International Journal of Public Health Science (IJPHS)
Vol. 13, No. 4, December 2024, pp. 1548~1553
ISSN: 2252-8806, DOI: 10.11591/ijphs.v13i4.23884

Prevalence and determinants associated with adolescent idiopathic scoliosis: results of screening in Surakarta, Indonesia

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Article Info

Article history:

Received Oct 3, 2023
Revised Feb 5, 2024
Accepted Feb 21, 2024

Keywords:

Adolesent idiopathic scoliosis
Determinants
Paediatrics
Prevalence
School-based screening

ABSTRACT

Scoliosis is defined as a vertebral deformity characterized by a lateral deviation of at least 10° with vertebral rotation. Adolescent idiopathic scoliosis is generally found in children aged 10-18 years. Changes in the scoliosis curve are influenced by various etiologic factors including age, sex, growth factors, curve location and biomechanical factors. The study was conducted to determine the prevalence of adolescent iidophatic scoliosis in school students aged 12-15 years in Surakarta city. Physical examination using Adam's forward bending test, scoliometer and risk factor questionnaire. The research subjects were 325 people with an age range of 12-15 years. Research subjects are included in the adolescent idiopathic scoliosis category if the Adam's forward bending test is positive and the scoliometer value is >10°. The highest prevalence of adolescent idiopathic scoliosis was found in school children aged 14 years. The prevalence of adolescent idiopathic scoliosis is higher in female (3.4%) than male students (0.3%). Determining factors that might influence the onset of adolescent idiopathic scoliosis including age, gender, biomechanical factors, habits or lifestyles factors and physical activity.

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1. INTRODUCTION

Scoliosis is defined as a vertebral deformity condition characterized by a lateral deviation of at least 10º with vertebral rotation [1]. Scoliosis is caused by several factors, including idiopathic, congenital, genetic factors and the result of neuromuscular disorders [2], [3]. Idiopathic scoliosis is a scoliosis condition with the most prevalence, which is around 85% of all scoliosis cases [4].

Adolescent idiopathic scoliosis is generally found in children aged 10-18 years. Adolescent idiopathic scoliosis has no definite etiology. Several factors can cause the condition of adolescent idiopathic scoliosis including genetic factors, abnormalities in connective tissue and skeletal muscles and biomechanical factors. Clinical manifestations that appear in scoliosis vary from asymptomatic to clinical symptoms such as neuromuscular and cardiopulmonary disorders [5].

Data on the implementation of screening and the prevalence of scoliosis in Indonesia is still limited. Data on the prevalence of adolescent idiopathic scoliosis in Surabaya was recorded at 2.93% in children aged 9-16 years [5]. School-based screening is one of the most widely method to determine the prevalence of adolescent scoliosis. Screening with physical assessment, Adam's forward bending test and scoliometer measurement [6]-[8].

Changes in the scoliosis curve are influenced by various etiological factors. Some of these factors include age, gender, growth factor, curve location and biomechanical factors. Scoliosis is related to female gender and ages 13-15 years [9]. This is related to the early age of menarche and peak growth in women. The development of adolescent idiopathic scoliosis is also related to growth factors [10]. Study revealed that there is a positive relationship between height and the risk of spinal deformities such as idiopathic scoliosis and kyphosis [11]. In women, the time of peak growth is closely related to menarche [10]. Studies have proven that delayed puberty and late menarche are associated with a higher prevalence of adolescent idiopathic scoliosis [12], [13].

Examination to establish the diagnosis of scoliosis can be done by taking the patient's history and physical examination. Patient history including history of problems or complaints, age, gender, general condition of the patient and family history. Prenatal, natal and postnatal history also needs to be obtained if the subjects examined are children. The physical examination includes gait, pain, neurological symptoms, physical examination, and radiological examination [2], [6], [10].

Observations were made to see and find out the asymmetrical changes in body posture caused by vertebral deformities. Observation of body posture is carried out in a standing position and observed from the front and back. Observations were also made in a forward bending position or what is known as the Adam's forward bending test. Examination is carried out to determine the presence of protrusion of the scapula and rotation of the spine. The protrusion is measured by a Scoliometer, which gives an angle of trunk values, or measures the height of the protrusion directly and recorded in centimeters [2]. Based on this background, researchers are interested in conducting research to determine the prevalence of cases of adolescent idiopathic scoliosis in the city of Surakarta and to analyze the factors that influence this condition.

2. METHOD

The study design was a cross-sectional observational study conducted from March to August 2022 in Surakarta city. The study population was junior high school students with an age range of 12-15 years in Surakarta. The cluster random sampling method was used to obtain research subjects as demonstrated in Figure 1. Cluster random sampling is a probability sampling method in which we devide a population into clusters, such as districts, village or schools, then randomly select some of these clusters as sample. The research subjects were obtained by sampling 1 sub-district from 5 sub-districts in Surakarta city, then sampling 5 schools from 1 selected sub-district. Then from each school the research subjects were taken by simple random sampling. The research subject were 325 children aged 12-15 years old. This research has received an ethical statement from the Health Research Ethics Commission of Universitas 'Aisyiyah Surakarta, No: 102/IV/AUEC/2023, April 2022.

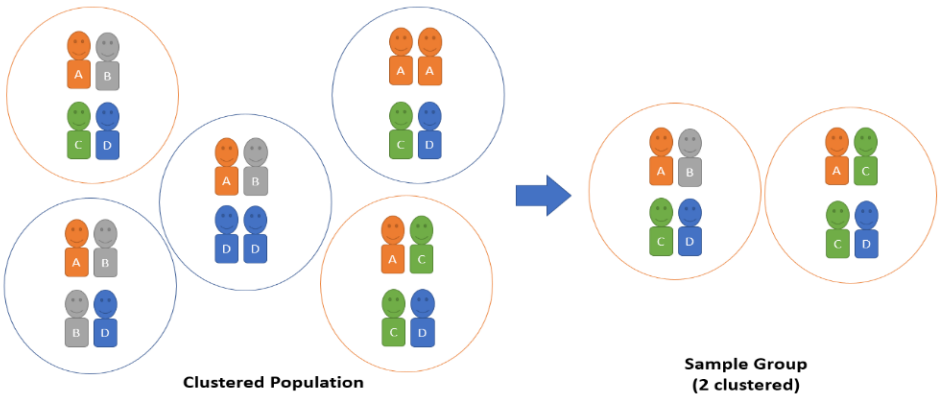

Figure 1. Cluster random sampling

The research instrument used a questionnaire, Figure 2 shows clinical test for scoliosis using Adam's forward bending test as shown in Figure 2(a) and a scoliometer as presented in Figure 2(b). Vertebral inclination angle was measured using a scoliometer and documented in a questionnaire sheet. The scoliometer, is a tool to measure the vertebral inclination angle or trunk rotation angle [8], [14]. Scoliometer showed excellent intrarater reliability values and very good interrater realiability values with r=0.7, p<0.05 [15]. Variable subject characteristics such as age, gender, family history and type of bag were documented in a questionnaire sheet.

(a) (b)

Figure 2. Clinical test for Scoliosis with (a) Adam's forward bending test and (b) measurement of the vertebral inclination angle in scoliosis with scoliometer [16]

The data analysis used was univariate and bivariate analysis. Univariate analysis by presenting the characteristic distribution of each variable including age, gender, and type of school bag. The bivariate test uses the Chi-square test and the Odd Ratio calculation with a 95% CI to see the relationship between the independent and dependent variables.

3. RESULTS AND DISCUSSION

3.1. Results

The research subjects were 325 people with an age range of 12-15 years. The characteristics of the respondents are described based on age, gender, scoliometer degree and the results of the Adam's forward bending test. Table 1 shows that research subjects aged 14 years had the highest frequency of 278 children. Subjects with male gender were 244 children and female as many as 81 children. The results of the scoliometer examination showed that 3.7% of all subjects had a vertebral inclination angle of >10°. The results of the Adam's forward bend test showed that 10.2% of all subjects experienced trunk rotation.

Table 2 showed the results of the positive Adam's forward bending test based on gender of the subjects and measurement of the trunk inclination angle using a scoliometer >10°. The prevalence of scoliosis was 3.7% of the total subjects. The highest prevalence of scoliosis in children aged 14 years was 3.7% and female was 3.4%. The results of the scoliometer examination to determine the degree of vertebral inclination showed that the highest prevalence of vertebral inclination angle was 11°-15° (2.5%).

Table 1. Subject characteristics

Age	Gender		Adam's forward bending test				Scoliometer	
	Female	Male	Negative		Positive		>10°	
			n	%	n	%	n	%
12	0	1	1	0.3	0	0.0	0	0.0
13	11	32	39	12.0	4	1.2	0	0.0
14	68	210	250	76.9	29	8.9	12	3.7
15	0	2	2	0.6	0	0.0	0	0.0
Total	81	244	292	89.8	33	10.2	12	3.7

Table 2. Prevalence of scoliosis

characteristics	Scoliosis (n)	Prevalence (%)
Gender		
Male	1	0.3
Female	11	3.4
Total	12	3.7
Angle of inclination measured by Scoliometer		
11°-15°	8	2.5
16°-20°	3	0.9
21°-25°	1	0.3
Total	12	3.7

3.2. Discussion

Based on the results of the positive Adam's forward bending test and measurement of the trunk rotation angle using a scoliometer >10°, the prevalence of scoliosis was 10.2% of the total subjects. The highest prevalence of scoliosis children is 14 years old at 98.9%. This is related to the age of onset of

menarche and peak growth in women as one of the factors associated with the cause of the condition of adolescent idiopathic scoliosis [10], [17]. This is in line with the results of the research by Agung *et al*. [5] and Tahirbegolli *et al.* [18] which explained that the highest prevalence of adolescent idiopathic scoliosis was found in the age range of 14-15 years. The age factor influences the growth process of the vertebral curve, where the most growth occurs at this time and slows down in early adolescence before reaching the peak of skeletal growth.

Growth and maturity of the reproductive system affect the development of the vertebral curve. This development may cause unbalanced muscle activation which can lead to deformity of the vertebral curve or scoliosis. Other research shows that delayed puberty and late menarche are associated with higher rates of adolescent idiopathic scoliosis [13].

The prevalence of scoliosis in girls is higher than boys, which is 7.4%. The progression of the scoliosis curve can be influenced by several factors, one of which is gender. The prevalence of adolescent idiopathic scoliosis is higher than men, one of which is influenced by the early age of menarche in women affecting growth hormone. This growth hormone activity can affect the development and maturity of the vertebrae. Vertebral deformities generally develop in adolescence before the peak of skeletal growth [18], [19].

Other study revealed that girls with severe adolescent idiopathic scoliosis (AIS) had delayed menarche with faster skeletal growth rates and generally taller than healty population [20], [21]. The thoracic spine is longer anteriorly than posteriorly in AIS patients, know as relative anteriror spinal overgrowth (RASO) phenomenon or uncoupled neuroosesseous growth. Anterior-posterior length discrepancy was a consequence of both anterior and posterior column shortening and due to the secondary increased of the anterior intervevrtebral disc height. The longitudinal growth of the vertebral bodies in AIS patients is disproportionate and faster than in age-matched controls and mainly occurs by endochondral ossification [10], [17], [22].

Another factor that the author found in the literature is heavy school bags. Backpacks can affect a child's balance and pulmonary function. This occurs because of the child's abnormal posture or tends to lean on one side of (AIS), so that muscle performance is not optimal [23], [24]. The next factor that we encountered in some literature related to bag use is the impact of using a sling or one-sided bag. By weighting one side of the back of the body will make changes in the degree of vertebral curvature. And than with the weight of bag that children carry. If this habit is carried out continuously, it will make the body's children adapt to the bad direction, and postural muscles will be change. The muscles of the sholuders, elbow and back area will be problematic. This unilateral load carrying mostly occurs in children who use sholders bags daily. These unbalanced paravertebral muscles play a role in the incidence of scoliosis [25], [26].

The solution can be affected is not to overload the bag, either using a backpack or a single-sided bag. The students can use a bag with wheels to reduce the burden on the spine is highly recommended. Although indeed the highest risk can be experienced by children with the use of one-sided bags. Reducing the load on this bag, it is expected that performance of the paravertebral postural muscles is not overused. Normally, the weight of a student’s backpack is no more than 10% of the child's body weight. If overweight of bag, there will be a risk of abnormalities in the child's posture, leg shape and gait in the future [23], [27].

Several studies have found the evidence that trunk asymmetry and poor posture in children are associated with AIS. This condition is related to the presence of asymmetric and imbalanced paraspinal muscle activity. Poor posture can cause imbalanced paraspinal muscle activity. Study found a higher average root-mean-square (RMS) of surface electromyography (sEMG) values on the convex side of the affected group muscles. This indicates an asymmetry of muscle activity between the left and right sides of the upper trapezius and latissimus dorsi in habitual sitting position [28], [29]. Some studies suggest that asymmetry in paraspinal muscle activity may predictor of curve progression in AIS [29]-[31].

Another finding that may influence the incidence of scoliosis is screen time for day. Such as, how long children spending time to electronic products such as computers, TVs, and cell phones. Some studies mention that overtime with gadget will make children do less physical activity, so muscle fitness and bone health will decrease. The using of gadgets is not without reason, because of pandemic COVID-19, many children take online classes and using computers, cellphones or tablets to complete homework. So, this result in increase of screen time and reducing time spent on outdoor activities. Normally, daily screen time for children and adolescents aged 6-17 years is two hours day [24], [32]-[34]. In conclusion, determining factors that might influence the onset of adolescent idiopathic scoliosis including age, gender, biomechanical factors, habits or lifestyles factors and physical activity.

4. CONCLUSION

The highest prevalence of adolescent idiopathic scoliosis was found in school children aged 14 years. The prevalence of adolescent idiopathic scoliosis is higher in female (3.4%) than male students (0.3%). It is hoped that early detection can be carried out to prevent the growth of the curve deformity and reduce other clinical manifestations that arise as a result of scoliosis.

ACKNOWLEDGEMENTS

Acknowledgments to Universitas ‘Aisyiyah Surakarta and Sekolah Tinggi Ilmu Kesehatan Nasional for supporting the funding of this research. This research was funded by Universitas 'Aisyiyah Surakarta, Grant Number: 053/P3M/III/2022.

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