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Association Between Curve Magnitude in Scoliosis and Low Body Mass Index

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Abstract

Background: Adolescent idiopathic scoliosis is a spinal deformity characterized by Cobb angle deviation of more than 10°. **Objective:** This study aims to determine the association between low body mass index (BMI) and curve magnitude in adolescent idiopathic scoliosis. **Methods:** This was a retrospective cohort study using medical record data of patients diagnosed with scoliosis at Bhayangkara Tk I Pusdokkes Polri Hospital. BMI classification was based on WHO BMI-for-ages z-scores in children and adolescents. **Result:** The study included 22 AIS subjects, with the majority aged 14–17 years and a higher proportion of females than males. The p-value for the association between low body mass index and adolescent idiopathic scoliosis is 0.169. **Conclusion:** Curve magnitude is not associated with low body mass index.

Keywords: Adolescent, body mass index, scoliosis

Original Research Article

INTRODUCTION

Scoliosis is defined as curvature of the spine with Cobb angle deviation greater than 10° (Li et al., 2021). Scoliosis is divided into 3, namely congenital scoliosis, neuromuscular scoliosis, and idiopathic scoliosis (Sun et al., 2023). Adolescent Idiopathic Scoliosis (AIS) is the most common scoliosis with 84-89% of scoliosis cases (Ceballos-Laita et al., 2023). The prevalence of AIS ranges from 0.47 - 5.20% worldwide (Peng et al., 2020). In Indonesia, the prevalence of AIS is unknown but a study showed that the prevalence of AIS was 2.93% in Surabaya (Komang-Agung et al., 2017).

Adolescent idiopathic scoliosis has a severity determined by the degree of Cobb angle (Horng et al., 2019). AIS is generally asymptomatic at mild degrees but severe AIS can cause functional disorders such as hypercapnia, hypoxemia, and respiratory failure (Achsar & Fatoni, 2021). In addition, an asymmetrical spine can lead to decreased self-confidence, cause pain, and cause depression (Nuryani et al., 2024). Severe AIS can increase the risk of cartilage damage and osteoarthritis (Supartono et al., 2016). The decrease in quality of life due to scoliosis encourages the importance of screening in children and adolescents as a form of prevention (Jeon & Kim, 2021). Screening helps in controlling progression and minimizing potential complications (Utami & Adyas, 2022).

The exact cause of AIS is still unknown (Lee et al., 2022). Risk factors for AIS include gender, genetics, and body mass index (Scaturro et al., 2022). The link between AIS and genetics is still widely studied today. Several studies have identified genes as risk factors for AIS. Chromosome 20p11.22, located downstream of paired box 1 (PAX1) gene, is a susceptibility locus for AIS. The ladybird homebox 1 (LBX1) gene is linked to susceptibility and progression of AIS due to its role in regulating muscle precursor cell migration (Petrosyan et al., 2024). AIS is more common in women than men (Kim et al., 2020). BMI is related to muscle mass, bone density and stability of musculoskeletal structures so that someone with a low BMI is at risk of scoliosis (Jeon & Kim, 2021). Low BMI causes an inadequate supply of nutrients to the bones, resulting in a decrease in bone mineral density which can further increase the risk of scoliosis (Parmitha et al., 2023).

The degree of curvature of AIS is assessed based on the size of the Cobb angle. The degree of curvature can be divided into moderate and severe. Moderate describes scoliosis with a degree $<40^{o}$ while severe indicates a large Cobb angle $\geq 40^{o}$ (Miyagi et al., 2021).

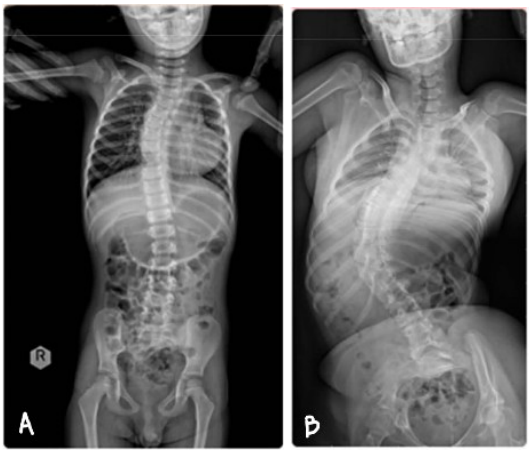

Figure 1. Adolescent Idiopathic Scoliosis moderate (A), severe (B)
(Fabijan et al., 2024)

Body mass index is often used as one of the screening criteria for AIS (Kim et al., 2020). However, research on the relationship between low BMI and the degree of curvature of AIS still shows contradictory results. A study in Japan showed that low BMI was associated with the degree of curvature of AIS, that is, someone with a low BMI was more at risk of having scoliosis with a greater angle (Miyagi et al., 2021). Research by (Woods et al., 2022), however, suggests that BMI is not associated with the degree of AIS curvature. AIS curvature seems to be more related to endocrine dysregulation, such as body composition, leptin, ghrelin. Therefore, this study was conducted to determine the relationship between low BMI and the degree of AIS curvature as current information that can be used in AIS prevention plans in children and adolescents. Bhayangkara Tk. I Pusdokkes Polri Hospital provides services to the public. Therefore, the aim of this study was to investigate the association between low body mass index and the degree of curvature in adolescent idiopathic scoliosis.

MATERIALS AND METHODS

The research design used in this study was observational analytic research with a cross sectional design. This study used secondary data in the form of medical records from January 1, 2021 to August 31, 2024 at the Bhayangkara Hospital Tingkat I Pusdokkes Polri. This study has passed the ethics review under the number KET/EC-233/X/2024/RS.BHAY.TK.I., issued by the Ethics Commission of Bhayangkara Tingkat I Pusdokkes Polri Hospital.

Sampling used a total sampling technique due to the limited population size. Total sampling involves using the entire population, including all patient data that meets the inclusion and exclusion

criteria. The inclusion criteria for this study were patients aged 10-18 years who were diagnosed with scoliosis with medical records equipped with the results of weight, height, and plain photo examination with information on the size of the Cobb angle. The exclusion criteria for this study were medical records of patients without data on weight, height, and plain photo examination, as well as medical records of patients with infectious disorders, trauma, and musculoskeletal tumors of the spine.

Weight and height data were used to calculate body mass index. Body mass index in adolescents was classified according to WHO BMI-for-ages z-scores in children and adolescents (aged 5-19 years). Analysis used the chi-square test with a significance level of $\alpha = 0.05$. Fisher Exact test was used if there were data that showed an expected count value <5.

RESULTS

Table 1. Subject Characteristics of Adolescent Idiopathic Scoliosis

Characteristics	n = 22	%
Age		
10 – 13 years	3	13,6
14 – 17 years	15	68,2
18 years	4	18,2
Gender		
Male	8	36,4
Female	14	63,6
Body Mass Index		
Severely Thinnes	2	9,1
Thinnes	4	18,2
Normal	15	68,2
Overweight	1	4,5
Obese	0	0

There were 92 patients who suffered from AIS at Bhayangkara Tingkat I Pusdokkes Polri Hospital from 2021 to 2024. The number of patients who met the inclusion and exclusion criteria was 22. Based on data obtained from 22 research subjects, this study was dominated by 15 people (68.2%) aged 14-17 years, while the fewest subjects were 3 people (13.6%) aged 10-13 years (Table 1). The majority of subjects were female, with 14 people (63.6%) and 8 people (36.4%) were male (Table 1). There were 15 people (68.2%) who had a normal body mass index and 1 person (4.5%) who was overweight (Table 1).

Table 2. Relationship between Low Body Mass Index and Degree of Curvature of Adolescent Idiopathic Scoliosis

BMI	AIS		*p-value*
	Moderate	Severe	
Severely thinnes	4	1	
Thinnes	3	1	0,169
Normal	14	1	
Overweight	1	0	
Obese	0	0	
Total	**18**	**3**	

Based on the data obtained from 22 research subjects, it was found that the highest number was in moderate AIS with normal body mass index, namely 14 people (Table 2). Statistical tests showed that there were 2 cells that had an expected count of less than 5, so Fisher's Exact alternative test was used. The p value obtained was 0.169, indicating that there was no association between low body mass index and the degree of curvature of Adolescent Idiopathic Scoliosis (Table 2).

DISCUSSION

The results of this study indicate that adolescent idiopathic scoliosis is mostly experienced by adolescents aged 14-17 years. The development of scoliosis in adolescence is associated with rapid growth during puberty. Growth spurts can increase the risk of developing spinal deformities. Research by (Dimeglio & Canavese, 2020), states that rapid growth during puberty increases the risk of spinal deformity. This study shows that adolescent idiopathic scoliosis is mostly experienced by adolescent girls. Estrogen in adolescent girls has higher levels than men. Estrogen hormones can cause imbalances in the formation of the spine. The results of this study are in line with research (Kim et al., 2020), that the ratio of women and men with AIS is 2.3: 1. Research (Zheng et al., 2018) states that the high incidence of scoliosis in women is thought to be related to estrogen because it can cause unsynchronized endochondral ossification between the anterior and posterior column of the spine.

The hormone leptin is also thought to be associated with scoliosis as it modulates bone formation. Leptin levels are higher in women than men. Research (Zadjali et al., 2023) shows that women have higher serum leptin levels than men. Leptin affects bone formation through regulation of neuropeptide expression in the hypothalamus and sympathetic activation (Palhinha et al., 2019).

The results of this study showed that AIS occurred most in the moderate degree of curvature. Body mass index indicates a person's nutritional status so that a low BMI generally describes a nutritional condition with an inadequate supply of nutrients. Inadequate nutrient supply can affect growth. Research by (Jeon & Kim, 2021), suspects that underweight body mass index affects muscle mass, bone density, and stability of musculoskeletal structures thus increasing the prevalence of scoliosis. However, body mass index does not fully illustrate the presence of bone and muscle formation optimization. Body composition examination can be used to determine the condition of bones and muscles. Research by (Chung, 2015), states that body mass index cannot describe deficiencies in the composition of bone and muscle components.

The results of the Fisher's Exact alternative test analysis, obtained a p-value of 0.169 which indicates there is no relationship between low body mass index and the degree of curvature of adolescent idiopathic scoliosis. Factors associated with the degree of curvature of AIS have been widely studied to date. These factors include gender, poor posture and body mass index. Poor posture due to sitting on one side can lead to spinal instability and worsen the degree of scoliosis curvature. Severe scoliosis is more common in women than men (Erkkila et al., 2023). Research by (Mudhari et al., 2024), shows that a tilted sitting position resting on one side can worsen the degree of scoliosis.

Low BMI is widely discussed in relation to the degree of curvature of AIS. Research conducted by (Miyagi et al., 2021), stated that the group with IMT was significantly lower in the severe group compared to the moderate group ($p<0.05$). Low body mass index is often associated with low fat mass conditions. Low fat mass can describe low leptin levels which can then trigger unbalanced bone growth in the anterior vertebrae. Research by (Burwell et al., 2016), states that low fat mass has low leptin levels which can trigger unsynchronized growth of the anterior vertebrae. A meta-analysis study by (Wang et al., 2020), found that scoliosis patients had lower leptin levels than the normal group. Low leptin levels in scoliosis patients are thought to be caused by abnormalities in the feedback cycle of the hormonal system.

The results of this study are in accordance with research (Woods et al., 2022) which states that low BMI is not associated with the degree of curvature of adolescent idiopathic scoliosis. The degree of curvature of scoliosis is related to the level of spinal stability and is related to bones and muscles. Calculation of body mass index only measures height and weight so it cannot show deficiencies in bone and muscle mass. Research by (Matusik et al., 2020), states that spinal growth and stability are closely related to body composition components that can be examined by dual energy-X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA).

CONCLUSION

The degree of scoliosis curvature was not associated with BMI in patients at Bhayangkara Hospital Tingkat I Pusdokkes Polri. The results of this study indicate that other criteria in scoliosis preventive examinations need to be considered, not just BMI. The limitations of this study are related to the limited amount of medical record data. Future research is expected to conduct research on a larger population so that the data analyzed can better represent the population.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

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