

## HUBUNGAN DISTRIBUSI LEMAK TERHADAP KEMIRINGAN KURVA TULANG BELAKANG PADA ANAK USIA 8-12 TAHUN

### *THE RELATIONSHIP BETWEEN FAT DISTRIBUTION AND SPINAL CURVE INCLINATION IN CHILDREN AGED 8-12 YEARS*

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#### ABSTRAK

Distribusi lemak tubuh berpotensi memengaruhi postur tubuh, termasuk kelengkungan tulang belakang. Anak-anak berusia 8 hingga 12 tahun berada dalam masa pertumbuhan yang rentan terhadap gangguan postural, seperti kelainan pada kurva tulang belakang. Penelitian ini bertujuan untuk mengevaluasi hubungan antara distribusi lemak tubuh dengan derajat kemiringan kurva tulang belakang pada anak usia 8–12 tahun. Penelitian ini menggunakan desain cross-sectional dan melibatkan 109 siswa dari MI Muhammadiyah Gonilan. Pengukuran distribusi lemak tubuh dilakukan dengan menggunakan *skinfold caliper*, sedangkan kemiringan kurva tulang belakang diukur menggunakan skoliometer melalui *Adam's Forward Bend Test*. Analisis data dilakukan dengan uji normalitas Kolmogorov-Smirnov, dilanjutkan dengan uji korelasi Spearman sesuai hasil normalitas. Hasil penelitian menunjukkan tidak terdapat korelasi yang signifikan antara ketebalan lemak tubuh dan tingkat kemiringan kurva tulang belakang ( $r = 0,193$ ;  $p < 0,05$ ). Tidak ditemukan hubungan yang signifikan antara distribusi lemak tubuh dan kemiringan kurva tulang belakang pada anak usia 8–12 tahun. Pemantauan distribusi lemak tubuh sejak dini tetap penting untuk mencegah potensi gangguan postural pada anak-anak.

**Kata Kunci:** distribusi lemak; kurva tulang belakang; anak usia 8–12 tahun

#### ABSTRACT

*Body fat distribution can influence posture, particularly the curvature of the spine. Children aged 8 to 12 years are in a critical growth phase and are vulnerable to postural disorders, including spinal curvature abnormalities. This study aims to examine the relationship between body fat distribution and spinal curve inclination in children aged 8–12 years. This research employed a cross-sectional design involving 109 students from MI Muhammadiyah Gonilan. Body fat distribution was measured using a skinfold caliper, while spinal curve inclination was assessed using a scoliometer through the Adam's Forward Bend Test. Data analysis included the Kolmogorov-Smirnov normality test, followed by Spearman correlation tests, depending on data distribution. The findings showed no significant correlation between body fat thickness and the degree of spinal curve inclination ( $r = 0.193$ ;  $p < 0.05$ ). There is no significant relationship between body fat distribution and spinal curve inclination in children aged 8–12 years. However, early monitoring of body fat distribution remains important in preventing postural disorders in children.*

**Keywords:** *fat distribution; spinal curve; children aged 8–12 years*

## **Introduction**

The human body consists of fat mass. The higher the body mass index, the greater the fat content in the body. In general, the normal percentage of body fat is in the range of 20-25% (Walukow et al., 2021). Excess body fat occurs due to an imbalance of energy in the body, where energy intake is higher than the energy expended over a long period of time. Excess energy from the metabolism of macronutrients will be stored in adipose tissue as body fat. Excess fat accumulation can also affect the flexibility of the trunk and the curvature of the spinal curve, because less elastic muscles will reduce the range of motion of the joints, thereby reducing the ability of basic movements in daily activities (Lestari et al., 2024). Children and adolescents with obesity had significantly greater thoracic kyphosis and lower lumbar mobility compared to normal-weight peers, indicating postural and movement limitations (Bayartai et al., 2022). Fat in the body actually has an important role if it is in a normal percentage of fat (Mighra & Silaban, 2021). The method used to measure the percentage of body fat can be measured with a skinfold caliper. A skinfold caliper is a tool for measuring the thickness of subcutaneous fat tissue at a specific location. This measurement is used to estimate the percentage of body fat by measuring subcutaneous fat. The accuracy and precision of this method depend on the skill of the examiner, the type of skinfold caliper used, and the sample being measured and the pattern of body fat distribution in individuals with spinal curvature abnormalities can affect the degree of spinal curvature (Wijayanti et al., 2020). Body fat plays an important role when maintained at normal levels, but excess fat can reduce trunk flexibility and influence spinal curvature. Measuring body fat with a skinfold caliper is effective, though its accuracy depends on the examiner's skill, the type of caliper used, and the individual's condition. Additionally, fat distribution patterns may affect the severity of spinal abnormalities. Significant relationships between the shape of anterior-posterior curvatures and body composition were found in schoolchildren (Wilczyński et al., 2020).

Spinal Curvature Disorders are influenced by various risk factors that can worsen the condition, such as growth process, gender, age, location of the spine, and congenital spinal problems (Baswara et al., 2019). This spinal deformity starts from weakness or paralysis of the nerves that pull the vertebrae. This pull should keep the spine straight (Wahyuni & Fahrudi, 2020). Spinal disorders not only occur in adults and the elderly, but can also be experienced by children who are susceptible to these problems (Pristianto et al., 2022). The growth and development of children can experience disorders in posture, especially due to daily habits and activities. One of the most important parts of the motor system is the spine (Pratama et al., 2023). Comparatively, students demonstrate greater engagement in various physical behaviors. Children typically exhibit a preference for movement over remaining sedentary (Siantoro et al., 2024). The prevalence of spinal curvature in children aged 5 to 14 years shows a percentage of 7.1% in boys and 10.7% in girls. The most common spinal deformity has a very varied prevalence, namely between 0.3% and 15.3% (Winata, 2015). Low weight and the risk of developing spinal disorders are very closely associated. Maintenance of appropriate and normal

weight appears to be effective in preventing spinal disorder (Jeon & Kim, 2018). Spinal curvature is a health problem that is often found around us. This condition can cause discomfort, pain in the spine, and affect posture. Spinal curvature plays a role in maintaining good posture and balance, so it can support bone health and reduce the risk of injury or other disorders. In addition, the spinal curve also functions to maintain balance and stability of the body when standing, walking, and doing various movements (Iqrima et al., 2024). Spinal disorders are conditions characterized by abnormal curvature of the spine. This condition can affect posture and cause symptoms that vary from person to person (Sartika et al., 2024). Spinal curvature disorders are influenced by factors such as age, gender, growth, and daily habits. These conditions can begin in childhood and affect posture, comfort, and body balance. Given the spine's crucial role in maintaining stability, early detection and management are essential. The trend of increasing deformities such as kyphotic or lordotic postures was observed in all age groups, alongside rising BMI values (Kapo et al., 2018).

To detect spinal curvature disorders, the commonly used examination method is the Adam's Forward Bend Test (AFBT) combined with the use of a scoliometer. This tool allows for fast and safe detection of scoliosis without the risk of radiation exposure (van West et al., 2022). Similarly, according to the most commonly used screening method to detect spinal curve disorders, the Adam's Forward Bend Test and scoliometer. The Adam's Forward Bend Test is a cheap and easy method. The scoliometer is a tool that is widely used to detect spinal curve disorders in children (Li et al., 2021). The increasingly severe curvature will cause the spinal curve to become "C" or "S" shaped, commonly known as scoliosis (Wasid et al., 2020).

Previous studies have indicated that body fat distribution may influence posture and spinal curvature, mainly through its impact on trunk flexibility and muscle elasticity, which can reduce joint range of motion and basic movement abilities (Lestari et al., 2024). Additionally, patterns of fat distribution in individuals with spinal curvature abnormalities have been suggested to affect the degree of spinal curvature (Wijayanti et al., 2020). However, these studies have not specifically examined this relationship in children aged 8–12 years using practical and safe measurement methods. The present study addresses this gap by focusing on children in this age group, employing validated tools such as skinfold calipers and scoliometers, and uniquely analyzing the asymmetry of fat distribution between the right and left sides of the body a factor rarely explored in prior research. The findings reveal no significant correlation between body fat distribution and spinal curve inclination in children aged 8–12 years, clarifying that fat distribution may not directly influence spinal curvature during this growth phase. This study thus provides more specific and practical evidence for postural health management in children, complementing and enriching the existing literature.

## **Method**

This study uses a quantitative approach with the Cross Sectional Study method. Cross Sectional Study is a type of study that provides an overview of a population at a certain time. The observational approach was chosen because this study only made observations related to

measurement results and did not provide special treatment. This study aims to analyze the relationship between fat distribution and the slope of the spinal curve in children aged 8-12 years.

This research was conducted in April 2025. The research was conducted at MI Muhammadiyah Gonilan, Kartasura District, Sukoharjo Regency, Central Java. Because this school has more respondents than other schools.

The population in this study was all students of MI Muhammadiyah Gonilan, totaling 150 children aged 8–12 years. The sample was obtained using the Slovin formula, which was entered into the formula, according to (Majdina et al., 2024).

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

With N= 150 and a margin of error 0.05 resulting in 109 respondents who met the inclusion and exclusion criteria. A sample is a subset of the population selected to be the subject of the study. In this research, the sample consisted of 109 students selected from a total population of 150 children.

Sampling in this study was conducted using a simple probability method calculated based on the Slovin formula. Determination of the sample was based on certain inclusion and exclusion criteria. The inclusion criteria in this study include: children aged 8–12 years, have normal health conditions, are willing to follow the entire series of research until completion, are students at MI Muhammadiyah Gonilan, actively participate in Tapak Suci extracurricular activities, and have measurable body fat. Meanwhile, the exclusion criteria include children who have a history of back injury in the last six months and those who do not follow the complete research stages.

Data collection was done through direct observation and measurement using tools. Data were analyzed using SPSS software and for data analysis using the Kolmogorov-Smirnov normality test because to see the difference in distribution in two different samples and because the sample was more than 50, then conducting a correlation test (Pearson if the data is normal, Spearman if not normal).

The Independent Variable is the distribution of body fat measured using a caliper (personal body fat tester) for the measurement location on the right and left abdomen with a ratio scale and units in mm (skin fold thickness). While the Dependent Variable is the slope of the spinal curve measured using a scoliometer with parameters of the degree of spinal slope and a ratio scale.

Some of the tools used, namely Skinfold Caliper with a personal body fat tester model, are used to measure the thickness of subcutaneous fat on the right and left abdomen. In a study to determine validity measuring fat thickness using Caliper is effective for measuring fat levels in the body with a correlation coefficient of  $r = 0.92$  in males and  $r = 0.83$  in females, the validity of

the skinfold caliper in estimating body fat percentage is considered high (Beam & Szymanski, 2010).

Scoliometer is used to measure the degree of spinal curvature. The scoliometer has a high level of intrarater and interrater reliability and indicates that the measurement results are stable and can be repeated with a good level of accuracy. In terms of screening accuracy, the Scoliometer is a fairly effective tool for early detection of spinal curvature abnormalities with a correlation coefficient ranging from  $r = 0.46$  to  $0.54$ , this level of correlation indicates that the scoliometer can still be effectively used as a reliable screening tool (Amendt et al., 1990).

The study was accompanied by informed consent from parents and approval from enumerators and accompanied by a research permit letter from the Faculty of Health Sciences, Muhammadiyah University of Surakarta with Number: 317.3 / C.8-III / FIK / II / 2025. Ethical clearance is stated through the inclusion of an attachment of the consent form and research permit letter.

## Results

This study was conducted to analyze the relationship between body fat distribution and the slope of the spinal curve in children aged 8–12 years. Descriptive characteristics of respondents are summarized in table 1. It is known that most respondents were 8-9 years old (75%,  $n=112$ ), with the rest aged 10-12 years (15%,  $n=38$ ). For BMI, most of the categories are underweight (75%,  $n=112$ ), normal (17%,  $n=26$ ), overweight (5%,  $n=7$ ) and obesity (3%,  $n=5$ ). For gender, there are females (51%,  $n=76$ ) and males (49%,  $n=74$ ). Right and left side fat and fat difference (100%,  $n=150$ ). In the slope of the spinal curve, most of the slopes were 1 (36%,  $n=54$ ), normal (35%,  $n=52$ ), slope 2 (18%,  $n=27$ ), slope 3 (5.3%,  $n=8$ ), slope 4 (3.3%,  $n=5$ ), slope 5 (2.3,  $n=2$ ) and for slopes 6 and 8 they had the same figures (0.6%,  $n=1$ )

**Table 1.** Characteristic Statistics

Variables	Category	N	%	Average	SD	Min	Median	Max
Age (years)	8-9	112	75	NA	NA	NA	NA	NA
	10-12	38	15					
BMI	<18.49	112	75					
	18.5-22.9	26	17	16.57	3.55	11.20	15.40	26.80
	23-24	7	5					
	>25	5	3					
Gender	F	76	51	NA	NA	NA	NA	NA
	M	74	49					
Fat	Left	150	100	11.28	6.73	2.00	10.00	44.00
	Right	150	100	11.88	7.18	2.00	10.00	42.00
Fat Difference		150		0.60	2.95	-10.00	0.00	8.00
	Normal	52	35					
	1	54	36					
	2	27	18					

Slope of the Curve	3	8	5.3	NA	NA	NA	NA	NA
	4	5	3.3					
	5	2	2.3					
	6	1	0.6					
	8	1	0.6					

Based on the normality test presented in table 2 using the Kolmogorov-Smirnov method, it produces a significance value (p) of 0.00, which indicates that the data is not normally distributed ( $p < 0.05$ ).

**Table 2.** Results of normality test with Kolmogorov-Smirnov

Variables	Significance Value (p)	Distribution
Body Fat Distribution	0.000	Abnormal
Degree of Spinal Curvature	0.000	Abnormal

Since the data is not normally distributed, a non-parametric statistical test, namely the Spearman test, was used to analyze the correlation. The results of the Spearman test in Table 3 show a correlation value of  $r = 0.193$ , which indicates a weak positive correlation between body fat distribution and the degree of spinal slope, although it has not reached the level of statistical significance indicating a strong relationship.

**Table 3.** Spearman correlation test results

Variable 1	Variable 2	r value (Correlation)	Significance (p)	Interpretation of Correlation
Body Fat Distribution	Spinal Curve Slope	0.193	$> 0.05$	Weak Correlation, Not Significant

## Discussion

This study found that most participants were in a critical growth phase, a period during which the spine is highly susceptible to postural changes. This is consistent with (Pratama et al., 2023), who emphasized that children's postural development is strongly influenced by daily activities and habits, particularly during growth spurts. The spine, as a central structure in the motor system, is especially vulnerable to these changes.

The analysis also indicated that many children did not have an ideal body composition, with a large proportion being underweight. This may negatively affect muscle strength and spinal stability. These findings align with those of (Lestari et al., 2024), who reported that imbalanced or excessive fat accumulation can reduce trunk flexibility and alter spinal curvature by limiting joint mobility and movement efficiency.

An asymmetry in body fat distribution was also observed. Although the difference between the right and left sides was small, the imbalance may suggest a predisposition to postural asymmetry. This supports the findings of (Mighra & Silaban, 2021), who stated that while body

fat is essential for physiological function, an uneven distribution can compromise postural alignment and stability.

Postural abnormalities particularly mild degrees of spinal curvature were relatively common among the participants. This supports (Sartika et al., 2024), who highlighted that abnormal spinal curvatures can develop early and may influence both posture and physical performance if not addressed during growth.

While the correlation between fat distribution and spinal curve slope in this study was weak, it still suggests a potential relationship. This finding is consistent with previous research by (Lestari et al., 2024), which proposed that uneven fat distribution can affect trunk flexibility and posture. However, the modest strength of the correlation also implies that other factors likely contribute to spinal alignment in children.

Overall, this study reinforces the importance of monitoring children's body composition and postural development during growth. Early interventions such as strengthening exercises and nutritional management could help prevent long-term musculoskeletal issues. The findings generally support existing literature, underscoring the role of body composition in postural health without identifying it as the sole determinant.

## **Conclusion**

This study found a weak positive correlation between body fat distribution and spinal curve slope in children aged 8–12 years, as well as significant imbalance between fat thickness on the right and left sides of the body. These findings suggest that imbalanced fat distribution may contribute to postural changes, making it important to conduct early physical monitoring and prevention through muscle strengthening and a balanced diet. For future research, it is recommended to include a larger and more diverse sample, involving participants from various schools and different regions. This approach aims to broaden the data coverage and enhance the external validity of the research findings, so that the results can be applied more widely. Additionally, it is important to consider other variables that may contribute to changes in posture and spinal curvature in children. Several relevant factors that warrant further investigation include sitting habits during learning, daily physical activity levels, the weight of the carried backpack, and back muscle strength. By expanding the scope of the variables studied, it is expected that the relationship between these factors and children's spinal health can be understood more thoroughly and comprehensively.

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