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ORIGINAL ARTICLE

Relationship between backpack weight and incidence of low back pain in senior high students

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ABSTRACT

Low back pain (LBP) is one of the most common musculoskeletal disorders that can impair daily activities. The causes of LBP are mostly non-specific, including the abnormalities in the soft tissues or form of muscles, ligament injuries, and muscle spasms or fatigue. One of the causes of LBP is carrying excess weight. If the load carried exceeds 15% of body weight, the person who carried the weight will experience musculoskeletal disorders. Students may carry a backpack with a weight that exceeds the recommended weight and this weight will put pressures on the muscles, ligaments, and tendons, causing tension and acute neck pain. These students then will have a higher risk of suffering LBP. The aimed of this study was to identify the relationship between the backpack load and the incidence of low back pain in students. Using the cross-sectional analytical method, this study was performed on a total of 63 students from a senior high school in Cimahi, Indonesia. Subjects were selected using the multistage random sampling and data on the sociodemographic, backpack load, and low back pain were collected and analyzed using the chi-square test. Results showed that 45 students (71.4%) experienced LBP, while the average weight of the backpack carried by these students 6.59 kg ($p < 0.001$). Thus, there is a significant relationship between the excessive backpack weight and the incidence of LBP among students.

Keyword: backpack weight, incidence, Low Back Pain (LBP), musculoskeletal, student

INTRODUCTION

Musculoskeletal disorders are injuries that occur in the joints, ligaments, muscles, nerves, tendons, and structures that support the limbs, neck, and back. Musculoskeletal disorders can be caused by infection, inflammation, tumors, and mechanical/physiological injuries / traumas to the affected part. Low back pain (LBP) is one of the most common musculoskeletal disorders and may hinder daily activities in those experiencing this type of pain. LBP is defined as a pain and discomfort localized below the costal margin and above the lower buttock crease, with or without leg pain.[1] LBP is a very common world health problem that restrict activities and increase number of absence from work. Adolescents have a similar risk of low back pain as adults,

with a prevalence rate of 70-80% by the age of 20.[2] The causes of LBP are mostly (85%) non-specific and link to abnormalities in the soft tissues in the form of muscle and ligament injuries, muscle spasms, or fatigue. Other serious causes are specific in nature including, among others, vertebral fractures, infections, and tumors. Students often carry a lot of books and stationeries to support their learning activities using their bag. From the various types of bags available, backpacks are considered a convenient and safe way to carry loads by this group.[3] Backpack use is the most important factor of low back pain among students. Backpack weight increases significantly with the higher grade as students need more academic equipment to be carried to school.

The type of backpack also affects how the LBP may be experienced by students, with the two-strap backpack being the most ergonomic design. The way the students carry the backpack also determines the risk for low back pain, as asymmetrical way of carrying a load contributes to LBP.[1] Carrying a backpack on one shoulder instead of both shoulders increases the risk of back pain due to the posture irregularities. The International Chiropractic Pediatric Association (ICPA) and the American Occupational Therapy Association (AOTA) stated that backpacks are often designed to have larger dimensions, thus can carry more load than the recommended load for children, adolescents, and students. It is recommended that the maximum load for a backpack should be around 10-15% of the student's body weight. If the load carried exceeds 15%, musculoskeletal complaints will arise and the heavy weight of the backpack will put pressure on the muscles, ligaments, and tendons, causing tension and causing acute neck pain.

The weight of a bag are categorized into 3 groups, which influence the possibility for low back pain. These groups are light (<10% of body weight), moderate (10-14% of body weight), and heavy (≥15% of body weight).[3] The global prevalence of LBP varies greatly every year, ranging from 15% to 45%.[4] In developed countries such as the United States, the annual prevalence of LBP ranges from 15% -20%, with 14.3% were identified from the number of patients visiting the doctor for this complaint.[5] About 80-90% of LBP cases will heal by itself within two (2) weeks. The majority of those experiencing LBP, 85% of sufferers were 18-56 years old.[6] A previous study n Poland showed that more than 70% of adolescents aged 10-19 years experienced back pain[7] while the primary health services in Australia stated that 5.8 out of 100 children aged less than 18 years are indicated to have a musculoskeletal disorder. It is estimated that there are 880.000 musculoskeletal problems in children and adolescents per year in Australia.[8] Data for the number of LBP sufferers in Indonesia are unknown, but it is estimated that the percentage will vary between 7.6% to 37% of the total population.[9] According to Jones, the prevalence of low back pain in school-aged children aged 12-17 years is 26%.[10] The incidence rate based on patient visits in several hospitals in Indonesia ranges from 3% to 17%.[11] This study aimed of this study to identify the relationship between the load of the backpack carried by senior high school students and the incidence of low back pain in this population.

METHODS AND SUBJECT

This study has received the ethical clearance from the ethics committee of the Faculty of Medicine, Jenderal Achmad Yani University, through the issuance of the ethical clearance no. 051/UMI.10/2021 on October 28, 2021. This study was a cross-sectional analytical study conducted during the period of November to December 2021. The population of this study was students who use backpacks with excessive weight. Sampling was done using the multistage random sampling approach from the 11 graders of Senior High

School 5 Cimahi, Indonesia. A total of 390 students in 11 classes were selected by rolling a dice and 2 classes with a total of 70 students were obtained. The inclusion criteria applied in this study were 16-17 years old; backpack load of more than 10% body weight; Normal Body Mass Index (BMI, ≤ 25 kg/m2), has been using a backpack for at least three years; and willing to take part in this study as proven by signing an informed consent. The exclusion criteria in this study were the presence of previous musculoskeletal disorders such as scoliosis, kyphosis, and lordosis. Based on these criteria, seven students were excluded from the study because they did not use backpacks, which gave a total number of subjects of 63 students. The Chi Square test was applied to analyze the data using the Statistical Product and program Service Solution (SPSS) for windows version 18.0. The confidence level was set at 95% confidence level and a p-value of ≤0.05 was considered significant.

RESULTS AND DISCUSSION

LBP itself can be caused by various disorders. Based on its etiology, LBP can be classified into viscerogenic, vasculogenic, neurogenic, spondylogenic, and psychogenic.12 Approximately 84% of LBP cases have no specific cause and are classified as non-specific LBP.13 Several mechanical factors, such as sitting too long, poor posture and body position, standing, walking, carrying heavy loads, bending, and lifting, are thought to play an important role in causing low back pain.14 LBP can occur in people with severe physical activities with a normal spinal structure, or in people with normal physical activity but with an abnormal spinal structure. One of the main causes of LBP is the mechanical load on the spine in the form of the pull and strain that can occur as a result of strenuous activities, herniated discs, and spinal stenosis.[15]

Mechanical loads experienced by the spine due to heavy activities or supporting a heavy object on the spine are thought to be an important factor in the pathogenesis of LBP. The habit of using backpacks with excessive loads can be categorized as one of the cause of the mechanical stresses. Mechanical loads applied to the spine can cause pressure loads, namely compressive stress loading on the spinal structures, including musculus erector spinalis, which consist of musculus sacrospinal, musculus quadratus lumborum, musculus longissimus dorsi, and musculus multifidus. The excessive load applied to the musculus flexor of the lower extremities, which consists of musculus gluteal and musculus hamstring, the branches of the spinal nerves, the facet joints, the periosteum, the vertebrae, and the fibers in the external layer of the annulus fibrosus, causes fatigue and repeated micro-trauma to these structures. The structures involved in the mechanical load contains somatosensoric nerves which will be stimulated by the mechanical load. After being stimulated, pain impulses will be formed and delivered to the pain center, causing a sensation of pain in the spine.[16]

As seen in table 1, there were 27 subjects aged 16 years and 36 aged 17 years. There were more male research subjects (n=33) than females (n=30). The average body weight of these students was 58.24 kg with an average height of 155.19 cm, and the average body mass index was 20.98 kg/m^2.

The information on the gender of the subjects is important since a previous study has proven that the level of risk of muscle complaints is influenced by gender. This may link to the fact that, physiologically, male muscle abilities tend to be greater than those of females.[17]

Table 1. Subject characteristics

Variable	n (%)	Mean (SD)
Age (years)		
16 years	27 (42.9)	
17 years	36 (57.1)	
Gender		
Male	33 (52.4)	
Female	30 (47.6)	
Weight (kg)		58.24 (7.78)
Height (cm)		166.19 (7.57)
Body mass index (kg/m^2)		20.98 (1.23)

A previous study by Ernawati (2016) in an Islamic Junior High School of Pontianak demonstrated a relationship between gender and the incidence of back pain in nine-grader students (p-value=0.005). The proportion of female students experiencing back pain was higher (56.0%) compared to the male students (44.0%), which supports the association with the fact that females have lower female muscle abilities than those of male students.[18]

A study by Dumondor (2015) also discovered that more female respondents who experienced back pain (46.7%) than their male counterparts (36.7%), which strengthen the notion that the fact that the physical abilities of females are physiologically lower than those of male; hence, male students tend to experience milder back pain complaints compared to female students.[19]

In terms of the body mass index (BMI), all students in this study had a normal BMI with an average of 20.98 kg/m^2. Students with abnormal BMI are at greater risk of experiencing back pain. Roland, Roy, Marc, Buckwalter Goldber, and Victor (2010) as quoted by Lailani (2013) explains that increased BMI can lead to a weakening abdominal muscle tone. This results in the center of gravity being pushed to the front of the body, causing increased lordosis lumbaris, which will then result in fatigue in the paravertebral muscles. In this condition, increased body weight will put additional pressure on the spine as a result of receiving the heavy load, which can trigger a mechanical stress on the lower part.[11]

In this study, 52 students (82.5%) carried a backpack with an excessive weight, as seen in table 2, while the remaining 11 students (17.5%) did not carry an excessive weight in their backpack.

Table 2. Weight of backpack carried by respondents

Variable	n (%)	Mean
Backpack weight (kg)		6.59
Excessive backpack weight	52 (82.5)	
Not excessive backpack weight	11(17.5)	

The recommendations from the ACA (American Chiropractic Association), regarding the threshold for a backpack load permitted to be carried by a person is a maximum of 10-15% of their body weight. Fageeh A (2013), who conducted research on the relationship between the weight of schoolchildren's bags and the vital capacity of the lungs, potential for back pain, and posture problems, stated that when students carry excessive loads to school, the vital capacity of the lungs will decrease, flexi and extension motions also tend to decrease, causing left or right bend.[20]

As listed in table 3, 45 students (71.4%) were stated that they experienced LBP and they carried a backpack with excessive weight. Meanwhile, 2 students who did not carry a backpack with excessive load (18.2%) had less complaints of LBP.

Table 3. Incidence of low back pain in students

Variable	n (%)
LBP in excessive backpack weight	45(71,4)
LBP in not excessive backpack weight	2(18,2)

Several studies have shown that there is a tendency of increased back pain in school students and some of these studies suggest that improper use of backpacks is associated with musculoskeletal trauma. Even though it is still controversial, the type of bag, method to carry it, and how long it is carried are linked to musculoskeletal disorders due to backpack use. Other influencing factors are bag weight, size, shape, weight distribution, and individual physical condition.[21]

According to Tarwaka (2008), loads that are carried continuously in a static position can cause disturbances in the blood flow when transporting oxygen and, over time, will create a lack of oxygen in the muscles, resulting in and anaerobic metabolism. Eventually, lactic acid and body heat will accumulate and ultimately lead to fatigue in the skeletal muscles which will trigger muscle pain complaints.[21]

Of the 52 students with excessive backpack weight, 43 (82.7%) experienced LBP. Meanwhile, from 11 students with non-excessive backpack weight, only 2 experienced LBP events (18.2%).

Table 4. Incidence of low back pain in students by backpack weight

Variable	LBP Incidence			PR
	n (%)	n (%)	n (%)	(95% CI)
Backpack weight (kg)				4.54
Excessive backpack weight	43 (82.7)	9 (17.3)	52 (100)	
Not excessive backpack weight	2(18.2)	9 (81.8)	11 (100)	

The Prevalence Ratio (PR) in this study was 4.54 with a 95% Confident Interval of 1.29-16.0, indicating that there isa tendency that students with excessive backpack weight have a 4.5 times higher risk for LBP when compared to those who do not carry an excessive backpack weight. The results of statistical tests using the chi square test at 95% confidence level showed that there was a statistically significant relationship between backpack weight and the incidence of LBP in the study subjects a p-value of <0.001 (p value ≤0.05).

CONCLUSION

There is a relationship between excessive backpack weight and the incidence of LBP among students of Senior High School 5 Cimahi, Indonesia, who carried an average backpack weight of 6.59 kg.

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DECLARATION OF INTERESTS

Authors declare no conflict of interest.

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