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Early clinical detection of adolescent idiopathic scoliosis: an observational study. Preliminary report

Detección clínica temprana de la escoliosis idiopática del adolescente: un estudio observacional. Informe preliminar

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Palabras clave:
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ABSTRACT

Early scoliosis screening programs have been implemented in Latin America. In Brazil, a prevalence of 23.5% was reported using the Adam's sign, whereas Argentina reported a prevalence of 0.5% in 12-year-old schoolchildren. In Mexico, there is a lack of epidemiological data regarding adolescent idiopathic scoliosis (AIS). This observational, analytical, cross-sectional study analyzed 251 patient companions aged 10 to 18 years in an outpatient setting. Data collection included demographic information, personal and family medical history, socioeconomic level, somatometry, and physical examination with a focus on spinal assessment. Spinal evaluation included shoulder and scapular symmetry, posterior scapular protrusion, spinous process alignment, Adam's test, and laterality. The diagnosis was confirmed using panoramic radiographs and measured via the Cobb method. A total of 17 patients (6.9%) exhibited a positive Adam's sign; 10 (4%) had a left-sided hump and 7 (2.8%) a right-sided hump. Shoulder height asymmetry was present in 57 individuals (22.7%), while 18 (7.2%) exhibited spinous process misalignment. Suspected scoliosis cases comprised 9 females (52.9%) and 8 males (47.1%) with a mean age of 13.9 ± 2.5 years. The preliminary clinical incidence of AIS was 6.8%, while radiographic confirmation yielded a prevalence of 2.4%. At present, the Adam's test has a positive predictive value of 0.6.

RESUMEN

En América Latina se han realizado programas y campañas de escoliosis temprana. En Brasil se reportó una prevalencia de 23.5% utilizando el signo de Adam, mientras que Argentina notificó una prevalencia de 0.5% en escolares de 12 años. En México no existe información sobre la escoliosis idiopática del adolescente (AIS) en cuanto a prevalencia y factores asociados. Este estudio fue observacional, analítico y transversal. La población fue consulta externa en 251 acompañantes de pacientes entre 10 y 18 años. La información obtenida fue identificación, antecedentes familiares y personales de enfermedades, nivel económico, somatometría, exploración física y exploración clínica de enfoque de columna. La exploración de la columna consistió en simetría y alineación de hombros y escápula, protrusión de la escápula, alineación de las apófisis espinosas, prueba de Adams. Se confirmó el diagnóstico con radiografía panorámica medida por el método de Cobb. Un total de 17 pacientes (6.9%) tenían signo de Adams positivo, 10 (4%) giba izquierda y siete (2.8%) giba derecha, un total de 57 personas (22.7%) presentaban asimetría en la altura de los hombros y 18 (7.2%)

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de la población total no mostró linealidad en el proceso espinoso. Los pacientes con sospecha de escoliosis fueron nueve mujeres (52.9%) y ocho hombres (47.1%). La edad media de este grupo fue de 13.9 ± 2.5 años. La incidencia preliminar de AIS en nuestra muestra es de diagnóstico clínico 6.8%, diagnóstico radiográfico confirmado en 2.4%. Por el momento la prueba de Adams tiene un valor predictivo positivo de 0.6.

INTRODUCTION

The Scoliosis Research Society (SRS) defines AIS as a structural, lateral, and rotational spinal deformity affecting otherwise healthy individuals during puberty.[1] AIS accounts for approximately 80% of all scoliosis cases. It manifests as a three-dimensional deformity involving coronal, axial, and sagittal planes, with a curvature > 10º in the coronal plane and no association with congenital or syndromic disorders. AIS predominantly affects individuals aged 10 to 18 years.[2-4]

AIS is a significant health concern, as it can impact patients psychologically, functionally, and aesthetically.[3,5] Vertebral rotation is most pronounced at the apex, altering the rib cage morphology and producing a kyphotic appearance. Vertebral wedging progresses over time, with minimal or absent wedging at transitional vertebrae and maximal wedging at the apical vertebrae. The most common convexity is rightward in thoracic curves.[6]

A clinical examination is the primary diagnostic tool for AIS. Essential components include evaluating shoulder and scapular symmetry, pelvic leveling, Adam's test, and Pitre's sign.[7] A positive Adam's sign indicates spinal rotation, warranting further investigation.[8] The test has high sensitivity (73.9-100%) and specificity (77.8-99%).[9,10]

Following clinical suspicion of scoliosis, a Bunnell scoliometer can quantify spinal inclination. If the Cobb angle exceeds 10º, an anteroposterior panoramic radiograph is recommended to determine curve magnitude, classification, and skeletal maturity.[11] The Cobb-Lippman method, introduced in 1948, calculates the scoliotic curve using a circular model, yielding high validity.[12]

In the United States, routine AIS screening has been conducted for over 50 years, contributing to increased nonoperative management.[13,14] Reported AIS prevalence in the U.S. ranges from 2 to 2.5% for curves exceeding 10º.[8,9,13,14] A U.K. study confirmed AIS prevalence rates of 2% for curves > 10º, 0.5% for curves > 20º, and 0.1% for curves > 40º.[14] In Brazil, the Adam's sign prevalence was 23.5%, whereas Argentina reported a 0.5% prevalence among 12-year-old schoolchildren.[15-17] Global prevalence varies between 1 and 24.8%, while incidence rates range from 0.47 to 5.2%.[17] Epidemiological data in Mexico is outdated, with the most recent statistics dating back to 1989.[1,18,19]

AIS is associated with female sex, with a female-to-male ratio of 1.5-2:1, increasing to 5:1 for curves > 30º and 10:1 for curves > 40º.[1,20-22] Screening programs identifying demographic, epidemiological, and clinical variables may facilitate early diagnosis and timely intervention, reducing long-term disability.

MATERIAL AND METHODS

The objective of this study was to determine the incidence of AIS in a population of patient companions attending an outpatient clinic, as well as to identify associated demographic and clinical characteristics. This observational, analytical, cross-sectional study included 251 patient companions aged 10 to 18 years who self-reported as healthy and provided informed consent (or parental consent for minors). Exclusion criteria included prior diagnosis of congenital, syndromic, or neuromuscular scoliosis, musculoskeletal malformations, and incomplete questionnaire responses. Data collection involved demographic information, medical and family history, socioeconomic status, and physical examination focused on spinal alignment, including evaluation of shoulder and scapular symmetry, posterior scapular protrusion, spinous process alignment, Adam's test, and laterality. The diagnosis was confirmed with panoramic radiographs measured using the Cobb method.[12] Statistical analyses included measures of central tendency (mean, median, mode) and dispersion (variance, standard deviation, percentiles) for quantitative variables, while qualitative variables were analyzed using proportions and ratios. Statistical significance was determined using the χ^2 (Mantel-Haenszel) and Student's t-test comparisons. The predictive value of the Adam's test was also assessed based on the study results.

RESULTS

A total of 251 participants met the inclusion criteria and were included in the study, comprising 41.4% males

and 58.6% females. The age range was 10 to 18 years, with a mean age of 13.5 years (± 2.5). The overall mean weight was 51.9 kg (± 12.8), mean height was 156 cm, and mean body mass index (BMI) was 21.0 (± 4.1). Regarding place of residence, 59.5% of participants lived in Mexico City, 22.3% in the State of Mexico, and 18.3% in other states of the country. Gestational age at birth was reported by 231 individuals, with a mean of 38.4 weeks (± 2.7).

A total of 17 individuals (6.8%) exhibited a positive Adam's sign, with 10 (4%) showing a left thoracic hump and 7 (2.8%) a right thoracic hump. Shoulder height asymmetry was observed in 57 participants (22.7%), while 18 (7.2%) displayed misalignment of the spinous processes. Among individuals suspected of scoliosis, nine were female (52.9%) and eight were male (47.1%).

Comparison of demographic variables between individuals with suspected scoliosis and those without scoliosis is presented in *Table 1*. The mean age of mothers was 40.49 years (± 2.4), while the mean paternal age was 44.1 years (± 5.3). Educational attainment in the scoliosis group showed that 17.6% of mothers had a university degree, 11.8% a technical degree, 35.3% completed high school, 17.6% attended junior high school, 5.9% attended elementary school, and 11.8% had no formal education. Among fathers, 11.8% had a university degree, 5.9% had a technical degree, 52.9% completed high school, 17.6% attended junior high school, and 11.8% attended elementary school. In total, 70.6% of mothers and 82.4% of fathers had at least a high school education.

Regarding birth order, 111 (44.2%) participants were the firstborn, 75 (29.9%) were second-born, 42 (16.7%) were third-born, 13 (5.2%) were fourth-born, and 6 (2.4%) were fifth-born. Birth order comparisons showed a statistically significant trend (p = 0.05), with a higher incidence of scoliosis among firstborn individuals (nine suspected scoliosis cases occurred in firstborn children).

No statistically significant differences (p = 0.59) were found between individuals with suspected scoliosis and those without scoliosis concerning family medical history, including cardiovascular, endocrine, neurologic, musculoskeletal, gynecologic, oncologic, gastrointestinal, congenital, or malformation-related conditions. Similarly, no significant association was found between a family history of scoliosis and suspected scoliosis cases (p = 0.57). Birth complications did not show a significant association with scoliosis (p = 0.48), with 4 of 17 (23.5%) individuals with suspected scoliosis reporting birth complications, compared to 13 of 17 (76.5%) reporting no complications.

Of the 17 individuals with suspected scoliosis, 12 underwent confirmatory panoramic radiographs, with eight cases revealing a Cobb angle > 10º, averaging 14.4º (± 2.7º). Five individuals did not undergo radiographic confirmation. Based on these findings, the radiographically confirmed incidence of scoliosis was 2.4%. The positive predictive value of the Adam's test in this study was calculated at 66.6%.

DISCUSSION

AIS is a disease that compromises the psychological, functional, and cosmetic state of the patient, leading to significant disability in the long term.[3] The necessity

Table 1: Description of sociodemographic variables, t test was performed for independent samples, observing homogeneity between groups.

Variable	Comparison between groups		p
	Suspect of scoliosis	No suspect of scoliosis	
N (%)	17 (6.8)	234 (93.2)	
Age (years)	13.94 ± 2.5	13.5 ± 2.52	0.483
Weight (kg)	49.62 ± 7.7	52.1 ± 13.14	0.444
Height (cm)	154 ± 15	156 ± 10	0.422
BMI (kg/m^2)	21.46 ± 6.3	21.05 ± 3.94	0.695
Gestational age at birth (weeks)	37.29 ± 3.81	38.49 ± 2.613	0.106
Birth weight (kg)	2.94 ± 0.716	3.15 ± 0.592	0.247
Birth height (cm)	50.5 ± 1.927	49.69 ± 4.3	0.597

BMI = body mass index.

of systematic AIS screening remains controversial; however, some countries, such as the United States, have implemented early diagnostic programs.[12-14] International organizations like the Scoliosis Research Society and the American Academy of Orthopedic Surgeons advocate for scoliosis screening to enable early diagnosis and treatment.[23] Most prevalence studies have been conducted in school settings, though this methodology remains debated.[24]

Our preliminary study reported a clinical AIS incidence of 6.8% using the Adam's test, 7.2% based on spinous process misalignment, and 20% based on shoulder asymmetry. Confirmatory radiographic assessment yielded an AIS incidence of 2.4% for Cobb angles > 10º.[21] Konieczny et al. described AIS epidemiology, citing prevalence estimates between 0.5 and 5.2%.[24] Prior studies from Monterrey, Mexico, in 1989 indicated an AIS incidence of 1.4%.[13] In the United States, AIS prevalence in pubertal populations ranges from 2 to 2.5%,[5,14,20] whereas China reports a prevalence of 2.4%.[21] Reports from Latin America indicate a prevalence of 1.4-2.3% in Brazil and 0.4% in Argentina.[13,16] Our incidence aligns with global estimates, and while our clinical assessment may overdiagnose scoliosis, it remains a valuable screening tool for identifying high-risk individuals requiring further evaluation.

Prevalence studies frequently measure scoliosis presence at a single time point. Since scoliosis is a chronic condition, prevalence approximates the product of incidence and disease duration. The variation among reported prevalence rates likely results from differing detection methodologies and study populations.[25] A limitation of our study is the small sample size; an estimated 9,600 participants would be necessary to minimize a beta error of 1%. Other studies utilized sample sizes ranging from 376 to 2,822 participants, with minimal impact on prevalence estimates.

Our analysis found no statistically significant associations ($p > 0.05$) between scoliosis and potential risk factors, including parental age, parental education level, family medical history, prenatal conditions, musculoskeletal disorders, patient age, sex, weight, height, and medical history. Zheng et al. reported increased AIS prevalence among females and individuals with low BMI; however, their study comprised 79,122 participants, potentially explaining discrepancies with our findings.[24] Similarly, Konieczny et al. documented a higher AIS incidence in females, with sex ratios ranging from 1.5:1 to 2:1.[9,24] Our smaller sample size may have influenced deviations from international trends.

Screening programs have gained recognition for early disease detection, facilitating prompt diagnosis and intervention. Leading orthopedic organizations, including the Scoliosis Research Society and the American Academy of Orthopedic Surgeons, recommend scoliosis screening at 13 years for females and 14 years for males. Adam's test yielded a positive predictive value of 0.6 in our study. While relatively low, it remains useful for identifying candidates for further radiographic assessment.[26,27]

CONCLUSIONS

Our study underscores the importance of early clinical detection of AIS using systematic physical examination and radiographic confirmation. While the clinical incidence was 6.8%, radiographic confirmation identified a lower incidence of 2.4%, highlighting the limitations of physical examination alone. The Adam's test demonstrated moderate predictive value, reinforcing its role as a useful screening tool but emphasizing the necessity of confirmatory imaging for accurate diagnosis.

No statistically significant associations were found between AIS and common risk factors such as parental age, education level, or prenatal history. However, the variation in prevalence across studies suggests that environmental and genetic factors may still contribute to AIS development. Given the need for larger sample sizes to improve statistical power, future studies should aim to refine screening methodologies and explore potential risk factors further.

Implementing structured screening programs, particularly in school-aged populations, could facilitate early diagnosis and timely intervention, reducing the risk of severe spinal deformities and long-term disability. Additionally, optimizing diagnostic protocols with improved predictive tools would enhance scoliosis management and treatment outcomes. Further research is needed to validate screening strategies and assess the long-term benefits of early scoliosis detection programs.

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