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Prevalence angle of trunk rotation in adolescents: a study from an idiopathic scoliosis school screening in Surabaya

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ABSTRACT

Background: Adolescent idiopathic scoliosis (AIS) is the most common type of scoliosis. The condition begins in early puberty, affects 1-3% of adolescents, and randomly affects young women. Scoliosis screening is still a hot topic discussed by various researchers, especially in the school child population, and it is still an important preventive program to reduce the progression of spinal deformity. This study aims to determine the prevalence rate angle of trunk rotation in idiopathic scoliosis school screening in Surabaya.

Methods: This research is a cross-sectional study with a descriptive observational type using surveys and examinations. In this study, the sample used was 405 junior high school students in Surabaya. The sampling method is cluster random sampling, where each member of the population is divided into subclasses with the school as the cluster. Samples were randomly selected from each area of Surabaya. Data were analyzed using SPSS version 25.0 for Windows.

Results: These data found that the age distribution of the scoliosis screening study was an average of 13.87 years and a median of 14 years. The gender distribution of the scoliosis screening study sample was more female, 211 samples (52.1%) compared to men, 194 samples (47.9%). The distribution was obtained from 405 total samples; 2 positive samples were obtained during the Adam's Forward Bend Test, both 14 years old and female. On examination with a scoliometer, both showed 9 and 11 degrees, respectively. The prevalence angle of trunk rotation in idiopathic scoliosis school screening in Surabaya was 0.49%.

Conclusion: This figure is lower than several studies conducted in several other countries. This may be obtained due to differences in the number of research samples undertaken in each country.

Keywords: Adam's forward bend test, adolescent idiopathic scoliosis, AIS, prevalence.
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INTRODUCTION

Adolescent Idiopathic Scoliosis (AIS) is a lateral curvature of the spine, with a Cobb angle of 10 degrees or more, that affects adolescents 10 to 18 years of age, with the absence of congenital or neuromuscular disorder.[1] It is the most common type of scoliosis and affects approximately 1% to 3% of adolescents. It commonly occurs at the age of 10-18 years and accounts for approximately 90% of cases of idiopathic scoliosis in children.[1,2] The literature identified differences in the prevalence in other countries. This variability can be explained by discrepancies in the identification method, targeted age and sex, and the impact of geographic, socio-economic, and environmental aspects on human biology.[3]

AIS lacks an agreed theory of aetiopathogenesis. Nonetheless, various concepts and hypotheses have been proposed to explain its pathogenesis rather than its etiology. These concepts can be loosely grouped into six main categories based on the type of abnormality they describe genetics, central nervous system (CNS), skeletal spinal growth and bone metabolism, metabolic pathways, biomechanics, and others.[4]

Curve progression in AIS is related to the child's age and the deformity's magnitude. Most children do not display progressive curves, although some adolescents with idiopathic scoliosis may exhibit rapid progression.[5] Most patients with adolescent idiopathic scoliosis will not develop clinical symptoms in their lifetime. Back pain is more common among those with scoliosis; however, it does not result in disability or functional impairment.[1]

Early diagnosis and appropriate therapeutic methods will help to inhibit the progressive changes in the musculoskeletal system. Detection during the initial stage, when the deformity is unnoticeable, offers an opportunity for non-surgical treatment. That is why scoliosis screening is so important in primarily preventing deformity progression.[6] The Scoliosis Research Society and the American Academy of Pediatrics have issued a knowledge statement that recommends scoliosis screening annually in girls aged 10 and 12 and only once in boys aged 13 or 14.[7]

The basic method for scoliosis detection in school screening programs is an examination using a scoliometer. It has not been designed to be a diagnostic method but to select children with a high probability of occurrence of idiopathic scoliosis out of the healthy population.[8,9] The implication of the scoliometer measurement of the angle of trunk rotation with a combination of the Adam Forward Bending Test is the easiest, non-invasive measure of trunk deformity.[10,11] Scoliometer is an instrument that measures axial trunk rotation in individuals with scoliosis. Frequency analysis revealed relatively good specificity, sensitivity, and predictive capability. Previous study by Coelho DM et al noted the correlation between the scoliometer measurement and the radiographic analysis ($r = 0.7$ with $p < 0.05$) in their research.[12] The use of this tool as a screening device is appropriate based on the previous studies.[13,14]

Based on those mentioned above, this study aims to evaluate Prevalence angle of trunk rotation in adolescents: a study from an idiopathic scoliosis school screening in Surabaya.

METHODS

Cross sectional epidemiologic study was performed to determine the prevalence and distribution of scoliosis in school children in Surabaya, Indonesia. The Health Research Ethics Committee Universitas Airlangga School of Medicine approved the study under process number 223/EC/KEPK/FKUA/2023. Data was collected in August 2023, and 405 students were screened for scoliosis in schools in Surabaya. Ages ranged from 12 to 16 years (mean age 13,87 years). The schools were randomly selected with cluster of 5 territorial divisions in Surabaya, East Surabaya, West Surabaya, North Surabaya, South Surabaya, and Central Surabaya. There were no duplicate screenings of children or schools. Data were analyzed using SPSS version 25.0 for Windows.

Sample Size

The study involved 405 students who met the inclusion criteria. A total of 5 schools in Surabaya were taken in this study. The inclusion criteria for the examination were the following: The participants had no history of surgery on the back or lower limbs, and there was no history of accident in the back. Students with congenital deformities, neuromuscular disorders, or spina bifida were excluded. Parents or legal guardians of all participants signed an informed consent form before participation.

Research procedure

The male volunteers participated in the examination bare-chested. The female volunteers had their hair tied up and wore the custom thin t-shirt to provide a good view of their back. After collecting anthropometric measures, the angle of trunk rotation was examined using a Bunnell scoliometer. The screening test was quick, easy to perform and repeat, non-invasive, and safe. The examination procedure was carried out in Adam's forward bending test position and also allowed to rate the angle of trunk rotation. The students bent their trunk forward until it was parallel to the ground, keeping the palms of their hands together. We finally checked the distribution values of ATR values <=7° and >7°.

Procedures

- The parents of examined children have a consent form to fill out with the approval to include the child in the study.
- Demographic data, including the child's name, age, and gender, were taken.
- Clinical assessment: A physical examination was conducted by observing the patient standing to assess asymmetry of the shoulder, ribs, scapula, waist, and hips. The relative position of both shoulders assessed shoulder asymmetry according to Adam's forward bending test. Children with positive Adam's forward bending test were examined using a scoliometer. Axial trunk rotation (ATR) on the scoliometer was recorded.
- Adam's forward bending test was performed with the child standing on a flat surface and leaning forward while allowing the upper extremities to hang freely with the palms opposed in a relaxed manner.

RESULTS

A total of 405 students were assigned to 5 territorial divisions in Surabaya; each group consists of 81 students, as shown in Figure 1.

The prevalence of trunk rotation as determined with the Bunnell scoliometer reading greater than 7° was 0.49% (Table 1).

The most frequent age in this study (represented by 50.62%) was 14 years, with 2 of them having an angle of trunk rotation >7° (defined by 0.49%). The least frequent age (represented by 1.24%) was 16 years. There were no significant differences between the territorial divisions regarding age (Table 2).

The ratio between female and male students in this study had no significant differences between the territorial divisions. We found that 2 of the female students had an angle of trunk rotation greater than 7° (represented by 0.49%)

DISCUSSION

Routine school screening for adolescent idiopathic scoliosis continues to be a controversial issue. Several previous studies state support for this screening program and several previous studies do not approve of this screening program. In 2004, U.S. The Preventive Services Task Force (USPSTF) issued a recommendation statement that they disapproved of routine school screening for scoliosis, saying that routine screening for adolescent idiopathic scoliosis was not effective.[15] Then, in 2016, several associations such as the American Academy of Orthopedic Surgeons (AAOS), the Scoliosis Research Society (SRS), the Pediatric Orthopedic Society of North America (POSNA), and the American Academy of Pediatrics (AAP) suggested that school screening for adolescent idiopathic scoliosis is effective for early detection. These differences in expert opinion are constantly subject to discussion and research. Patients, healthcare professionals, and policymakers can use information from previous research to assess the relative risks and benefits of early detection and treatment of this disease.[5]

Screening examinations for adolescent idiopathic scoliosis vary in different

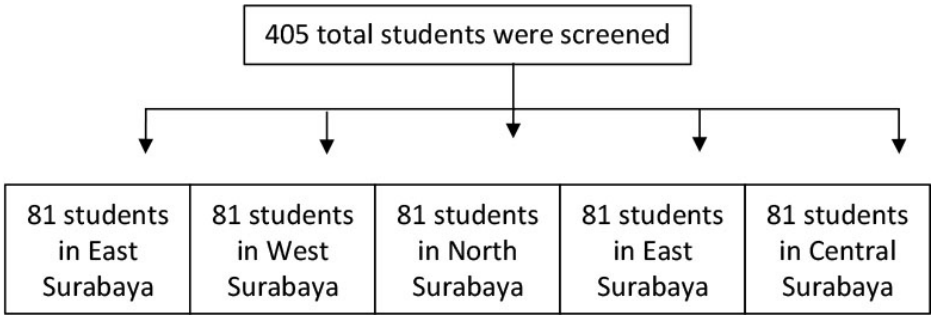

Figure 1. Participant's flowchart.

Table 1. Frequencies of scoliometer reading results according to age

Age	<= 7°	>7°
12, n (%)	6 (1.48)	0 (0.00)
13, n (%)	119 (29.38)	0 (0.00)
14, n (%)	203 (50.13)	2 (0.49)
15, n (%)	70 (17.28)	0 (0.00)
16, n (%)	5 (1.24)	0 (0.00)

Table 2. Frequencies of scoliometer reading results according to gender

Gender	<=7°	>7°
Male, n (%)	194 (47.90)	0 (0.00)
Female, n (%)	209 (51.61)	2 (0.49)

countries, from purely visual examinations to physical examinations, scoliometer readings, and topographic measurements during annual healthcare examinations. The finding of asymmetry during clinical examination is closely related to adolescent idiopathic scoliosis spinal deformity. The SRS task force approves Adam's Forward Bend Test using a scoliometer as an effective quantitative measure, with 5 to 7 degrees of deformity as the threshold for positive screening. The SRS task force did not agree on the need for topographic measurements. This is because girls reach puberty about two years before boys and suffer from severe scoliosis that requires treatment three to four times more often than boys; the SRS task force recommends that checks be carried out twice for girls, once at age 10 and also at age 12, to capture variations in incidence. Boys can be screened earlier, at 13 to 14 years of age.[5]

There are differences in the procedure of school screening for adolescent idiopathic scoliosis, for example in Hong Kong, Adolescent Idiopathic Scoliosis screening is carried out at Student Health Service Centers (SHSC) using the Forward Bending Test (FBT) and measuring the Angle of Trunk Rotation (ATR) using a scoliometer. Students with ATR >15 degrees will be sent to a specialist hospital that treats spinal deformities, where a thorough radiological examination of the spine will be carried out.[16]

Based on the data obtained, it was found that the prevalence of Adolescent Idiopathic Scoliosis in Surabaya was 0.49%. This data is lower than research conducted in Malaysia, which was stated to be 4.6%, with a male/female sex ratio of 1.2:1.[17] In different articles, very other data were obtained, for example, in the screening carried out in Turkey with a large sample size, 16045 samples. In this article, it was found that 15.9% of the total samples (2545 samples) were found positive on the Adam's Forward Bend Test.[18]

The age of Adolescent Idiopathic Scoliosis sufferers based on the Adam's Forward Bend Test in this study was 14 years. In another article from Turkey, the average age was 12.0±1.3 years.[18] This difference in average age is likely due to differences in the frequency of screening programs carried out in Indonesia and Turkey. The more frequently screening is carried out, the earlier the possibility of detection so that immediate treatment can be carried out for students.

On examination using a scoliometer, ATR was found to be 9 degrees and 11 degrees. Based on the Cobb Angle estimation formula according to Coelho DM et al., the Cobb Angle is obtained at 18 degrees and 23.4 degrees.[12] The progression of the curve in the thoracolumbar/lumbar region was said in a study by Ohashi M et al. to be ~0.50 per year.[19] If, af 14 years, the Cobb Angle is found to be 18 degrees and 23.4 degrees, then the possibility of progression at the age of 18 years will reach 20 degrees and 25.4 degrees. This is important because by knowing the Cobb angle, we can determine the next action by informing students so they can carry out supporting examinations. If scoliosis exists, the student can be treated relatively quickly.

Genetic factors are thought to be one of the factors that influence the incidence of Adolescent Idiopathic Scoliosis. In the systematic review article reported by Salvatore S et al., it is stated that several genes are thought to have a relationship with the incidence of this disease. The CALM1 gene, for example, calmodulin, has previously been linked to idiopathic scoliosis and musculoskeletal development. The LBX1 gene is also thought to influence the incidence of idiopathic scoliosis; apart from playing a role in muscle development, this gene can also determine different neuronal subtypes in the spinal cord.[20-22]

Socioeconomic conditions in patients are thought to influence the incidence of idiopathic scoliosis. Still, one article examining Adolescent Idiopathic Scoliosis in Texas stated that there was no significant difference in the Cobb angle of patients with high-income and low-income levels. There is no significant correlation between income level and type of insurance. These results refute the hypothesis of those who suspected that patients with higher income levels would have lower curvature angles due to easier access to specialist hospitals and more adequate insurance coverage. Based on the data, it was found that Texas has the highest ratio of people without insurance; however, there were no significant differences in the Cobb angle observed between high and low-income level groups.[21-25]

CONCLUSION

The prevalence Angle of Trunk Rotation in idiopathic scoliosis school screening in Surabaya is 0,49%. The school screening

of adolescent idiopathic scoliosis using a scoliometer is a safe, easy, and low-cost screening tool for calculating trunk rotation.

CONFLICT OF INTEREST

The authors state no conflict of interest.

ETHICAL CONSIDERATIONS

The study was approved by the Health Research Ethics Committee Universitas Airlangga School of Medicine under process number 223/EC/KEPK/FKUA/2023.

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AUTHOR CONTRIBUTIONS

All authors contributed to the study from the conceptual framework, data gathering, and analysis until the study's results were interpreted upon publication.

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