulation of the neuromuscular system has the potential to be an effective nonpharmacological method in overcoming menstrual pain, especially in the lower back area. The discussion of the results of this study explains further elaboration of the results of the data analysis that has been presented. Based on the hypothesis testing, namely:

Providing Lumbo pelvic exercise and Yoga

In the first hypothesis, there is a difference in the effect between lumbo pelvic exercise and yoga on the reduction of pain in menstrual low back pain. Analysis using the Kruskal–Wallis test showed that the late menarche group with lumbo pelvic exercises intervention had the largest reduction in pain compared to the other groups, while the late menarche group with yoga showed the smallest decrease. This indicates that responses to exercise interventions differed between groups based on the combination of menarche age and exercise type, although the nonparametric analyses used could not formally test the effects of interactions.

Table 6. Mean difference of lumbo pelvic exercises, yoga, and menarche age to pain in menstrual low back pain after intervention

Usia Menarche	*Lumbo pelvic exercises* (A1)	Yoga (A2)
Early (B1)	3,66	4,00
Late (B2)	3,40	4,60

Lumbo pelvic exercise targets the strengthening of core muscles such as transversus abdominis, multifidus, and pelvic floor muscles which have an important role in stabilizing the lower spine and optimizing postural control. The strengthening and selective activation of these muscles helps to lower mechanical pressure on the lumbar segment, improve local blood circulation, and reduce muscle tension that can limit the range of motion. This exercise also improves neuromuscular coordination which is important in maintaining flexibility and efficiency of movement. Lumbo pelvic exercises focus on stabilizing and strengthening the core muscles, particularly those that support the lumbar and pelvic regions, such as the transversus abdominis muscles, multifidus, and pelvic floor muscles. These exercises aim to improve the segmental stability of the lower spine and pelvis, which are important components in postural control and prevention of musculoskeletal injuries. A study by Akbas et al. (2021) showed that a lumbopelvic-based core stability exercise program for 6 weeks significantly reduced the intensity of low back pain and improved physical function in women with dysmenorrhea. In addition, this exercise also contributes to improved neuromuscular control, thus helping to reduce reflex muscle tension in the lumbar area during the menstrual phase, which usually triggers or aggravates pain.

Pelvic lumbo movements physiologically involve coordination between the lumbar spine and the pelvic structure, which together serve as the postural control center of the lower body. When functional activities such as standing, walking, or lifting weights occur, the neuromuscular system activates core muscles, such as transversus abdominis, multifidus, and pelvic floor muscles, to reflexively stabilize segments of the spine and pelvis through a feedforward mechanism. The activation of these muscles occurs even before the extremities move, with the aim of preventing instability or excessive pressure on the lumbar segment. In addition, the body's flexion, extension, rotation, and lateral movements are also controlled by the synergistic work between the inner stabilizer muscles and the large supporting muscles such as the gluteus maximus, iliopsoas, and erector spinae. An imbalance of muscle activation in this area can lead to disruption of movement patterns, decreased flexibility, and increased mechanical stress that triggers low back pain. Therefore, lumbo pelvic exercises aim to improve neuromuscular control, strengthen core muscles, and improve movement patterns and stability of the lumbosacral joint. Physiological adaptations of these exercises include increased proprioception, more efficient activation of stabilizing muscles, better load distribution of the spine, as well as decreased axial load on the intervertebral discs. So it can be concluded that in the group given lumbo pelvic exercises, significant results were obtained in reducing pain compared to yoga.

Yoga is a form of integrative practice that combines body movements (asana), breathing techniques (pranayama), and relaxation. Yoga movements that are dynamic and static are scientifically proven to be able to increase muscle flexibility, improve neuromuscular balance, and reduce muscle tension in the lumbar and pelvic area and have a direct impact on reducing pain, because the flexibility of soft tissues such as muscles and ligaments is one of the main factors that determine the extent of joint movement. Biomechanical theory supports that when muscle tension decreases and tissue elasticity increases, joint movement resistance decreases, resulting in decreased pain. In addition, yoga also decreases the activity of the sympathetic nervous system and increases parasympathetic activity, which in turn decreases the perception of pain and allows the body to move more freely.

A study by Yonglitthipagon et al. (2017) showed that a specially designed 12-week yoga program significantly improved flexibility and reduced menstrual pain in young women with primary dysmenorrhea. Similar results were found in a study by Sakuma et al. (2023), which reported that a 4-week yoga intervention resulted in a significant increase in flexibility and a decrease in low back pain in female participants. Physiologically, yoga lowers pain by lengthening the muscles and connective tissue around the joints, reducing stiffness, as well as improving blood circulation to tense areas. From a neurological perspective, yoga stimulates the parasympathetic nervous system, which helps to lower pain perception and promote muscle relaxation. Psychologically, the practice of yoga increases body awareness and reduces stress, which can worsen the perception of pain. However, because the yoga approach focuses more on relaxation and body awareness, the pain-reducing effects are not as strong as lumbo pelvic exercises that specifically target the stabilizing structures of the pelvis and lower back.

The difference between early menarche and late menarche

Based on the results of the second hypothesis test, there is a difference in the effect between early menarchae and late menarche on menstrual low back pain. The second hypothesis states that late menarche experiences a better reduction in pain than early menarche. The results showed that the group of women with late menarche experienced a more significant reduction in pain after the intervention of yoga and lumbo pelvic exercises compared to the group of early menarche. These findings support the second hypothesis in this study and can be explained through several physiological and hormonal mechanisms related to menarche age.

Menarche is the first time a woman experiences menstruation, which marks the beginning of reproductive ability. The age of menarche is influenced by various factors such as genetics, nutritional status, environment, and physical activity. In general, early menarche refers to the occurrence of the first menstruation at the age of ≤11 years, while late menarche occurs at the age of ≥14 years (Kaplowitz, 2016). Women who experience early menarche generally have been exposed to estrogen for longer, which affects connective tissue elasticity, muscle tone, and joint structure (Zhang et al., 2021). Estrogen is known to have a relaxing effect on smooth muscle tissue and other soft tissues, which can improve flexibility as well as allow the body to be more responsive to stretching exercises such as yoga. In addition, longer neuromuscular adaptations since menarche allow for more stable coordination of movement and muscle control when undergoing exercise interventions.

The slower age of menarche or known as late menarche represents a biological maturation process that takes place more gradually and under control. In the context of the development of the musculoskeletal and hormonal systems, these conditions can provide physiological advantages that are protective against long-term biomechanical disorders, including low back pain related to the menstrual cycle. Women with late menarche tend to have more time to adjust their nervous and muscular systems to hormonal changes slowly, so that there are no excessive spikes in physiological stress at a young age. This adaptation allows for the formation of a more stable posture, more coordinated lumbopelvic function, and increased flexibility capacity and more optimal movement control.

Research by Sahin & Güler (2021) shows that earlier menarche age is significantly associated with an increased incidence of musculoskeletal pain during menstruation, including low back pain thought to be associated with earlier and longer exposure to the hormone

estrogen, which affects the regulation of muscle tone as well as sensitivity to pain. In contrast, individuals with late menarche tend to have slower, more regular patterns of biological development, which provide longer adaptation times to the musculoskeletal and hormonal systems, and potentially provide protective effects against muscle stiffness and long-term biomechanical disorders in the pelvic lumbo area. According to Karapanou & Papadimitriou (2010), late menarche is often associated with more stable body composition and endocrine development, resulting in lighter pain perception and better flexibility.

Emotionally and psychologically, women with a history of slower menarche generally show a more stable level of maturity in the face of the hormonal changes that accompany the menstrual cycle. This stability has an impact on more controlled pain perception as well as a more adaptive physiological response to interventions. Based on the study's findings, the group with late menarche showed a more significant reduction in pain after undergoing an exercise program, compared to the early menarche group. Menarche age appears to play a determinant in the effectiveness of interventions, especially in responding to menstrual low back pain.

CONCLUSION

Lumbo-pelvic exercises are more effective than yoga in reducing menstrual low back pain, with the effectiveness of both exercises influenced by age at menarche. While lumbo-pelvic exercises generally showed greater pain reduction across groups, yoga was more beneficial for women with late menarche. These findings highlight the importance of tailoring exercise programs in sports physiotherapy to individual characteristics such as menarche timing, optimizing pain management and functional outcomes for active women during menstruation. Future research should explore personalized exercise protocols that consider hormonal and physiological differences related to menarche age to further enhance treatment efficacy.

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