

Hubungan antara Beban Tas Sekolah dengan Derajat Kurva Tulang Belakang Skoliosis Anak Usia 8-12 Tahun

The Relationship Between School Bag Load And The Degree Of Scoliosis Spinal Curve In Children Aged 8-12 Years

Reza Ghani Abdul Aziz^{1*}, Adnan Faris Naufal²

¹²Physiotherapy Study Program, Faculty of Health Sciences, Muhammadiyah University of Surakarta, Indonesian
Email : j120220155@student.ums.ac.id

Abstrak

Pendahuluan: Beban tas yang terlalu berat, khususnya jika melebihi 10% dari berat badan anak, merupakan salah satu faktor risiko yang dapat menyebabkan gangguan postur tubuh. Kondisi ini dapat berdampak pada perubahan derajat kelengkungan tulang belakang, terutama dalam konteks skoliosis. **Tujuan:** Penelitian ini bertujuan untuk mengkaji hubungan antara beban tas dengan tingkat kelengkungan tulang belakang skoliosis pada anak. **Metode:** Penelitian ini menggunakan pendekatan kuantitatif dengan desain observasional *cross-sectional*. Penentuan jumlah sampel dilakukan berdasarkan rumus Slovin. Desain yang digunakan adalah satu kelompok (*one-group design*) dengan pendekatan analitik tambahan untuk mengevaluasi pengaruh yang ditimbulkan. Pengumpulan data melalui pengukuran berat tas menggunakan timbangan digital dan pengukuran kelengkungan tulang belakang menggunakan alat skoliometer. **Hasil:** Hasil uji Kolmogorov-Smirnov menunjukkan bahwa data tidak mengikuti distribusi normal. Uji korelasi Spearman mengindikasikan adanya hubungan antara beban tas dan derajat kelengkungan tulang belakang, meskipun hubungannya bersifat lemah. Selain itu, uji Wilcoxon menunjukkan terdapat perbedaan yang signifikan antara dua metode pengukuran yang digunakan. **Kesimpulan:** Terdapat hubungan yang signifikan antara berat tas dengan kelengkungan tulang belakang pada anak usia 8 hingga 12 tahun.

Kata kunci: Beban Tas, Hubungan Variabel, Kurva Tulang Belakang, Skoliometer, Timbangan Digital

Abstract

Introduction: Carrying a bag that is too heavy, especially if it exceeds 10% of a child's body weight, is one of the risk factors that can cause postural disorders. This condition can have an impact on changes in the degree of spinal curvature, especially in the context of scoliosis. **Objective:** This study aims to examine the relationship between bag weight and the degree of scoliosis spinal curvature in children. **Method:** This study used a quantitative approach with a cross-sectional observational design. The determination of the number of samples was based on the Slovin formula. The design used was a one-group design with an additional analytical approach to evaluate the effects caused. Data were collected by measuring the weight of the bag using a digital scale and measuring the curvature of the spine using a scolimeter. **Results:** The results of the Kolmogorov-Smirnov test showed that the data did not follow a normal distribution. The Spearman correlation test indicated a relationship between bag weight and the degree of spinal curvature, although the relationship was weak. In addition, the Wilcoxon test showed a significant difference between the two measurement methods used. **Conclusion:** There is a significant relationship between bag weight and spinal curvature in children aged 8 to 12 years.

Keywords: Bag Load, Variable Relationship, Spinal Curve, Scolimeter, Digital Scale

* Corresponding Author: Reza Ghani Abdul Aziz, Muhammadiyah University of Surakarta, Surakarta, Indonesian.

E-mail : j120220155@student.ums.ac.id

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1. INTRODUCTION

Children are the next generation who have an important role in the sustainability of national development in the future. Therefore, attention to their education and physical health conditions is very important. Children who have a healthy physique will find it easier to follow the learning process and be able to adapt to the development of the times optimally. One aspect of physical health that needs to be monitored early on, starting from the prenatal period, babies, toddlers, to school age, is posture. Postural abnormalities such as kyphosis, lordosis, and scoliosis are conditions that need special attention [1]. There are a number of factors that can cause less than ideal posture, including heredity, use of inappropriate backpacks, bad posture habits, and lack of physical activity and exercise [2].

Scoliosis is a disorder of the spine characterized by a lateral curvature of more than 10° , which can be measured using a scoliometer ([3]. Visually, scoliosis appears as a sideways curvature of the spine forming a pattern like the letter "S" or "C". Over time, this curvature can be more obvious and cause discomfort [4]. In children aged 5 to 14 years, the prevalence of scoliosis is estimated at around 7.1% in boys and 10.7% in girls. This figure can vary between 0.3% and 15.3%, depending on various causes such as congenital abnormalities of the vertebrae, systemic or neuromuscular disorders, or those that are idiopathic [5]. Scoliosis is categorized into idiopathic and non-idiopathic. The idiopathic type is grouped based on the age of onset, namely infantile scoliosis (0–3 years), juvenile (4–10 years), adolescent (10–18 years), and adult (>18 years) [3]. One of the commonly used scoliosis examination methods is the *Adam's forward bend test*, with the help of a scoliometer to measure the rib hump, where a value of $\geq 7^\circ$ indicates significant scoliosis [6]. Symptoms of mild scoliosis are usually a difference in height between the shoulders, neck, and waist, and imbalance when wearing clothes. At moderate levels, there may be a protrusion in the shoulder blades, *rib hump*, and a feeling of fatigue after doing physical activity. While severe scoliosis can cause fatigue even when sitting or standing for a long time, and can be accompanied by symptoms such as coughing or shortness of breath [4].

The use of inappropriate school backpacks, especially with excessive loads, is one of the most common causes of scoliosis in children. Backpacks are indeed the main choice and most widely used by elementary school students because of their practicality. However, if used incorrectly, these bags can have negative impacts on body health. In the short term, excessive loads can cause pain, discomfort, and postural imbalances in body parts such as the shoulders, arms, waist, hips, and legs. If this condition continues, it is at risk of causing long-term disorders such as chronic pain, permanent postural abnormalities, joint disorders, even problems with the respiratory and cardiovascular systems, and decreased self-confidence in children [7]. School bags are used by children to carry textbooks and other equipment. With busy activities such as schoolwork, homework, and extracurricular activities, it is not uncommon for children to carry bags that exceed the ideal limit. In addition, they also tend to carry bags on only one side of the body when going to and from school, which also worsens postural imbalances [8]. The American Occupational Therapy Association (AOTA) and the American Physical Therapy Association (APTA) in 2013 recommended that the weight of a backpack should not exceed 15% of a child's body weight. However, in 2012, the standard was tightened to a maximum of 10% of a child's body weight. Several studies support this recommendation, because a bag weight that exceeds 10% of body weight has been shown to affect a child's spinal posture, leg shape, and walking pattern [9]. Based on these conditions, this study aims to determine the relationship between bag weight and the level of scoliosis curvature in a child's spine. In addition, it is hoped that the results of this study can be the basis for education for schools and parents in regulating appropriate school bag usage policies, so that elementary school students can avoid the risk of postural disorders and support an optimal learning process in a healthy body condition.

2. METHODS

This study uses a quantitative approach that aims to examine the relationship between the weight of the bag carried by children and changes in spinal curvature to the lateral and medial directions. The type of design applied is *Cross Sectional Study*, which is an observational study conducted by collecting data at a certain time [10]. The observational approach was chosen because the study only took measurements without providing treatment or intervention. In addition, an analytical approach was used to analyze the relationship between the bag load variable and the degree of spinal curvature [11].

This research was conducted in April 2025 at MIM Muhammadiyah Gonilan located in Kartasura District, Sukoharjo Regency, Central Java. This school was chosen as the research location because it has a larger number of students than other schools in the surrounding area, so it is considered to meet the requirements for the required sampling. Research activities have been designed since January, starting from determining the title to the planned publication of the results in July. The research process includes several stages, including initial observation, determining the number of samples, compiling and consulting proposals, compiling research plans, implementing data collection, processing and analyzing data, evaluating and revising, to the final stage in the form of publication of research results.

Research subjects are all students of MI Muhammadiyah Gonilan aged between 8 and 12 years, with a total population of 150 children [12]. The sample determination was carried out using the *total sampling method*, which is a technique in which the entire population is used as a sample because the number is still within reachable limits. To ensure the accuracy of the number of samples, the Slovin formula [13] which calculates sample requirements based on the number of populations with a tolerance level of *margin of error* of 5% or 0.05. The form of the Slovin formula used is as follows:

$$n = \frac{N}{1 + N \cdot e^2}$$

$$n = \frac{150}{1 + 150 \cdot (0,05)^2} = \frac{150}{1 + 0,375} = 109$$

rounded up produce sample totaling 109 children. To anticipate data loss, then own sample backup as many as 41 children. Inclusion criteria include students aged 8–12 years who use backpacks, are healthy, able to follow instructions, and are willing to participate in the study until completion. Meanwhile, exclusion criteria are students who use the same backpack model in the last six months and who do not complete the research stages.

The data used is primary data obtained through direct measurement using a digital scale to measure the weight of the bag and a scoliometer to assess the degree of spinal curvature. The research design used was *One-Group Research Design*, which aims to observe the relationship between bag weight and the degree of spinal curvature. An analytical approach is used to evaluate and explain the influence between the two factors.

Data collection using direct observation with an analytical [14]. The procedure starts from submitting an observation permit, determining the population and sample, to collecting respondents. At the research location, each child was asked to bring a backpack to the examination room to be weighed, then the spinal curvature was examined using a scoliometer. The measurement data were then analyzed using the SPS S 20 application. The data were analyzed by first conducting normality test using *Kolmogorov-Smirnov*, if the p value > 0.05, then the data is considered normally distributed and analyzed using parametric tests. If the p value ≤ 0.05, then the data is considered abnormal and non-parametric tests are used. *Validity tests* use *Pearson Correlation* for normal data or *Spearman* for abnormal data. The level of correlation is determined based on the r value. To see significant differences between the two methods, the *Paired T-test* is used for normal data and the *Wilcoxon Test* for abnormal data.

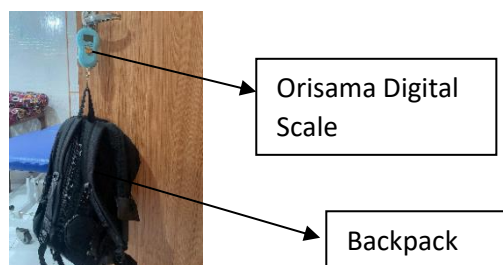


Figure 1. Orisama Digital Scales

Study This own Independent variables in the form of Bag load, the load of the bag that the child carries with scale ratio 0, measured with *Orisama digital scales*, tool This used study This because tool This of course made For know burden bag specification tool 50 Kg capacity, accuracy 10gr(0.10) 3digit=>1.1 Kg =1.10 with Size 16x7x2 cm. How to use tool *Orisama* digital scales is prepare digital scales where Already associated with the object

being held scales No shake as in figure 1 where scales blue has linked , then subject given directions For line up Then proceed one by one For deliver bag on the researcher where Later bag the associated with shaped objects like the hook on the digital scale after That results burden bag will appears on the scale layer and the values that appear entered in the value form subject .

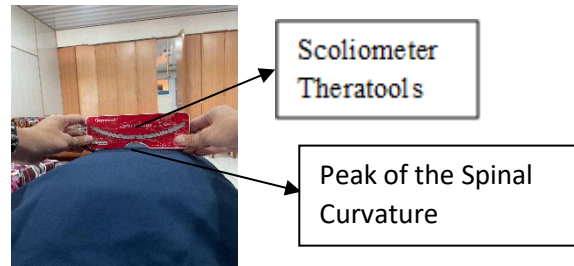


Figure 2. Scoliometer Theratools

Study this also has Variables dependent in the form of degree of curvature of the spine , tilt of the spine abnormal forming a “C” or “S” curve, with a minimum value of 7°, measured using a *Theratools scoliosimeter* with scale ratio . The use of the scoliosimeter in this study is very accurate because it is supported by existing research where the Intra-Observer *Reliability* has the highest point (0.994 for Rater A and 0.993 for Rater B), and has a *Validity point* ($r = 0.971$) so it can be concluded that the scoliosimeter is valid and reliable for measuring the trunk rotation angle in the diagnosis of scoliosis and very reliable if used repeatedly [15]. The inspection process is carried out by asking The subject bends forward in a parallel position so that the spinal curve can be seen more clearly, then the device is placed at the peak of the curve without applying excessive pressure, so that the measurement results remain accurate. The degree of curvature indicated by the scoliosimeter is recorded on the assessment form. subjects and analyzed. There are 3 criteria in the assessment of mild (0° - 3°), moderate (4° - 6°), and severe ($\geq 7^{\circ}$). Study obtain ethical approval from the Faculty of Health Research Ethics Committee Knowledge Health Muhammadiyah University of Surakarta after going through a review process with Number : 317.3/C.8-III/FIK/II/2025. *Ethical clearance* stated through attachment form agreement and letter permission research.

3. RESULT

The characteristics of the subjects consisted of 109 children aged 8–12 years, with both male and female genders. The majority used two-strap backpacks to carry equipment to support elementary school education, from the data obtained that there were still many children who carried non-ideal bag loads with quite a large number.

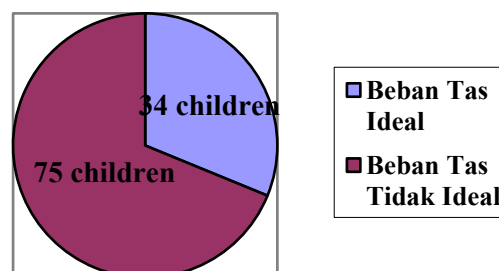


Figure 3. Bag Load

It can be seen from the graph above that around 75 children are carrying a non-ideal load and 34 children are carrying an ideal bag load.

Table 1. Degree Scoliosis

Evaluation Degrees Scoliosis	Amount Child
Light (0°-3°)	34
medium (4°-6°)	3
heavy ($\geq 7^\circ$)	1

Based on table 1, the measurement of the degree of spinal curvature using a scoliometer, the results show that there are children whose curvature is already visible pointing to the right or left, but most of the degree values are still below 7° which can be said to be in the mild category, because there are 3 criteria in the assessment of mild (0° - 3°), moderate (4° - 6°), and severe ($\geq 7^\circ$).

Table 2. Data Normality Test

Variables	p-value	$\alpha = 005$	Information
Bag Load	0,000	< 0.05	Abnormal
Degrees Curvature Bone Behind	0,000	< 0.05	Abnormal

Table 4 shows the results of the normality test for bag load data and scoliosis risk analyzed using the Kolmogorov-Smirnov test. The test results show that the data are not normally distributed, indicated by a 2-tailed significance value of less than 0.05.

Table 3. Spearman Correlation Test

Variables	Signification	Correlation Value	Information	Characteristic
Bag Load – Degree Curvature Bone Behind	0.931	0.008	There is a Relationship But Weak	Positive

Table 3 shows correlation test results using the Spearman Test, which was used For know existence connection between burden bag with degrees curvature bone back of the child age 9–12 years at MIM Muhammadiyah Gonilan Kartasura . From the test results obtained mark significance $p = 0.931$, which indicates there is connection between burden bag and degree curvature bone behind the group age The correlation value $r = 0.008$ shows that the relationship that occurs nature very weak . Because the value correlation positive , thing This means that increase in variables free (load) bag) followed by an increase in the variable bound (degree) curvature bone behind).

Table 4. Wilcoxon test

Variables	Z	p-value	Information
Bag Load – Degree Curvature Bone Behind	-3,393	0.001	Significant ($p < 0.05$)

Based on the data in table 4, the results of the *Wilcoxon* test there is significant difference between burden bag with degrees curve bone behind scoliosis ($Z = -3.214$; $p = 0.001$).

4. DISCUSSION

Bag load refers to the total weight of items carried in a bag, with the main focus on school bags used by students. In the world of education, the problem of excessive bag load is a major concern, especially in relation to its impact on students' physical health. musculoskeletal disorders, such as back pain, postural imbalance, and the possibility of developing scoliosis [16]. Especially for children at the elementary school level, there are several main factors that contribute to the high burden of student bags. One of them is the number and type of books they have to carry every day [17]. Ideally, the weight of the bag should not exceed 10% of the child's body weight [18]. This study use bag various bag backpack because of in School Education base This most subject bring bag various bag backpack For bring goods to school, bag This have design According to the journal "School Bag Design Based on Ergonomic-Anthropometry Model" by Deny Andesta, an ergonomic backpack must have a size that fits the user's body proportions, with a maximum height of 45 cm, a width of 33 cm, and a thickness of 16 cm, so as not to interfere with the child's movement when used. In addition, wide and soft shoulder straps, as well as the presence of back pads with an air ventilation system, can help reduce pressure on the spine and increase comfort [19].

The results of the independent variable data (bag load) show that based on the normality test, the data is not normally distributed (2-tailed significance value <0.05). The Spearman correlation test shows that the level of closeness of the relationship is relatively weak with a positive relationship direction, which means that the higher the value of the independent variable (bag load), the related variable also increases. Meanwhile, the results of the Wilcoxon test show a significant difference in the independent variables of this study.

Based on the results obtained, the burden of the bag also has an impact on physical health, which is divided into two types, namely short-term and long-term impacts. Short-term impacts include the emergence of pain, discomfort, and postural imbalance, including in body parts such as the scapula, arms, waist, hips, and legs. Meanwhile, long-term impacts can be in the form of long-lasting pain, permanent postural abnormalities, joint damage, impaired heart function, respiratory disorders, and decreased self-confidence [7]. In addition, the way students carry their bags also affects the distribution of the load on their bodies. If the bag is only used on one side of the shoulder, for example, this can cause postural imbalances that are at risk of triggering musculoskeletal disorders [20]. Using a bag for more than 30 minutes per day can also increase the risk of lower back pain in elementary school students [21].

Degrees curvature curve bone scoliosis back, This condition is a lifelong disorder characterized by a curvature of the spine of more than or equal to 7° on the Angle of Trunk Rotation examination [6]. Visually, scoliosis shows a sideways curvature of the spine that forms the letter 'S' or 'C'. Over time, this curvature will become more obvious and can cause discomfort [4]. Based on the degree of curvature, scoliosis is categorized into three levels: mild (0° - 3°), moderate (4° - 6°), and severe ($\geq 7^\circ$), these characteristics are taken through ATR calculations using the *Adam's test* and *Scoliometer* [6]. The influencing factors on scoliosis are various, from family genetic factors, congenital conditions such as abnormal spinal conditions, muscle and nerve problems, spinal growth and lifestyle such as stress, sitting, and carrying incorrect items. One of the main factors of scoliosis in elementary school students that is most visible is the use of inappropriate school backpacks and excessive loads [8].

Data results from variable bound (degree) curvature bone back) shows that based on the normality test , the data is not normally distributed (values 2-tailed significance < 0.05). Spearman's correlation test shows that level connection classified as weak with mark positive , which means the more tall mark variable bound (degree) curvature bone back), then variable free also tends to increased . In addition that , the Wilcoxon test results show existence significant difference to variable free study This .

Continuous pressure on the spine due to excessive weight can disrupt the body's natural balance, damage the natural curve of the back, and trigger prolonged muscle tension. In addition, this excessive pressure can also cause irritation to the ribs and spinal joints, which can potentially cause *chronic pain* and limited mobility [22]. In the long term, the habit of carrying heavy bags without paying attention to the correct way to distribute the load can increase the possibility of scoliosis or other postural disorders, which not only affect physical health but also the comfort and quality of life of students as a whole.

Physiotherapy services in preventive roles in children are part of health services that focus on individuals, families, groups, and communities to address problems and meet needs related to functional movement and physical activity. In the context of society, physiotherapy functions to improve the physical capacity of individuals [23]. In this case, physiotherapy can contribute by monitoring or screening the use of bags with excessive loads in children, especially elementary school students. Early monitoring aims to prevent negative impacts that can occur. In addition, physiotherapy also plays a role in providing education about good posture and how to maintain ideal posture [24]. The role of physiotherapy is not only limited to monitoring, but also includes awareness of wrong mindsets, especially for parents of elementary school students. With the education provided by physiotherapists, parents can apply the right input to their children so that they feel more comfortable in undergoing the learning process [25].

5. CONCLUSION

This study shows a significant association between school bag weight and the severity of scoliosis in children aged 8–12 years, although the relationship is still weak. The majority of students carry bags exceeding the safe limit, potentially causing postural problems. The strengths of this study lie in its valid instruments and adequate sample size, while its limitations are its cross-sectional design, which cannot describe long-term causal relationships. Future research should use a longitudinal design and consider additional factors, such as bag carrying habits, duration of use, physical activity, and genetics. Education for students, parents, and schools regarding safe bag weight limits and policies supporting scoliosis prevention is recommended.

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