



The usage and weight of backpacks are associated with shoulder pain complaints among elementary students



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ABSTRACT

Background: In recent years, backpack use has drastically increased, especially among elementary school students. This has led to an increase in musculoskeletal complaints, such as shoulder pain, due to the duration of use and the weight of the backpacks. This study investigated the correlation between the duration of use and the weight of backpacks on shoulder pain complaints in grades IV-VI elementary school students.

Methods: This study employed an analytical observational research design with a cross-sectional study design. The inclusion criteria for this study were students aged 10-12 years old, using backpacks with shoulder straps, walking to and from school. In contrast, the exclusion criteria were injuries in the shoulder region. The sampling technique employed in this study was probability sampling, specifically simple random sampling. The research was conducted at Islamic Elementary School 1 and 2 in Karangasem, Bali. The sample size was calculated using the Lameshow formula, resulting in 106 samples.

Results: Based on bivariate analysis using Pearson's Correlation Coefficient (r), the p -value obtained was 0.000 ($p < 0.05$) for both independent variables, with correlation coefficients of $r = 0.570$ for the duration of use variable and $r = 0.709$ for the backpack weight variable. Based on multivariate analysis using Multiple Linear Regression in the F-test or simultaneous test, the p -value obtained was 0.000 ($p < 0.05$).

Conclusion: Based on the research results, it can be concluded that there was a correlation between the duration of use and the backpack's weight on shoulder pain complaints, both partially and simultaneously.

Keywords: backpack weight, body posture, elementary school students, shoulder pain.

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INTRODUCTION

Elementary school students represent Indonesia's most basic level of formal education, with an age range typically between 6 and 12 years old.¹ Physical characteristics of children at this stage can be observed in the slowing rate of weight and height gain compared to earlier stages. Children's physical endurance, capability, and body coordination increase and develop during this phase. Additionally, compared to adolescents, elementary school children have bones still developing. Still, their muscle function is not fully matured, which can lead to injuries if they engage in excessive activities requiring muscle use. Injuries resulting from these activities can manifest as musculoskeletal complaints, such as shoulder pain.² Shoulder pain is a

musculoskeletal complaint characterized by pain commonly felt around the shoulder joint. While this condition is relatively minor, it has become a major health issue in recent years and burdened individuals and communities.³ Symptoms of shoulder pain can include muscle pain, tension in the shoulder joint, and restricted shoulder movement.⁴ Several studies conducted in developing countries have shown that shoulder pain is more common in children and adolescents. For example, in Iran, shoulder pain was reported in 28.6% of children aged 11-14 years old. Age, gender, and body mass index (BMI) have been identified as risk factors associated with musculoskeletal complaints, such as shoulder pain, among students in various studies. Furthermore, shoulder pain in children is considered a risk factor for health problems in adulthood.³

In addition to the above risk factors, using backpacks contributes to shoulder pain among students. Backpacks make it easier for students to carry their school supplies. Several studies have indicated that elementary school students mostly use backpacks.⁵ For instance, in Denpasar, Bali, 77.9% of students use backpacks, followed by shoulder bags (20.8%), and the rest use other types (1.3%).⁶ In recent years, there has been a drastic increase in the use of backpacks due to growing interest among students. This has led to increased impacts from using heavy backpacks for extended durations, including sudden injuries such as the risk of falling, muscle injuries, and chronic injuries.⁷ Around 90% of school students in various countries who use backpacks complain of back and shoulder pain.⁸ Another study in Hilla City, Babylon, Iraq, also showed

that elementary school children using backpacks experienced back pain (36.8%), neck pain, and shoulder pain (45%).⁶

Shoulder pain complaints are influenced by the duration of use and the backpack's weight. Backpack usage duration is considered high when it exceeds 30 minutes per day.⁹ According to Dockrell et al. (2016), wearing a backpack for more than 10 or 20 minutes daily could cause pain.¹⁰ The American Chiropractic Association (ACA) recommends backpack weight should not exceed 5-10% of body weight. However, it is unfortunate that many students still use backpacks for extended durations and carry loads heavier than recommended. A study conducted in Turkey in 2012 by Alaa'Osaïd with 800 student respondents found that shoulder pain (47.8%), low back pain (21.6%), and neck pain (18.2%) occurred in students who used backpacks for 5-30 minutes daily, with an average weight of 5.267 kg or 12.3% of body weight.¹¹ The onset of shoulder pain is caused by the backpack straps exerting pressure and tension on the shoulder region. Thus, if the backpack weight increases with prolonged use, the pressure on the shoulder region also increases, causing prolonged and increased pain.⁸ This is due to carrying too many school supplies and placing most of the load and pressure on the shoulders.¹²

Students regularly carry backpacks to and from school and during extracurricular activities, impacting the duration of backpack usage.⁶ In some elementary schools, particularly those far from urban centers, many students walk to school carrying backpacks due to the proximity of residential areas. Despite existing studies in Indonesia on the correlation between backpack use and shoulder pain complaints, research specifically focusing on the duration of use and weight of backpacks remains scarce. Previous studies in Bali only examined backpack weight, differing from the location and scope of this current study. Given these considerations, it is hypothesized that the duration of backpack use and weight influence the likelihood of shoulder pain complaints among elementary school students. With a significant rise in shoulder pain complaints, it is imperative to thoroughly explore the factors

contributing to this issue, particularly the duration of backpack usage and its weight.

METHODS

This study utilized an analytical observational research design with a Cross-Sectional study design. This design aimed to simultaneously examine the correlations among research variables within a specific period.¹³ The sample size was calculated using the Lameshow formula, resulting in 106 samples. Sampling was conducted using the probability sampling technique, specifically simple random sampling. In this method, subjects were first selected based on predetermined criteria within the accessible population. Then, the required subjects were randomly chosen based on their serial numbers using a random number generator in the computer system.

The inclusion criteria for this study were students aged 10-12 years old, using backpacks with shoulder straps, walking to and from school, having a normal BMI for age within the range of -2 SD to +1 SD based on Z-scores, willingness to participate in the study, and ability to communicate verbally and cooperatively. Exclusion criteria included a history of shoulder region injuries such as fractures, dislocations, etc., known through interviews and anamnesis, and students engaged in heavy household chores involving the shoulders, such as lifting heavy loads, moving heavy furniture, shoveling sand, hoeing, etc., identified through interviews.

The research was conducted in August 2023 at Islamic Elementary School 1 and 2 Karangasem. Data collection involved measuring the backpacks' weight using a scale, determining the duration of use through a questionnaire, and assessing shoulder pain using the visual analog scale (VAS). The data were analyzed using univariate *Pearson* correlation coefficient and multivariate multiple linear regression.

The Ethics Commission of the College of Medicine, Universitas Udayana, approved this study number 1491/UN14.2.2.VII.14/LT/2023 after a thorough review process. Each participant willingly agreed to participate, providing their voluntary consent. Additionally, respondents signed an informed consent document acknowledging their comprehension of

the study's objectives, methodologies, and potential risks.

RESULTS

Univariate analysis aimed to describe the characteristics of the research subjects for each variable. The variables analyzed by the researcher were gender, age, BMI-for-age, duration of backpack usage, backpack weight, shoulder pain complaints, and pain scale. Table 1 shows 56 male subjects (52.8%) and 50 female subjects (47.2%). In this study, 50 subjects (47.2%) were ten years old, 35 subjects (33%) were 11 years old, and 21 subjects (19.8%) were 12 years old. The research subjects had a normal BMI for their age (100%). It was also known that the average weight of the sample was 30.1 kg. The research subjects carried backpacks with an average duration of 16.74 minutes/day. The average weight of the backpacks in the research sample was 3.012 kg. There were 85 subjects (80.2%) who complained of shoulder pain, while 21 subjects (19.2%) did not complain of shoulder pain.

Table 2 showed that the research subjects who complained of shoulder pain, totaling 85 people, used backpacks with an average duration of 18.54 minutes/day. Additionally, it was known that the backpack weight of the 85 subjects who experienced shoulder pain was 3.349 kg, meaning >10% of body weight, as seen from the subject's weight of 29.89 kg. The shoulder pain scale using VAS perceived by these 85 subjects was an average of 4.706 (moderate pain), based on the interpretation of VAS according to Afifah (2018).¹⁴

Bivariate analysis aimed to determine the correlation between each independent variable, namely duration of backpack usage and backpack weight, and the dependent variable, namely shoulder pain complaints. Table 3 showed a positive correlation with a moderate and significant strength between the duration of backpack usage variable and shoulder pain complaints, with a correlation coefficient of 0.570 and a *p*-value of 0.000 < 0.05. Additionally, it was known that there was a strong and significant positive correlation between the backpack weight variable and shoulder pain complaints, with a correlation coefficient of 0.709 and

Table 1. Characteristics of respondent

Characteristics	n (Percentage (%)) or mean $\pm$ SD
Gender	
Male	56 (52.8)
Female	50 (47.2)
Age	10.73 $\pm$ 0.76
10	50 (47.2)
11	35 (33)
12	21 (19.8)
BMI	
Normal	106 (100)
Body weight	30.1 $\pm$ 4.44
Duration of usage	16.74 $\pm$ 6.61
Backpack weight	3.01 $\pm$ 0.84
Shoulder pain	
Yes	85 (80.2)
No	21 (19.8)

BMI, body mass index; n, frequency; SD, standard deviation

Table 2. Characteristics of respondent who complained of shoulder pain

Characteristics	Mean $\pm$ SD
VAS scale	4.71 $\pm$ 1.34
Body weight	29.89 $\pm$ 4.25
Duration of usage	18.54 $\pm$ 3.35
Backpack weight	3.35 $\pm$ 0.43

VAS, visual analog scale; SD, standard deviation

Table 3. Correlation between duration of usage and backpack weight on shoulder pain complaints

Variable Correlation	Correlation Coefficient	<i>p</i> -value
Duration of backpack use on shoulder pain complaints	0.570	0.000
Backpack weight on shoulder pain complaints	0.709	0.000

Table 4. Simultaneous test and test the coefficient of determination in the results of multiple linear regression

	<i>p</i> -value	Adjusted R Square
Simultaneous Test	0.000	
Coefficient of Determination		0.574

a *p*-value of 0.000 < 0.05.

Multivariate analysis aimed to determine the simultaneous influence of the research variables on an object. Table 4 shows the F-test results to assess the independent variables' simultaneous effect on the dependent variable. The obtained *p*-value was 0.000 < 0.05. Thus, it could be concluded that this multiple regression model was suitable for use, and the independent variables (duration of backpack usage and backpack weight) simultaneously affected the dependent variable (shoulder pain complaints). Additionally, Table 3 shows the coefficient of determination test results to determine

the extent of the simultaneous influence of independent variables on the dependent variable. The adjusted R-squared value obtained was 0.574. This indicated that the effect of the independent variables, namely duration of backpack usage and backpack weight, on the dependent variable, namely shoulder pain complaints, was 57.4%. In comparison, the remaining 42.6% was influenced by variables not studied in this research.

DISCUSSION

Using backpacks for longer periods correlates with increased shoulder pain complaints in children aged 10-12

years, where bone growth in children aged 10-14 was critical, meaning musculoskeletal problems could cause pain and discomfort.¹⁵ Additionally, according to Izzat (2013), children aged 9-12 years are prone to musculoskeletal problems, especially shoulder pain caused by carrying too heavy backpacks.¹⁶ This research was dominated by 10-year-old children, totaling 50 individuals (47.2%). This finding is supported by Legiran et al.'s (2018) study involving 96 samples aged 10-12 years. They administered questionnaires, conducted statistical analyses, and found that most children, 68 individuals (68%), used backpacks for 10-30 minutes/day.¹² The obtained *p*-value was 0.000, indicating a significant relationship between the duration of backpack usage and musculoskeletal complaints, including shoulder pain. Wearing a backpack for more than 10 or 20 minutes per day can lead to the onset of pain.¹² This is due to increased pressure on the shoulder and neck muscles from prolonged usage.^{17,18} Children's muscles and joints, still in the growth phase, are vulnerable to excessive pressure, leading to tension and pain. According to Lisanti et al. (2017), prolonged and repetitive backpack usage can cause continuous muscle contractions, resulting in fatigue and the onset of pain. Fatigued muscles require more energy, and the breakdown of glycogen to meet energy demands produces lactic acid as a byproduct. Accumulation of lactic acid in muscles can lower pH levels and stimulate pain receptors, sending pain signals to the central nervous system and causing discomfort.⁶

This finding is supported by the study of Legiran et al. (2018) involving 96 samples aged 10-12 years, where questionnaires were administered and statistical analysis was conducted. The results showed that most children, 68 individuals (68%), used their backpacks for 10-30 minutes/day, with a *p*-value of 0.000, indicating a significant relationship between backpack usage duration and musculoskeletal complaints, including shoulder pain.¹²

The distribution of respondents based on usage duration indicated that, on average, elementary school children aged 10-12 walked from home to school for 16.74 minutes/day while using a backpack.

According to Dockrell et al. (2016), using a backpack for >10 or >20 minutes per day can lead to pain. This is because prolonged backpack usage can increase pressure on the shoulder and neck muscles. In growing children whose muscles and joints are not fully developed, excessive pressure can lead to tension and pain.¹⁰ Additionally, Lisanti et al. (2017) stated that carrying a backpack for long and repeatedly can lead to prolonged muscle contractions, resulting in muscle fatigue and the emergence of pain complaints.⁶ Fatigued muscles require more energy, with the main energy source being glycogen. The breakdown of glycogen produces lactic acid as a by-product. Accumulation of lactic acid in muscles can lower pH, leading to increased muscle acidity. This can stimulate pain receptors, namely acid receptors, sending pain signals to the central nervous system, ultimately causing pain.

This result is supported by a study conducted by Tantriyani et al. (2019). The sample consisted of 80 respondents aged 10-12 years. The researchers collected samples to measure the weight of each backpack, with the average weight of the backpacks used being 4.337 kg (>10% of their body weight). Shoulder pain was assessed using the SPADI form. The research results were analyzed using the *Spearman Rho* test, and a *p*-value of $0.000 < 0.05$ was obtained, indicating a relationship between backpack weight and shoulder pain complaints.¹⁹

Another supporting study is the research by Dewantari and Adiputra (2017) involving 113 elementary school students in the Kuta District. Data collection included measuring backpack weight, body weight, and height and filling out questionnaires regarding musculoskeletal complaints such as lower back pain, shoulder pain, and neck pain. The analysis using the *Chi-square* test on the relationship between backpack weight and shoulder pain complaints yielded a *p*-value of $0.012 < 0.05$, indicating a significant relationship between backpack weight and shoulder pain complaints.⁸

The distribution of respondents based on backpack weight in this study showed that, on average, elementary school children carried backpacks weighing

more than 10% of their body weight, which many researchers concluded was not recommended. This caused children to experience pain, and their muscles became stiff due to the strong pressure on the shoulder area.²⁰ When using a heavy backpack, more than 10% of their body weight caused their posture to change forward on the head and trunk. This position caused muscles to be unbalanced, affecting the children's body shape and walking posture and resulting in pain.²¹ Furthermore, this load compressed blood vessels in the muscles, leading to muscle oxygen deficiency. Subsequently, muscles activated anaerobic metabolism to obtain energy, causing the release of pain mediators.²²

The duration of usage and backpack weight simultaneously or together influenced shoulder pain complaints. Alaa'Osaid's study (2012) in Turkey with a sample of 800 students concluded that wearing a backpack for 5-30 minutes/day from home to school with an average backpack weight of 5.267 kg or 12.3% of their body weight caused shoulder pain (47.8%), lower back pain (21.6%), and neck pain (18.2%).¹¹ Alaa'Osaid's (2012) study supported the findings of this research. The results revealed that the duration of usage and backpack weight affected posture in the cervical and shoulder regions.²³ Shoulder pain in children aged 10-12 years due to the duration and weight of backpacks can occur due to excessive load on their growing body structures. Using a backpack that is too heavy or worn for too long can exert extra pressure on the spine, muscles, and joints, which are not fully developed. This can cause tension and discomfort and even potentially affect their body posture. Additionally, using a heavy-loaded backpack repeatedly and for a long duration will cause muscles to contract for an extended period, leading to fatigue and pain. The intensity of shoulder pain experienced varies for each individual. Shoulder pain in children can be caused by carrying a heavy daily load for a long duration, increasing pain intensity. The body may experience fatigue when carrying a load due to increased energy expenditure and more active work. If muscles are continuously forced to work without rest, muscle endurance may

decrease due to fatigue, making children prone to injury.¹⁹

The research is characterized by several weaknesses that warrant attention. Firstly, the study's sample size is relatively small, comprising only 106 samples aged between 10 to 12 years. This limited sample size may compromise the broader applicability of the findings to a more diverse population of children within the same age group. Additionally, the reliance on self-reported data collected through questionnaires introduces the potential for recall bias. Children may struggle to accurately recall and report their experiences, leading to possible inaccuracies in data regarding the duration of backpack usage and the severity of shoulder pain. Moreover, the study lacks adequate control over various confounding variables that could influence the relationship between backpack usage duration and shoulder pain complaints. Factors such as physical activity levels, ergonomic considerations, and individual differences in musculoskeletal health were not sufficiently accounted for in the analysis. These weaknesses could impact the overall validity and reliability of the study's findings.

CONCLUSION

There was a correlation between the duration of backpack usage and the weight of the backpack on shoulder pain complaints, both partially and simultaneously, with a strong and positive correlation.

ETHICAL CLEARANCE

This study obtained ethical approval from the Ethics Committee of the Faculty of Medicine at Udayana University. It was deemed ethically feasible under reference number 1491/UN14.2.2.VII.14/LT/2023.

CONFLICT OF INTEREST

There are no conflicts of interest in this study.

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AUTHOR CONTRIBUTIONS

ASA compiled the study design and methodology, collected and analyzed the data, and drafted the manuscript; AAGESU, AWI, and GPK participated in the literature search and manuscript revisions. All authors read and approved the final version of the manuscript.

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