A descriptive study of scoliosis incidence in sixth-grade students at SD Muhammadiyah Kleco, Yogyakarta

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Abstract. Scoliosis is a musculoskeletal disorder characterized by an abnormal curvature of the spine that can affect quality of life. It is defined as a lateral curve in the frontal plane, which may or may not be accompanied by vertebral rotation in the axial and sagittal planes. This study aimed to identify the age of onset and degree of scoliosis in elementary school students. A descriptive observational study was conducted in August 2025 at SD Muhammadiyah Kleco, Yogyakarta. The study included all sixth-grade students present during the examination whose parents provided informed consent (n =40). Scoliosis was assessed using a scoliometer combined with the Adam's Forward Bending Test. The results showed that 55% of students had scoliosis, most commonly in the intermediate category with an Angle of Trunk Rotation (ATR) of 4°–6°. Scoliosis was observed in students aged 10–12 years. These findings highlight the importance of early scoliosis screening in schools to enable timely detection and intervention.

1 Introduction

Scoliosis is a musculoskeletal disorder characterized by an abnormal curvature of the spine that can affect the quality of life of the sufferer [1-2]. Scoliosis is also defined as an abnormality of the spine in the form of a lateral curvature. When observed from behind, the spine in scoliosis will be shaped like the letter "C" or "S". Another definition states that scoliosis is a type of postural deviation of the spine with any cause, characterized by a lateral curve in the frontal plane that may or may not be associated with vertebral body rotation in the axial and sagittal planes. Scoliosis is a three-dimensional abnormality of the spine that causes observable deformity. Scoliosis is defined by the Cobb angle of the spinal curvature in the coronal plane and is often accompanied by vertebral rotation in the transverse plane and hypokyphosis in the sagittal plane. The prevalence of idiopathic scoliosis among children and adolescents in Indonesia ranges from 0.7% to 4.3%, with girls at higher risk than boys. Screening in Surakarta (ages 12–15) reported 3.4% in girls and 0.3% in boys [1], while post-pandemic studies in Yogyakarta suggest remote learning may worsen posture, though data for elementary school students remain limited [3]

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This condition is most often diagnosed in childhood or early adolescence. Normal spinal curvature occurs in the cervical, thoracic, and lumbar areas in a plane called the sagittal plane. These natural curves position the head over the pelvis and function as shock absorbers to distribute mechanical stress during movement. Scoliosis is often defined as curvature of the spine in the "coronal" (frontal) plane. While the degree of curvature is measured in the coronal plane, scoliosis is a more complex three-dimensional problem involving the following planes: the coronal plane, the sagittal plane, and the axial plane [4].

Based on the Indonesian Ministry of Health, 2021; Adolescent idiopathic scoliosis is defined by the Scoliosis Research Society (SRS) as an unknown spinal disorder with a coronal Cobb angle > 10 degrees that occurs in children over the age of 10-17 whose skeletons are still developing. The results of this study are expected to provide insights into the factors influencing the occurrence of scoliosis in adolescents. Approximately 15–20% of scoliosis cases have an unknown initial cause, and 80% of structural scoliosis cases have an idiopathic etiology and are typically found in children or adolescents [5].

Issues regarding the etiology, onset, prognosis, and treatment of scoliosis may vary, but the consequences of severe untreated scoliosis are the same, namely pain accompanied by various disorders in balance, cardiopulmonary function, emotional state, behavior, and activities of daily living (ADLs) [6]. Scoliosis affects 2-3 percent of the population, or approximately six to nine million people in the United States. Scoliosis can develop in infancy or early childhood. The initial age of onset of scoliosis ranges from 10 to 15 years, occurring equally in both sexes. Women are eight times more likely to develop a curvature that requires treatment. Each year, scoliosis patients make more than 600,000 visits to private doctors' offices, approximately 30,000 children are fitted with orthopedic braces, and 38,000 patients undergo spinal fusion surgery (US data). According to the 2018 Riskesdas (Basic Health Research), the incidence of joint disorders in Indonesia is 7.3%.

The causes and pathogenesis of scoliosis have not been definitively determined. The first possible cause is genetics. Many clinical studies support autosomal dominant, multifactorial, or X-linked inheritance patterns. The second cause is posture, which influences the occurrence of congenital postural scoliosis. The third cause is vertebral anatomical abnormalities, where the epiphyseal plate on the concave side of the curvature receives abnormal high pressure, so that reducing growth; while the convex side receives less pressure, which can cause faster growth [7].

Cases of scoliosis can be categorized as follows: Congenital, which develops at birth due to malformation, segmentation, or a combination of both. Idiopathic - develops during growth. Idiopathic scoliosis accounts for about 85% of cases and can be described as childhood and adolescent scoliosis. Classification of scoliosis based on age group: Infantile - Infantile scoliosis affects children from birth to 3 years of age. This category represents about 1% of all idiopathic scoliosis in children, and about 60% of these cases are male. Adolescent - Affects children between the ages of 4 and 10 years, accounting for 10-15% of all idiopathic scoliosis in children. If left untreated, the curve can lead to secondary cardiopulmonary complications [3]. In patients with a curve of 30° or more, the curve is likely to progress, and in 95% of cases, surgical intervention is indicated [8]. Adolescent - Adolescent idiopathic scoliosis has the highest prevalence among the three categories. This type of scoliosis appears at the age of ten and continues until the end of growth. Its prevalence depends on the curvature of the spine and the patient's gender [9].

Several previous studies have examined risk factors for scoliosis in adolescents. A study by [10] identified a relationship between poor sitting posture and an increased risk of scoliosis. Meanwhile, [11] found a significant correlation between the duration of gadget use and changes in spinal posture in adolescents. In Indonesia, it was found that 68% of adolescents experienced changes in posture during online learning, but the specific relationship with scoliosis has not been examined.

The purpose of this study is not only to identify the prevalence of adolescent idiopathic scoliosis, but also to provide a scientific basis for the development of prevention and early intervention strategies. The results of this study are expected to contribute to the development of school health policies that are more adaptive to changes in learning modes, as well as to increase awareness of the importance of correct posture.

Urgency of Research The impact on children and adolescents with scoliosis will affect physical problems such as the heart and lungs due to bone curvature >90o and psychological problems because adolescents experience volatile emotional changes and unpredictable mood swings [12].

Early detection through screening can monitor curvature and the timing of bracing use. Screening conducted in schools is recommended during puberty [13]. Imbalances in endocrine processes, particularly during puberty, play an important role in scoliosis [14]. Scoliosis screening is not designed as a diagnostic method. The main purpose of screening is to identify children with a high probability of scoliosis prevalence.

2 Methods

This study was a descriptive observational study conducted in August 2025 at SD Muhammadiyah Kleco, Yogyakarta. The study population included all sixth-grade students, and total sampling was used, meaning all registered students present during the examination whose parents provided informed consent were included (n =40). Scoliosis was assessed using the Adam's Forward Bending Test in combination with a scoliometer. The degree of scoliosis was classified based on Angle of Trunk Rotation (ATR): mild (ATR 1°–3°), intermediate (ATR 4°–6°), and severe (ATR ≥7°). Data were recorded and analyzed using descriptive statistics, including frequency and percentage for each scoliosis category. Figures of the Adam's test and scoliometer measurements were included to illustrate the examination procedure and support interpretation of the results.

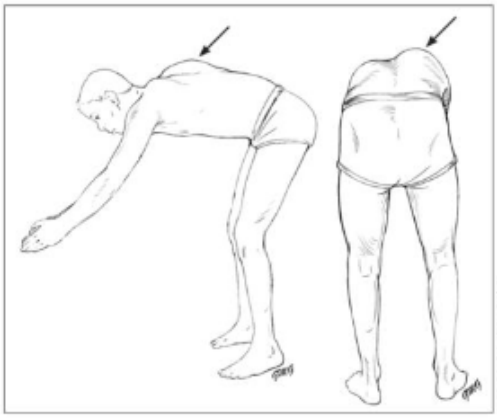

Figure 1. Examination using the Adam's Forward Bending technique [15]

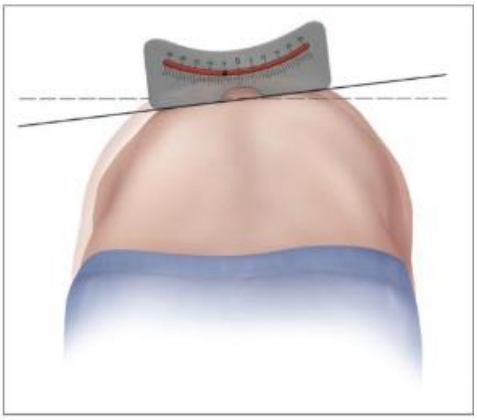

Figure 2. Scoliometer Test [15]

3 Results and Discussion

3.1 Results

This study included 40 sixth-grade students aged 10–12 years at SD Muhammadiyah Kleco, Yogyakarta. Scoliosis was detected in 55% of students, mostly in the intermediate category (ATR 4°–6°), The predominance of intermediate scoliosis may be related to growth-related biomechanical changes and postural habits, such as carrying heavy school bags or prolonged sitting. These results are consistent with previous studies showing higher prevalence in children aged 10–12 years, especially girls.

Limitations include the small sample size, single-school focus, and lack of a control group, which restrict generalizability. Nonetheless, the findings emphasize the importance of early school-based scoliosis screening to enable timely detection and intervention.

Table 1. Age distribution of sixth-grade students at SD Muhammadiyah Kleco, Yogyakarta

Age	Interpretation			Total
	High Potential for Scoliosis	Intermediate	Normal	
10	0	5	6	11
11	0	10	5	15
12	0	7	7	14
Total	**0**	**22**	**18**	**40**

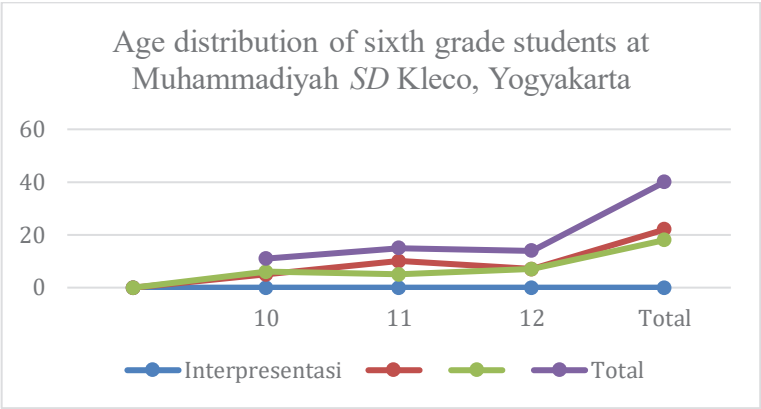

Figure 3. Age distribution graph

Table 2. Distribution of scoliosis potential among sixth-grade students at *SD* Muhammadiyah Kleco, Yogyakarta

Category	Number of students (person)	%
Normal (ATR 0-3)	11	27,5
Intermediate (ATR 4-6)	15	37,5
High Risk of Scoliosis (ATR>7)	14	35
Total	40	100

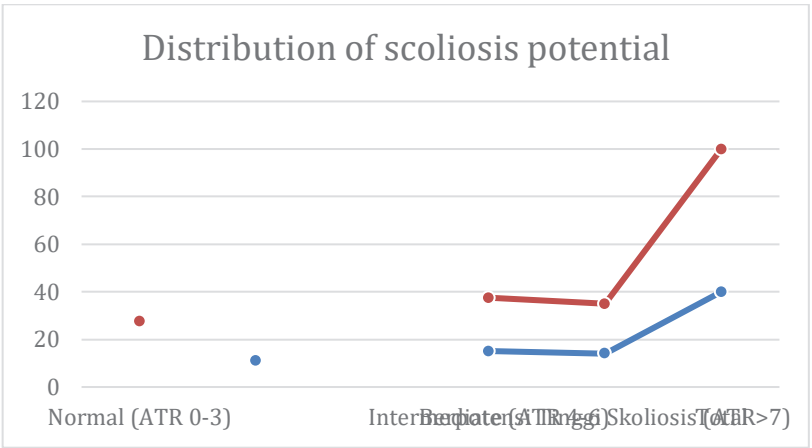

Figure 4. Graph of scoliosis category distribution

3.2 Discussion

Based on Table 1, it can be seen that there is a comparison between the number of sixth-grade elementary school students detected with intermediate scoliosis and normal scoliosis, namely 55% of students detected with intermediate scoliosis and 45% of students with normal scoliosis, and no students were detected with high-potential scoliosis. The age distribution was 10 years, 11 years, and 12 years, with the highest incidence of scoliosis occurring at the age of 11 in the intermediate category. From the above results, it can be seen that information regarding the incidence of scoliosis in sixth-grade students at SD Muhammadiyah Kleco has been detected in the moderate category, although the comparison with normal results is not significantly different. There are several factors that cause scoliosis,

including nutritional deficiencies, especially calcium and vitamin D, sedentary lifestyle, and a lack of exposure to sunlight. Epigenetic factors are also some of the main risk factors for poor health. During childhood growth, several diseases often arise that can affect the bones and interfere with a child's growth, one of which is scoliosis [10]. Another cause is congenital scoliosis, which occurs due to vertebral anomalies present since birth and accounts for about 10% of all scoliosis cases [14]. The cause of idiopathic scoliosis is still unclear. Several theories have been proposed, including genetic factors, connective tissue and skeletal muscle disorders, and biomechanical factors that may play a role in its development [14].

Scoliosis is actually a multifactorial disease that is related to habitual and environmental factors, which can increase the risk of scoliosis [15]. From the above

results, it is possible that the occurrence of intermediate scoliosis is due to habitual factors, which are one of the idiopathic factors. According to the research, this condition could be caused by carrying heavy loads at school or excessive use of electronic devices, which can lead to poor posture and scoliosis in children. Poor reading and writing posture, the habit of crossing legs, excessive weight in school bags, the habit of staring at electronic device screens for long periods of time, and the habit of sleeping in a curled-up position are known to be associated with idiopathic scoliosis. In addition, the habit of consuming milk or dairy products is also associated with idiopathic scoliosis. Individuals who rarely consume milk are at greater risk of experiencing scoliosis than those who regularly consume milk.

Based on Table 2, regarding the potential for scoliosis, it can be seen that the highest percentage is scoliosis in the intermediate category, defined as an Angle of Trunk Rotation (ATR) of 40 -60, while the normal ATR category is (00 -30), and the high ATR category is (<7). The examination was conducted using the Adam's forward bending technique, based on the detected age of 10-12 years. This is in line with previous research by Roach (1999), which shows that the incidence of scoliosis in the age of 10-16 was 2-4%. In 2012, epidemiological data presented by Konieczny on idiopathic scoliosis in adolescents showed a prevalence of 0.47-5.2%. Monitoring through scoliosis screening can detect development and prevent further progression in children with a high probability of scoliosis. Screening conducted in schools is recommended at puberty [13]. Scoliosis screening is not designed as a diagnostic method. The incidence of scoliosis in the age of 10-16 is 2-4%. Imbalances in endocrine processes, particularly during puberty, are also important in scoliosis. Endocrine insufficiency leads to water and mineral metabolism disorders, which can result in softening of the skeletal bones. The primary goal of screening is to identify children with a high probability of scoliosis prevalence.

4 Conclusion

Based on the results of scoliosis examinations of sixth-grade students at SD Muhammadiyah Kleco, Yogyakarta, it can be concluded that:

1. Scoliosis can be detected from an early age, with the students in this study being 10–12 years old.
2. 37.5% of students were diagnosed with intermediate scoliosis (ATR 4°–6°).

Recommendations: To promote early detection and prevention, it is suggested to implement regular posture screening in schools, provide physiotherapy-led posture education, and introduce ergonomic interventions to support proper spinal alignment for students.

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