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Analysis of Abdominal Muscle Strength on Pain and Lumbar Disability in Female Students at SMA Dwijendra: A Cross-Sectional Study

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Abstract

Introduction: Dysmenorrhea often involves lower back pain, affecting functionality. Abdominal muscles play a crucial role in maintaining stability and posture. In dysmenorrhea, strong abdominal muscles can reduce lumbar tension and pain intensity during menstruation. This study explores the relationship between abdominal muscle strength, pain intensity, and lumbar functional disability in female students with dysmenorrhea.
Methods: This cross-sectional observational study was conducted at SMA Dwijendra Denpasar with 117 female students with dysmenorrhea. Data were collected using a sphygmomanometer to measure abdominal muscle strength by placing the device under the lower back and recording pressure during muscle contraction. Pain intensity was measured using the NRS, and lumbar functional disability was assessed with the Modified Oswestry Disability Index.
Results: Spearman rho analysis showed a significant relationship between abdominal muscle strength and dysmenorrhea pain intensity (p=0.000, r= -0.643) and between abdominal muscle strength and lumbar functional disability (p=0.000, r = -0.651). The Spearman rho test provided significant correlation values, offering statistical evidence of the relationships among the variables.
Conclusion: There is a significant relationship between abdominal muscle strength, pain intensity, and lumbar functional disability in female students with dysmenorrhea. These findings suggest that schools integrate physical exercise programs focusing on abdominal muscle strengthening into the physical education curriculum to reduce dysmenorrhea's negative impact on young women's lives.

Keywords: Abdominal muscle strength, dysmenorrhea pain, lumbar functional disability.

Introduction

Dysmenorrhea is pain commonly experienced by most adolescent girls during menstruation. While the most frequently reported pain is in the lower abdomen, many adolescents also complain of pain radiating from the lumbar region (lower back) to the thighs.[1] Increased production and release of prostaglandins from the endometrium during menstruation cause irregular uterine contractions and reduced blood flow, leading to uterine hypoxia and resulting in pain.[1]

According to 2017 World Health Organization (WHO) data, there were 1,769,425 cases (90%) of dysmenorrhea worldwide, with 10-15% of women experiencing severe dysmenorrhea. In Indonesia, the prevalence of primary dysmenorrhea is also significant, with 64.25% of cases being primary dysmenorrhea and 35.75% secondary menstrual pain.[2] The intensity of dysmenorrhea varies among individuals, with approximately 30% consistently experiencing pain during menstruation and about 70% experiencing pain intermittently. The management of this pain also varies: 40% rest, 20% use warm compresses, 20% apply pressure to the area, and 20% take paracetamol.[3]

The intensity of pain during dysmenorrhea is often severe and debilitating for many women. Many are unable to get out of bed, have difficulty walking, and experience such significant discomfort that they are unable to carry out any activities.[4] For example, adolescent girls in school who experience primary menstrual pain often cannot concentrate on their studies, with some deciding not to attend school due to the pain. This situation disrupts their lives and reduces their quality of life.[5] The intensity of dysmenorrhea pain is measured using the Numeric Rating Scale (NRS), with the results categorized into three levels: mild dysmenorrhea (scale 1-3), moderate dysmenorrhea (scale 4-6), and severe dysmenorrhea (scale 7-10).

Regular light physical activity, such as stretching exercises for the abdominal area, can enhance muscle strength, endurance, and flexibility in that region.[6] Strong and repeated contractions of the uterus during endometrial shedding cause cramping in the lower abdomen, leading to menstrual pain. During dysmenorrhea, oxygen cannot flow to the reproductive organs due to vasoconstriction in the myometrium. Weak abdominal muscles can lead to more intense dysmenorrhea because they provide insufficient support to help mitigate the fierce and repeated pressure on the uterus.[7] Poor abdominal muscle strength can exacerbate posture while coping with dysmenorrhea, making women

more susceptible to injuries and health issues in the lumbar region.[8] Abdominal muscle strength can be measured using a sphygmomanometer. This device is an alternative method for clinically assessing muscle strength.

The back area is crucial for various movements that support work and daily activities. With the help of back movements, we can perform functional activities such as standing, sitting, lifting objects, and engaging in other tasks.[9] Bending movements used to relieve menstrual pain can lead to injuries in soft tissues such as muscles, ligaments, and fascia in the lumbar region, potentially limiting the range of motion in the lumbosacral joint.[10] During bending movements, the lumbodorsal muscles and hip extensors contract to maintain body stability. Repeated bending can cause muscle tension and reduce lumbar mobility, increasing disability levels such as difficulty transitioning from sitting to standing, standing for extended periods, walking long distances, lifting activities, and impacting social life.[10] The Modified Oswestry Disability Index (MODI) can measure disability, physical activity limitations, and social participation restrictions. It consists of a questionnaire designed to provide information on the extent of disability in performing daily activities.

Based on the background provided, this study aims to explore the relationship between abdominal muscle strength and the intensity of pain and lumbar functional disability in female students with a history of dysmenorrhea. The hypothesis is that a negative relationship exists between abdominal muscle strength, pain intensity, and lumbar functional disability. Therefore, the researcher is interested in investigating this topic with the study "The Relationship Between Abdominal Muscle Strength and Pain Intensity and Lumbar Functional Disability in Female Students with a History of Dysmenorrhea at SMA Dwijendra Denpasar."

Methods

Inclusion criteria for this study are female adolescents aged 16 to 17 years who have experienced menarche (first menstruation) and voluntarily agree to participate from the beginning to the end of the study. Participants must also sign an informed consent form provided by the researcher, which a parent or guardian will sign as proof of consent. Exclusion criteria include a history of secondary dysmenorrhea and the use of pain relief medication. The study was conducted in April 2024.

Data collection was conducted in two phases: the first on April 15, 2024, for 10th-grade students, and the second on April 16, 2024, for 11th-grade students at SMA Dwijendra Denpasar. The procedure included introducing the research, explaining the informed consent, and selecting participants using purposive sampling. All 10th and 11th-grade students meeting the inclusion and exclusion criteria were invited to participate. Confounding factors such as age were controlled through appropriate statistical analysis.

Data were collected and analyzed to isolate the relationship between the primary variables. Participants who met the study criteria were asked to complete the informed consent form, the Numeric Rating Scale (NRS) for pain assessment, and the Modified Oswestry Disability Index (MODI) questionnaire via Google Forms. After completing the Google Forms, abdominal muscle strength was measured using a sphygmomanometer. The device was placed under the lower back while the subject was lying down, and pressure was measured during abdominal muscle contraction. The sample size was determined based on statistical calculations and Aprilia's 2022 study references. A sample size of approximately 95 participants was required based on similar studies.

Data analysis was performed using Excel and SPSS and divided into three parts: descriptive analysis, univariate analysis, and bivariate analysis using Spearman's rho. The study was approved by Universitas Udayana/RSUP Sanglah Faculty of Medicine Denpasar with Ethical Clearance Number 1352/UN14.2.2.VII.14/LT/2024.

Results

The target sample for this study consisted of individuals aged 16-17 years, with a total of 95 participants initially planned. After conducting interviews to determine whether eligible participants met the inclusion criteria, the final sample size was 117 individuals. A flowchart illustrating the recruitment process is shown in Figure 1.

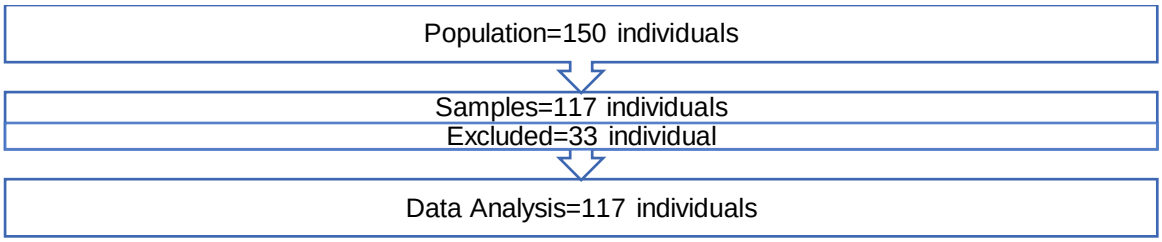

Figure 1. Recruitment process

Based on Figure 1, the study obtained a total sample of 117 individuals meeting the inclusion criteria. Additionally, 33 participants did not meet the inclusion criteria due to the use of pain relief medication. No values or data were missing for any variables examined in this study, and no sensitivity analysis was performed. The results of the univariate analysis of age and pain intensity are presented in Table 1.

Table 1. Univariate Analysis of Age and Pain Intensity

Characteristics	OR (95% CI)	p-value
Age	0.000 (-0.393 – 0.134)	0.331

Table 1 shows no significant relationship between the subject's age and pain intensity. This is indicated by the p-value for the age characteristic exceeding 0.05, suggesting that age is unrelated to pain intensity. The results of the univariate analysis of age about lumbar functional disability are presented in Table 2.

Table 2. Univariate Analysis of Age and Lumbar Functional Disability

Characteristics	OR (95% CI)	p-value
Age	0.004 (-0.542 – 0.135)	0.236

Table 2 shows that there is no significant relationship between the subject's age and lumbar functional disability. This is indicated by the p-value for the age characteristic exceeding 0.05, suggesting that age does not correlate with lumbar functional disability. The study's sample characteristics are presented in Table 3.

Table 3. Sample Characteristics

Characteristics	Frequency (n)	Percentage (%)
Age		
16 - 17 Years	117	100.0
Dysmenorrhea Pain Intensity		
Mild Pain (Scale 0-3)	32	27.4
Moderate Pain (Scale 4-6)	69	59.0
Severe Pain (Scale 7-10)	16	13.7
Disability Level		
Minimal Disability	54	46.2
Moderate Disability	46	39.3
Severe Disability	14	12.0
Very Severe Disability	2	1.7
Extremely Severe Disability	1	0.9
Sphygmomanometer Difference		
1	2	1.7
2	4	3.4
3	6	5.1
4	5	4.3
5	4	3.4
6	4	3.4
8	5	4.3
9	4	3.4
10	12	10.3
11	4	3.4
12	4	3.4
13	5	4.3
16	7	6.0
17	1	0.9
18	5	4.3
20	19	16.2
22	3	2.6
25	8	6.8
26	3	2.6
28	4	3.4
30	5	4.3
33	1	0.9
35	2	1.7

Table 3 shows the sample distribution by age: 117 individuals aged 16-17, representing 100.0% of the sample. The study found that most participants experienced moderate pain intensity on a scale of 4-6, with 69 individuals (59.0%). Pain intensity was mild on a scale of 0-3 for 32 individuals (27.4%) and severe on a scale of 7-10 for 16 individuals (13.7%). According to the Modified Oswestry Disability Index (MODI), the majority of the sample had minimal disability (54 individuals, 46.2%), moderate disability (46 individuals, 39.3%), severe disability (14 individuals, 12.0%), very severe disability (2 individuals, 1.7%), and highly severe disability (1 individual, 0.9%).

Regarding sphygmomanometer measurements, the results varied. Differences of 1 and 35 were each observed in 2 individuals (1.7%). Differences of 2, 5, 6, 9, 11, 12, and 28 were each found in 4 individuals (3.4%). Differences of 4, 8, 13, 18, and 30 were each noted in 5 individuals (4.3%). Differences of 22 and 26 were each observed in 3 individuals (2.6%). Differences of 17 and 33 were each recorded in 1 individual (0.9%). Differences of 3 were found in 6 individuals (5.1%), and a difference of 10 was found in 12 individuals (10.3%). Differences of 16 were observed in 7 individuals (6.0%). The most common difference was 20, found in 19 individuals (16.2%), followed by a difference of 25 in 8 individuals (6.8%). There were no set categories for sphygmomanometer differences in this study. The correlation between abdominal muscle strength and dysmenorrhea pain intensity is presented in Table 4.

Table 4. Correlation Between Abdominal Muscle Strength and Dysmenorrhea Pain Intensity

Variable Correlation	Correlation	P-Value
Abdominal Muscle Strength and Dysmenorrhea Pain Intensity	-0.643	0.000

Based on Table 4, Spearman's rho analysis yielded a significance value of $p = 0.000$ ($p < 0.05$), indicating a significant relationship between abdominal muscle strength and dysmenorrhea pain intensity among female students at

SMA Dwijendra Denpasar. Additionally, the correlation coefficient was found to be -0.643. This negative value suggests a strong inverse relationship between the variables, as it falls within the range of 0.60-0.79. This means that higher abdominal muscle strength is associated with lower dysmenorrhea pain intensity experienced by the students. The results of the correlation between abdominal muscle strength and lumbar functional disability are presented in Table 5.

Table 5. Correlation Between Abdominal Muscle Strength and Lumbar Functional Disability

Variable Correlation	Correlation	P-Value
Abdominal Muscle Strength and Functional Lumbar Disability	-0.651	0.000

Based on Table 5, the significance value of p = 0.000 (p < 0.05) from the bivariate analysis using Spearman's rho indicates a significant relationship between abdominal muscle strength and lumbar functional disability. Additionally, the correlation coefficient of -0.651 suggests a strong inverse relationship, as it falls within the range of 0.60-0.79. This means that greater abdominal muscle strength is associated with lower lumbar functional disability among the female students at SMA Dwijendra Denpasar.

Discussion

Relationship Between Abdominal Muscle Strength and Dysmenorrhea Pain Intensity

Spearman's rho analysis revealed a significant relationship between abdominal muscle strength and dysmenorrhea pain intensity, with a negative correlation coefficient. This indicates that weaker abdominal muscle strength is associated with greater dysmenorrhea pain intensity experienced by the subjects.

Increased levels of prostaglandins cause hypercontractility of the uterus, leading to hypoxia and ischemia of the myometrium. Primary dysmenorrhea is spasmodic, most severe in the lower abdomen, and may radiate to the back and thighs. Pain is typically felt several hours before the onset of menstrual bleeding and is most intense on the first day of menstruation.[11] Dysmenorrhea is caused by an imbalance of progesterone in the blood, leading to pain from lower abdominal cramps due to continuous contraction of the abdominal muscles. Both static and dynamic muscle contractions can result in muscle fatigue in the surrounding area. This fatigue occurs when the muscle's endurance time is exceeded. Muscle endurance time depends on the amount of force exerted by the muscle as a percentage of the maximum force it can achieve.[11] According to Fauzi's 2013 study, cited in Andriani's research, the intensity of dysmenorrhea pain can be influenced by various factors such as age, physical activity, nutritional status, the duration of menstruation, heavy menstrual flow, smoking, family history, and stress.[12]

The findings of this study align with the research conducted by Prado-Álvarez et al. in 2024, which reported a p-value < 0.05, indicating a statistically significant difference in abdominal muscle thickness between the primary dysmenorrhea group and the control group. Weak abdominal muscles in women with dysmenorrhea can lead to biomechanical imbalances in the pelvic and lower back regions. These imbalances may result in increased muscle tension and poor posture, which, in turn, exacerbate menstrual pain.

The findings of this study are consistent with the book by Speroff and Fritz, Clinical Gynecologic Endocrinology and Infertility (2011), which explains that abdominal muscle strength plays a significant role in managing dysmenorrhea symptoms. Strong abdominal muscles help maintain body posture and spinal stability and contribute to reduced muscle tension, improved blood circulation, and decreased stress. Speroff and Fritz suggest that increasing abdominal muscle strength can enhance blood circulation, helping alleviate pain by delivering sufficient oxygen and nutrients to the healing tissues and removing metabolic waste products. Good blood circulation also helps reduce muscle spasms that often occur during menstruation.

Relationship Between Abdominal Muscle Strength and Lumbar Functional Disability

Based on the analysis using Spearman's rho, significant results indicate a relationship between abdominal muscle strength and lumbar functional disability. The negative correlation suggests that higher abdominal muscle strength is associated with lower levels of lumbar functional disability among the students at SMA Dwijendra Denpasar.

These findings are consistent with Hasan's 2020 study, which reported a p-value < 0.01. Hasan's research explains that maintaining a bent or incorrect posture for extended periods causes the muscles in the back to contract to sustain normal body posture. Excessive muscle use leads to ischemia or inflammation, making the muscles more sensitive due to increased inflammatory mediators, which cause pain and exacerbate muscle spasms. Muscle spasms result in an imbalance between the abdominal and paravertebral muscles, limiting lumbar mobility. Regular exercise to improve abdominal muscle strength can enhance the balance between the abdominal and paravertebral muscles. This improves core muscle activity, which helps control lumbar movements, maintain the spine's natural curvature, and reduce pressure on the lumbar region.

These findings align with Uran et al.'s 2022 study, which explains that each body posture while enduring dysmenorrhea has its side effects on the body. Similarly, maintaining a fixed position for extended periods can lead to abdominal muscle fatigue and an increasing curvature of the vertebral column, resulting in overall fatigue, worsened posture, and weakened muscle performance.[10]. The habitual and repetitive hunched posture adopted by adolescent girls to manage menstrual pain, especially without adequate muscle stretching, poses a risk of skeletal muscle issues that can impede daily activities. Regular and appropriate physical activity, such as strength training and stabilization exercises, can strengthen the spinal-supporting muscles like the back and abdominal muscles. Stronger muscles help support the spine better, reduce pressure on spinal structures, and decrease lumbar functional disability.

This study has several limitations that should be considered. A primary limitation is purposive sampling, which may introduce selection bias. This method involves only those students who meet the inclusion criteria, which might not reflect the broader population or the variability beyond the studied group. Additionally, the measurement of abdominal muscle strength using a sphygmomanometer could be affected by variations in measurement technique or the subject's

ability to follow instructions consistently, potentially impacting the results. Other limitations include the control of factors such as nutritional status, physical activity, and stress levels, which were not fully managed in this study and may influence the relationships between the variables studied.

The findings of this study may not be fully generalizable to a broader population. Conducted with students from SMA Dwijendra Denpasar in Bali, the results may be influenced by local factors such as cultural practices, physical habits, and dietary patterns specific to this region. Additionally, the study only included female adolescents aged 16-17, which may differ in terms of the prevalence and intensity of dysmenorrhea compared to other age groups or genders. These factors limit the external validity of the findings, suggesting that the results may not fully apply to a broader population or different contexts.

Future research should aim to increase the sample size to enhance statistical power and accuracy and address the existing limitations. Expanding the study population to include participants from various ages, genders, and geographic backgrounds will help improve the generalizability of the findings. Future studies should also consider additional variables such as nutritional status, physical activity, and psychological factors that may influence abdominal muscle strength and dysmenorrhea. Moreover, employing a range of measurement methods for muscle strength could provide a more comprehensive and accurate assessment. By addressing these improvements, future research can offer more profound and comprehensive insights into the relationship between abdominal muscle strength, dysmenorrhea, and lumbar functional disability.

Conclusion

Based on the conducted study, it can be concluded that there is a significant negative relationship between abdominal muscle strength and both the intensity of dysmenorrhea and lumbar functional disability among female students with a history of dysmenorrhea at SMA Dwijendra Denpasar. These findings suggest that abdominal muscle strength plays a crucial role in managing pain and lumbar functional disability in adolescent girls experiencing dysmenorrhea. The results contribute significantly to a deeper understanding of dysmenorrhea management. They can serve as a basis for developing more comprehensive and evidence-based interventions to address pain and functional disability in adolescent girls. Further research is recommended to explore this relationship's underlying biological mechanisms and evaluate the effectiveness of abdominal muscle-strengthening programs in a broader population.

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