
The Effect Of Stretching Exercises On Reducing Back Pain Complaints Caused By Backpack Use Among Junior High School Students Based On Calista Roy's Adaptation Theory

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Abstract

Carrying a Backpack weighing more than 10% of their body weight often triggers back pain in adolescents. Stretching exercises can improve body flexibility, aligning with Callista Roy's Adaptation Theory regarding physical stimulation for positive physiological adaptation. This study aimed to determine the effect of stretching exercises based on Callista Roy's Adaptation Theory on reducing back pack-related back pain among junior high school students. This study employed a quasi-experimental design with purposive sampling, involving an intervention group at SMPN 5 Bojonegoro (35 respondents) and a control group at SMPN 2 Bojonegoro (30 respondents). Pain levels were measured before (pre-test) and after (post-test) the intervention using the Nordic Body Map (NBM) questionnaire and analyzed using the Wilcoxon and Mann-Whitney U tests. The Wilcoxon test was used to compare pain levels before and after stretching exercises within the intervention group, while the Mann-Whitney U test was used to analyze differences between the intervention and control groups regarding the impact of the exercises. At the pre-test stage, all respondents in both groups (100%) experienced moderate pain. Following the intervention, the majority of the intervention group (91.4%) showed a reduction to the low pain category, whereas 90.0% of the control group continued to experience moderate pain. Statistical tests revealed significant effects and differences in both groups ($p = 0.000$; $p < 0.05$). Stretching exercises are effective in reducing Backpack-related back pain among junior high school students by acting as an external coping mechanism that shifts the body's response from maladaptive to adaptive. Based on Callista Roy's Adaptation Theory, stretching exercises serve as a stimulus that enhances physiological coping mechanisms, enabling the body to adapt positively and reduce the pain response.

Keywords: Back Pain, Backpack, Calista Roy's Adaptation Theory, Stretching Exercises

INTRODUCTION

Musculoskeletal complaints, particularly back pain, are a common health issue for school-aged children and adolescents, one of which is related to the use of backpacks that are too heavy or not ergonomically designed. Backpacks are the primary means of carrying books, school supplies, drinking water, and other equipment, so the weight students carry can put excessive pressure on the muscles and supporting structures of the body. This condition is increasingly relevant as learning activities, assignments, and school activities increase, requiring students to carry various equipment. At the junior high school level, students can carry around 8–10 textbooks covering 4–5 subjects each day, while backpacking on both shoulders is the most common pattern, with the load generally being around 10% of body weight and the duration of use being around 15–30 minutes per day (Wiyono, 2023; Faridah, 2023). Excessive bag weight and improper use can increase muscle tension, change postural balance, and trigger complaints of back pain during growth (Syuhrrahmi, 2024; Helmaliah, 2024).

Back pain is a health problem with widespread global impact and is not only experienced by adults but is also becoming a concern in school-age groups. The World Health Organization (WHO) reported that in 2020, approximately 619 million people experienced back pain, and this number is projected to increase to approximately 843 million people by 2050 (Ministry of Health of the Republic of Indonesia, 2024). In students, musculoskeletal complaints can be found in several parts of the body, including the neck, shoulders, back, and waist, with the back being the most frequently affected area. In

Indonesia, the prevalence of back pain is reported to vary, while data by region shows differences in prevalence between provinces, including East Java, Central Java, and West Java (Yudhaningrum, 2023). This phenomenon is also evident in preliminary data from Bojonegoro Regency. Measurement results using the Nordic Body Map (NBM) questionnaire on backpack-using students indicate that the majority are in the low complaint category, but there are still students with moderate to high complaints. This condition shows that the use of backpacks still needs attention because musculoskeletal complaints in school age can develop if ergonomic risk factors continue.

Using a backpack that exceeds its ideal capacity can increase mechanical stress on the body and cause postural changes as a compensatory mechanism to maintain balance. The American Occupational Therapy Association (AOTA) and the International Chiropractic Pediatric Association (ICPA) recommend that children's backpacks should not exceed 10% of their body weight. Carrying a backpack that exceeds this limit can cause the head and body to lean forward, which, if carried for extended periods, can potentially affect spinal curvature and cause back pain (Cristella, 2023). In addition to the weight of the backpack, placing it too low and distributing the weight unevenly can also increase the burden on the shoulders and cause the body to lean forward, triggering back muscle tension (Sariana, 2020). This issue is increasingly important because adolescents are in a phase of bone growth and development, so repeated exposure to external loads can affect posture, movement patterns, and physical comfort (Ismiyasa, 2023). Therefore, promotive and preventive efforts are needed to prevent back pain complaints from developing into musculoskeletal disorders that can hinder students' learning and daily activities.

One simple non-pharmacological intervention that can be implemented in school settings to reduce back pain is stretching exercises. Stretching exercises involve controlled stretching of muscles and soft tissues, aimed at increasing flexibility, maintaining range of motion, improving blood circulation, and reducing muscle tension and spasms (Yudiansyah, 2022). Regular exercise can also help improve motor function, maintain postural balance, and reduce the risk of musculoskeletal disorders, making it suitable as a promotive and preventive intervention for school-aged adolescents (Shintya, 2024). The application of stretching exercises becomes increasingly relevant when linked to the Roy Adaptation Model, which views humans as adaptive systems capable of responding to internal and external stimuli. In the context of this study, the weight and use of backpacks are stimuli that can affect students' physiological conditions, while stretching exercises are provided as a stimulus/intervention to help the body generate an adaptive response through physiological-functional mechanisms. Thus, stretching is expected to help improve the body's ability to adapt to mechanical stress, reduce muscle tension, and reduce back pain complaints.

Although backpack use and musculoskeletal complaints in students have received considerable attention, data on back pain complaints specifically in adolescents and the effectiveness of stretching exercises as an intervention based on the Roy Adaptation Model still need to be strengthened, particularly in the school context and student characteristics in the study area. Preliminary data indicate that some students still experience moderate to severe musculoskeletal complaints, while backpack use is a routine activity performed almost daily. This condition indicates a gap between the high exposure to risk factors for backpack use and the need for simple interventions that can be carried out independently and sustainably by students.

RESEARCH METHODS

This study used a quantitative research type with a quasi-experimental design using a pre-test–post-test with control group design. The study was conducted at SMP Negeri 5

Bojonegoro as the intervention group and SMP Negeri 2 Bojonegoro as the control group in April–May 2026. The study population consisted of students who usedbackpack, namely 298 students at SMP Negeri 5 Bojonegoro and 240 students at SMP Negeri 2 Bojonegoro. The sample was selected using a purposive sampling technique based on predetermined inclusion and exclusion criteria, with 35 students as the intervention group and 30 students as the control group. Data collection was carried out through initial screening, measuring body weight and bag weight, health condition interviews, and completing the Nordic Body Map (NBM) questionnaire to identify the level of musculoskeletal complaints, especially back pain. The intervention group was given stretching exercises for eight meetings, while the control group was not given any intervention.

AnalysisData analysis was carried out through editing, coding, tabulating, and scoring stages, followed by univariate and bivariate analysis. Univariate analysis was used to describe the characteristics of respondents and the distribution of back pain complaint levels before and after the intervention. Bivariate analysis was used to determine changes in pain levels before and after stretching exercises and to compare changes between the intervention and control groups. The Wilcoxon Signed Rank Test was used to analyze differences in back pain complaint levels before and after the intervention in each group, while the Mann–Whitney U Test was used to determine differences in changes in back pain complaint levels between the intervention and control groups.

RESULTS AND DISCUSSION

Respondent Characteristics

This data will describe the characteristics of respondents after performing stretching exercises. The characteristics presented include age, gender, class, and medication use.

Table 1. Univariate Analysis of the Distribution of Characteristics of Age, Gender, Class, and Drug Consumption of Respondents at SMP N 5 Bojonegoro and SMP N 2 Bojonegoro in April – May 2026

		Intervention		Control
Variables	N	Presentation	N	Presentation
Age				
Early Adolescence	32	91.4%	30	100%
Middle Teenagers	3	8.6%	0	0%
Late Adolescence	0	0%	0	0%
Gender				
Man	14	40%	8	26.7%
Woman	21	60%	22	73.3%
Class				
Class A	3	8.6%	7	23.3%
Class B	3	8.6%	4	13.3%
Class C	5	14.3%	3	10%
Class D	5	14.3%	1	3.3%
Class E	4	11.4%	2	6.7%
Class F	3	8.6%	6	20%
Class G	3	8.6%	3	10%
Class H	3	8.6%	4	13.3%
Class I	3	8.6%	0	0%
Class J	3	8.6%	0	0%
Drug Consumption				

Yes	3	8.6%	0	0%
No	32	91.4%	30	100%

Source: Researcher's Primary Data, 2026

Based on Table 1, it is known that in the age variable, the majority of respondents in the intervention group were in the early adolescent category, namely 32 people (91.4%), while in the control group all respondents were in the early adolescent category, namely 30 people (100%). In the gender variable, both groups were dominated by female respondents, with a total of 21 people (60%) in the intervention group and 22 people (73.3%) in the control group. Based on the class variable, in the intervention group the most respondents came from class C and class D, each with 5 people (14.3%), while in the control group the most respondents came from class A, namely 7 people (23.3%). Meanwhile, based on the medication consumption variable, the majority of respondents in the intervention group did not take medication, namely 32 people (91.4%), while in the control group all respondents did not take medication, namely 30 people (100%).

Central Tendency

DataThe following table presents the results of a descriptive statistical analysis of the pre-test and post-test scores in the intervention and control groups. This analysis aims to provide an overview of the distribution of respondent data before and after treatment, including the minimum, maximum, average (mean), and standard deviation values.

Table 2. Central Tendency Analysis of Pre-Post and Post-Test Scores in the Intervention Group and Control Group

Variables	N	Minimum	Maximum	Mean	Std.
Intervention Group					
Pre-Test	35	21	29	23.86	1,987
Post-Test	35	10	27	16.94	4,459
Control Group					
Pre-Test	30	21	39	23.10	3,407
Post-Test	30	18	27	22.27	1,911

Source: Researcher's Primary Data, 2026

Based on the descriptive statistics table 2 obtained from the study, the total sample size was 65 respondents. The intervention group consisted of 35 respondents, while the control group consisted of 30 respondents. This study was conducted through two stages of measurement, namely a pre-test to determine the initial condition of the respondents and a post-test to see the final condition after the treatment was completed. Based on the descriptive statistics table presented, there was a striking difference in score changes between the intervention and control groups from the pre-test to the post-test stage. In the intervention group (), the average (mean) score experienced a very significant decrease from 23.86 at the pre-test to 16.94 at the post-test. This decrease was also followed by a shift in the middle value (median) from 24.00 to 17.00, as well as a decrease in the minimum value from 21 to 10, which indicates a fairly drastic improvement or decrease in the condition of complaints after being given therapy. On the other hand, in the control group (), the mean score from pre-test to post-test tended to be stable and only experienced a very slight decrease, namely from 23.10 to 22.27. The median and mode values in this control group did not even change at all, namely remaining at 22.00 and 21. Interpretation of this data shows that the provision of therapy in the intervention group was proven to be descriptively effective in significantly reducing complaint scores, while the control group that was not given intervention tended to maintain relatively the same level of complaints as the initial condition. $N = 35N = 30$

Characteristics of Pain Level Before Intervention

This data will describe the results of the characteristics of the category level before and after the intervention was carried out on respondents at SMP N 5 Bojonegoro and SMP N 2 Bojonegoro.

Table 3. Analysis of Pain Level Characteristics Before Intervention

	Intervention		Control	
	N	%	N	%
Low	0	0%	0	0%
Currently	35	100%	30	100%
Tall	0	0%	0	0%
Very high	0	0%	0	0%
Total	35		30	

Source: Researcher's Primary Data, 2026

Based on Table 3, it is known that the characteristics of the pain level before the intervention showed that all respondents in both groups had a moderate level of pain. In the intervention group, all 35 respondents (100%) experienced moderate pain, while no respondents experienced low, high, or very high pain (0%). Similarly, in the control group, all 30 respondents (100%) were in the moderate pain category, and no respondents were in the low, high, or very high pain category (0%). These results indicate that before the intervention, the pain levels in both groups were in the same condition, namely all respondents experienced moderate pain, so the initial characteristics of the two groups can be said to be homogeneous in terms of pain levels before the treatment was given.

Characteristics of Pain Levels After Intervention

Table 4. Analysis of Pain Level Characteristics After Intervention

	Intervention		Control	
	N	%	N	%
Low	32	91.4%	3	10.0%
Currently	3	8.6%	27	90.0%
Tall	0	0%	0	0%
Very high	0	0%	0	0%
Total	35		30	

Source: Researcher's Primary Data, 2026

Based on Table 4, it is known that the level of pain of respondents after the intervention was different between the intervention group and the control group. In the intervention group, the majority of respondents experienced low pain, namely 32 people (91.4%), while 3 people (8.6%) remained in the moderate pain category. No respondents experienced high or very high pain (0%). Meanwhile, in the control group, the majority of respondents remained in the moderate pain category, namely 27 people (90.0%), while only 3 people (10.0%) experienced low pain. There were no respondents with high or very high pain levels (0%). These results indicate that after the intervention, there was a better reduction in pain levels in the intervention group compared to the control group. The majority of respondents in the intervention group shifted to the low pain category, while in the control group the majority of respondents remained in the moderate pain category.

Characteristics of Differences Before and After Intervention

Table 5. Analysis of the Level of Pain Complaints and Respondent Characteristics Before and After the Intervention

	Intervention		Control	
	N	%	N	%
Go on	0	0%	0	0%
Still	3	8.6%	27	90.0%
Down	32	91.4%	3	10%
Total	35	100%	30	100%

Source: Researcher's Primary Data, 2026

Based on Table 5, the frequency distribution of the pain change variable, there are significant descriptive differences between the two groups. In the Intervention Group, the majority of respondents experienced a decrease in pain intensity, namely 32 people (91.4%), and only 3 people (8.6%) whose pain scale remained the same. In contrast, in the control group, the majority of respondents did not experience a change in pain level (remained) namely 27 people (90.0%), while only 10.0% of respondents (3 people) experienced a decrease in pain.

Characteristics of the Level of Pain Complaints Before and After Intervention in the Control Group

Table 6. Analysis of the Level of Pain Complaints Before and After Intervention in the Control Group

	Pre-Test		Post-Test	
	N	%	N	%
Low	0	0%	3	10.0%
Currently	30	100%	27	90.0%
Tall	0	0%	0	0%
Very high	0	0%	0	0%
Total	30		30	

Based on Table 6, the analysis results for the control group show that before the intervention, all respondents were in the moderate pain category. After the intervention, 3 respondents (10.0%) experienced a decrease to the low pain category, while 27 respondents (90.0%) remained in the moderate category. This indicates that there was a relatively small change in pain levels in the control group, as the majority of respondents remained in the moderate category after the measurement. Based on the analysis results in the control group, there was no difference in the level of back pain complaints before and after the intervention. This indicates that without the stretching exercise intervention, the level of back pain complaints in the control group respondents tended not to experience significant changes. This condition may occur because the control group did not receive the stretching exercise intervention, while respondents continued to carry out daily activities such as using a backpack, sitting for long periods, and studying in less ergonomic postures. These factors can maintain a static load on the back muscles, so that pain complaints tend to persist.

The Effect of Differences in Pre and Post Tests on the Intervention Group and the Control Group

OnIn this study, the variables measured used the Wilcoxon Test to identify differences before and after the stretching exercise therapy group was carried out on respondents from SMP N 5 Bojonegoro and SMP N 2 Bojonegoro.

Table 7. Results of Pre-Test and Post-Test Variables in the Intervention Group

	N	Mean rank	Sum of Ranks	P – Value
Negative Ranks	32	16.50	528.00	0.000
Positive Ranks	0	0.00	0.00	
Ties	3			
Total	35			

The p-value is obtained from the Wilcoxon test.

Source: Researcher's Primary Data, 2026

Table 7 shows a significant difference in the level of back pain complaints before and after the stretching exercise intervention, with a p-value of 0.000 ($p < 0.05$). The negative ranks value with a mean rank of 16.50 indicates that most respondents experienced a decrease in the level of back pain complaints after the intervention. These results indicate a statistically significant change in the level of back pain complaints, thus concluding that the stretching exercise intervention was effective in reducing back pain complaints in respondents.

Table 8. Results of Pre-Test and Post-Test Variables in the Control Group

	N	Mean rank	Sum of Ranks	P - Value
Negative Ranks	3	2.00	6.00	0.109
Positive Ranks	0	0.00	0.00	
Ties	27			
Total	30			

The p-value is obtained from the Wilcoxon test.

Source: Researcher's Primary Data, 2026

Based on Table 8, the results of the Wilcoxon Signed Rank Test show a p-value of 0.109 ($p > 0.05$), thus it can be concluded that there is no significant difference in the level of back pain complaints before and after in the control group. These results indicate that without being given a stretching exercise intervention, the level of back pain complaints in the control group respondents did not experience a statistically significant change. Thus, the condition of the control group tended to remain stable and did not show a significant decrease in back pain complaints during the study.

Comparison of Intervention Group and Control Group

OnIn this study, the variables were measured using the Mann-Whitney Test to analyze the comparison of the Intervention Group and the Control Group in respondents from SMP N 5 Bojongoro and SMP N 2 Bojonegoro.

Table 9. Results of Variables of Therapy Group and Control Group

Therapy group	N	Mean rank	Sum of Ranks	P – Value
Intervention	35	21.63	757.00	0.000
Control	30	46.27	1388.00	

The p-value is obtained from the Mann-Whitney test.

Source: Researcher's Primary Data, 2026

Based on Table 9, the Mann-Whitney test results obtained a p-value of 0.000, indicating that there was a statistically significant difference in the post-test scores between the intervention and control groups. The mean rank results showed that the control group had a higher score, namely 46.27, while the intervention group had a mean rank value of 21.63. The difference in mean ranks indicates that the post-test scores in the control group tended to be higher than those in the intervention group after the study period was completed.

This indicates that respondents in the intervention group had a lower level of back pain complaints compared to the control group. Thus, it can be concluded that there is a difference in the level of back pain complaints between the group given the stretching exercise intervention and the group that was not given the intervention, so that stretching exercises are effective in reducing back pain complaints in respondents.

Discussion

Identification of the Level of Back Pain Complaints Before and After Stretching Exercise Intervention

Based on the research results, it was found that before being given the stretching exercise intervention, all respondents in the intervention group experienced complaints of back pain in the moderate category. This condition indicates that using a Backpack in daily activities can put pressure or mechanical load on the back muscles, potentially causing muscle tension and pain. After being given a structured stretching exercise intervention, the majority of respondents experienced a decrease in pain levels to the low category. This condition indicates that stretching exercises can help improve musculoskeletal conditions, resulting in a decrease in complaints of back pain. Meanwhile, in the control group that was not given the stretching exercise intervention, the majority of respondents remained in the moderate pain category with relatively smaller changes. These results can be concluded that the reduction in pain levels in the intervention group is related to the stretching exercise administration and is not solely caused by the natural recovery process.

Exercise Stretching exercises are a non-pharmacological intervention that can help reduce back pain by increasing muscle flexibility, joint range of motion, blood circulation, and reducing muscle tension and spasms. Increased tissue elasticity and blood flow help improve muscle metabolism, thereby reducing pain intensity.(Yudiansyah, 2022). Furthermore, stretching exercises are beneficial in maintaining posture, improving motor function, and reducing the risk of musculoskeletal disorders caused by repetitive activities and static loads. Therefore, stretching exercises are a simple, safe, and appropriate intervention for adolescents in school settings as a promotional and preventive measure against back pain.(Ayu Rahma Shintya, 2024)According to Calista Roy's Adaptation Theory, stretching exercises are a stimulus that helps the body adapt through physiological coping mechanisms, thereby reducing muscle tension, improving musculoskeletal function, and alleviating back pain.

According to researchers, the high number of back pain complaints experienced by respondents before the intervention may be related to the habit of carrying a backpack every day for relatively long periods, a backpack weight that approaches or even exceeds the recommended weight limit, and a lack of stretching after school activities. During adolescence, high levels of physical activity that are not accompanied by efforts to maintain muscle flexibility can make the back muscles more susceptible to fatigue and tension. After receiving the stretching exercise intervention, respondents showed a more relaxed condition, increased muscle flexibility, and reduced discomfort in the back area. According to researchers, the success of the intervention is influenced not only by stretching movements, but also by the implementation of the exercises with proper technique, regularly, and in accordance with SOPs to produce an optimal physiological response. Although most respondents in the intervention group experienced a decrease in pain levels to the low category, there were still some respondents who remained in the moderate pain category after the intervention. This condition is thought to be related to the stretching exercises that were not performed optimally, both in terms of movement accuracy, regularity, and sincerity in participating in the exercises. Responses to interventions in each individual can also vary and are influenced by several factors, one of which is boredom or lack of motivation during the exercise. This condition can cause respondents to perform each stretching movement less

than optimally, resulting in less than optimal effects on muscle relaxation and flexibility. Therefore, although stretching exercises have an impact on reducing overall back pain, some respondents still require more consistent and optimal exercise performance to achieve better results.

Thus, stretching exercises can be a simple, safe, and easily implemented alternative non-pharmacological nursing intervention in the school environment. These activities can also be performed routinely before and after learning as a preventative measure or to help reduce back pain in adolescents using Backpacks. Consistent implementation, while focusing on student motivation and involvement, is expected to increase the effectiveness of the exercises in helping reduce back pain.

Identification of the Level of Back Pain Complaints Observation 1 and Observation 2 in the Control Group

The results showed that the control group did not experience significant changes between the first observation (pre-test) and the second observation (post-test). The majority of respondents, 90%, remained in the moderate pain category, while only a small proportion experienced a decrease in pain levels to the low category. This indicates that without the provision of stretching exercises, complaints of back pain in adolescents tended to persist throughout the study period. This condition may occur because respondents continued to carry out daily activities, including carrying backpacks to and from school, which can place repeated mechanical loads on the back muscles so that pain complaints remained relatively unchanged. These findings further strengthen the evidence that the reduction in pain levels in the intervention group was related to the provision of stretching exercises, not solely due to the natural recovery process during the study period.

The control group was a comparison group that did not receive stretching exercises, so changes in back pain levels were more influenced by the body's physiological condition, daily activities, postural habits, and other risk factors associated with back pain. Back pain in adolescents is generally caused by excessive backpack use, non-ergonomic posture, heavy physical activity, and the habit of sitting or standing for long periods. These factors cause tension in the back muscles and ligaments, resulting in pain complaints that can persist if not given proper prevention and treatment.(Erna Sariana, 2020)Physiologically, continuous use of back muscles due to maintaining incorrect posture or carrying excessive weight can lead to nociceptor activation, tissue ischemia, and muscle spasms. These conditions result in limited mobility and back pain that can persist without intervention to improve muscle function and tissue flexibility.(Muhammad Alim, Divine Gift, 2024).

According to the researchers, the lack of significant changes in pain levels in the control group may be due to ongoing pain-triggering factors throughout the study. Respondents continued their normal school activities, including carrying backpacks daily and sitting for relatively long periods during the learning process. Furthermore, respondents did not receive stretching exercises that could help reduce tension and relax back muscles. Another possible contributing factor is the habit of maintaining an unergonomic posture when sitting, standing, or carrying a backpack, which can lead to continued tension in the back muscles. According to the researchers, although the body has the natural ability to adapt to various stimuli, this ability may not be sufficient to cope with repeated mechanical loads without interventions that support the adaptation process. Therefore, pain levels in the control group tended to remain constant between the first and second observations. These results suggest that stretching exercises as a non-pharmacological intervention play a role in helping reduce back pain complaints in adolescent backpack users.

Analysis of Back Pain Complaint Levels Before and After Stretching Exercise Intervention

Based on the results of statistical analysis using the Wilcoxon Signed Rank Test, a significant difference was obtained in the level of back pain complaints before and after the provision of stretching exercise intervention in the intervention group, with a p value = 0.000 ($p < 0.05$). In the pre-intervention measurement, all respondents (100%) were in the moderate pain category. After receiving the stretching exercise intervention, the majority of respondents (91.4%) experienced a decrease in pain levels to the low category. These results indicate that the provision of stretching exercises has a significant effect on reducing back pain complaints related to the use of Backpack in junior high school students. Therefore, the research hypothesis stating that there is an effect of stretching exercises on reducing back pain complaints in adolescents can be accepted.

ExerciseStretching is a non-pharmacological therapy aimed at increasing muscle flexibility, maintaining joint range of motion, improving blood circulation, and reducing muscle tension and spasms. Regular stretching can increase tissue elasticity, thereby helping reduce pressure on musculoskeletal structures and reducing back pain. Furthermore, stretching can increase oxygen supply to tissues, thus optimizing muscle recovery.(Yudiansyah, 2022). According to(Ayu Rahma Shintya, 2024)Stretching exercises not only increase body flexibility, but also help maintain good posture, improve motor function, reduce tension in muscles and joints, and reduce the risk of musculoskeletal disorders. This intervention is safe, easy to do, and can be applied as a promotive and preventive effort in adolescents who are at risk of experiencing back pain due to Backpack use. Based on Calista Roy's Adaptation Theory, stretching exercises are an external stimulus that stimulates an individual's physiological adaptation mechanisms. This adaptive response helps the body reduce muscle tension, improve musculoskeletal function, and improve the body's ability to maintain physiological balance so that complaints of back pain can be reduced.

According to the researchers, the effectiveness of stretching exercises in helping reduce back pain complaints is not solely influenced by the stretching movements, but also related to the consistency of exercise implementation, the accuracy of movement techniques, and respondents' compliance in following the entire series of interventions according to the SOP. During adolescence, muscle tissue that still has relatively good flexibility allows the body to provide an adaptive response to stretching exercises. This can support the process of muscle adjustment to the load of activity before complaints develop into a more permanent condition. Furthermore, respondents continued their school activities as usual throughout the study, so the reduction in pain complaints that occurred indicates that stretching exercises can help reduce the impact of mechanical loads caused by using a Backpack in daily activities. According to the researchers, the results of this study also provide benefits for the implementation of community nursing and school health programs. Stretching exercises can be used as a promotive and preventive effort that is relatively easy to implement in the school environment because it does not require special equipment, is safe for adolescents, and has the potential to help reduce complaints of back pain. Routine implementation, whether before learning activities, after sports activities, or after carrying a Backpack for a considerable period of time, can be one effort to reduce the risk of musculoskeletal disorders in adolescents. These results can be concluded that stretching exercises as a non-pharmacological intervention can help improve students' physiological adaptation abilities to the burden of daily activities, in line with the concept of Calista Roy's Adaptation Theory.

Analysis of the Level of Back Pain Complaints in Observation 1 and Observation 2 in the Control Group

Based on the analysis results using the Wilcoxon Signed Rank Test in the control group, a p value of 0.109 ($p > 0.05$) was obtained, indicating that there was no significant difference between the level of back pain complaints in the first and second observations. These results indicate that during the study period there was no significant change in pain levels in respondents who did not receive stretching exercise intervention. Descriptively, most respondents were still in the moderate pain category both in the first and second observations, while only a small portion experienced a decrease in pain levels. Thus, the hypothesis stating that there was a change in the level of pain complaints in the control group cannot be accepted. These results indicate that without stretching exercise intervention, back pain complaints related to Backpack use in adolescents tended to persist throughout the observation period.

The control group did not receive stretching exercises, so changes in back pain levels were more influenced by the body's natural processes and factors that influence back pain. The habit of carrying a backpack with a load exceeding 10% of body weight, poor ergonomic posture, repetitive physical activity, and a lack of stretching can cause muscle tension to persist, leading to persistent back pain. (Erna Sariana, 2020) Back pain prevention efforts include maintaining good posture, exercising and stretching regularly, maintaining a healthy weight, avoiding excessive lifting, and getting enough rest. Failure to do these efforts can lead to musculoskeletal disorders and persistent back pain. (Casiano, et al., 2023)

According to the researchers, the lack of significant changes in the control group indicates that back pain complaints in adolescents did not directly decrease simply due to the passage of time. During the study period, respondents continued their daily school activities, such as carrying a backpack every day, sitting for relatively long periods during the learning process, and did not engage in stretching or physical activity that could help reduce muscle tension. These conditions caused the factors that contribute to the onset of pain to persist, resulting in a tendency for pain complaints to experience no significant change. According to the researchers, these results also strengthen the effectiveness of the stretching exercises given to the intervention group. The lack of significant changes in the control group indicates that the decrease in pain complaints in the intervention group was more related to the regular stretching exercises and not solely due to the natural recovery process. Therefore, stretching exercises can be considered an effective non-pharmacological intervention to help improve physiological adaptation, reduce muscle tension, and reduce back pain complaints in adolescents who use Backpacks.

Analysis of Back Pain Levels Between the Group Given Stretching Exercise Intervention and the Control Group

Based on the results of the analysis using the Mann–Whitney U Test, it was found that there was a significant difference in the level of back pain complaints between the intervention group and the control group after the study was conducted, with a p value = 0.000 ($p < 0.05$). These results indicate that respondents who received stretching exercise intervention experienced a greater reduction in the level of pain complaints compared to respondents in the control group who did not receive the intervention. Descriptively, the measurement results after the intervention showed that most respondents in the intervention group experienced a reduction in pain levels to the low category, while the majority of respondents in the control group were still in the moderate pain category. Therefore, the research hypothesis stating that there was a difference in the level of back pain complaints between the group given stretching exercises and the control group can be accepted. These results indicate that stretching exercises play a role in helping reduce back pain complaints in junior high school students who use Backpack in their daily activities.

Theoretically, the group receiving stretching exercises had better physiological mechanisms for reducing back pain than the group not receiving the intervention. Stretching can increase muscle flexibility, improve blood circulation, increase tissue elasticity, reduce muscle spasms, and maintain musculoskeletal function, thus helping to reduce pain intensity.(Yudiansyah, 2022). Conversely, in the group that did not receive stretching exercises, muscle tension due to Backpack use, non-ergonomic posture, and daily physical activity could still persist, so the physiological adaptation process to pain did not occur optimally. Therefore, stretching exercise intervention is seen as an effective non-pharmacological strategy to help reduce complaints of back pain in adolescents using Backpacks.(Ayu Rahma Shintya, 2024)Calista Roy's Adaptation Theory explains that individuals are adaptive systems that respond to stimuli. Stretching exercises, as a positive stimulus, will improve physiological coping mechanisms, help the body adapt to the mechanical stress of using a backpack, and support the recovery of musculoskeletal function, thus reducing back pain.

According to the researchers, the difference in back pain complaints between the intervention and control groups is related to the provision of stretching exercises that can help reduce muscle tension and tissue stiffness due to daily backpack carrying activities. Respondents in the intervention group participated in the exercises regularly and in accordance with the SOP, so that it can help improve muscle relaxation and flexibility and support the body's ability to adapt to the load of activities received. Meanwhile, respondents in the control group continued their school activities as usual without receiving stretching exercises, so that the muscle tension experienced tended to remain and pain complaints did not experience significant changes. According to the researchers, the results of this study also indicate that stretching exercises can be an alternative non-pharmacological nursing intervention that is simple, safe, and relatively easy to implement for adolescents in the school environment. The implementation of stretching exercises can be integrated into School Health Program (UKS) activities or carried out before the learning process as an effort to help prevent musculoskeletal disorders related to backpack use. In addition, the results of this study are in line with the application of Calista Roy's Adaptation Theory, which views humans as adaptive systems to various stimuli. In this study, stretching exercises acted as a stimulus that could support students' physiological adaptation responses to the burden of daily activities, thereby helping to significantly reduce complaints of back pain compared to the group that did not receive intervention.

CONCLUSION

Based on the results of the study on the Effect of Stretching Exercises on Reducing Back Pain Complaints Due to Backpack Use in Junior High School Adolescents Based on Calista Roy's Adaptation Theory, it can be concluded that before being given stretching exercise intervention, the majority of respondents in the intervention group experienced back pain complaints in the moderate category. After being given stretching exercise intervention, the majority of respondents experienced a decrease in the level of pain complaints to the low category. In the control group, the level of back pain complaints before and after the measurement tended to remain in the moderate category because no intervention was given. The results also showed that stretching exercises were effective in reducing back pain complaints in adolescent backpack users. In addition, there was a significant difference between the intervention group and the control group before and after stretching exercises were given, so stretching exercise intervention can be used as an effort to reduce back pain complaints in adolescents.

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