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Letter to the Editor

Analysis of Factors Implicated in Adolescent Idiopathic Scoliosis Using a Logistic Regression Model

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Dear Editor-in-Chief

Idiopathic scoliosis generally has an insidious onset with no identifiable cause, progresses slowly, has 3 to 5 folds higher prevalence among girls than boys, and is most likely to develop during adolescence at around 10 to 16 yr of age (1). During adolescent growth, the skeleton grows faster than the muscles, leaving the spine more vulnerable to various factors, such as injury, lifestyle, and abnormal posture (2). Although the etiopathogenesis of adolescent idiopathic scoliosis (AIS) remains elusive, previous studies have suggested several factors to explain the increased prevalence of idiopathic scoliosis in adolescence, such as rapid growth, lack of exercise, and other environmental and lifestyle factors (3, 4). Asymmetric growth during puberty is associated with gradual loss of muscle function and deformation due to poor posture, resulting in symptoms such as physical deformities, including asymmetric pelvis, shoulder, chest cavity, and chest height, as well as impaired function and upper quadrant musculoskeletal pain (5). Furthermore, improving abdominal and spinal muscle strength, increasing upper body flexibility, and postural correction and retention can be effective in improving the spinal curvature in patients with AIS (2). Thus, early treatment and choosing the appropriate treatment options, whether it be observation, bracing, surgery, posture training, or exercise therapy, are paramount to growing adolescents. We aimed to examine the relationship between AIS symptoms and patient characteristics and to provide data to support treatment and rehabilitation.

Generally, the most accurate method to measure the spinal curvature is to analyze X-rays. However, this is not recommended because of problems with measurement efficiency, as well as the radiation dose and cancer risk associated with repeated scanning. Moreover, with the forward bend test, which enables easy and convenient measurement, variation in the measurement posture and position causes problems when using a scoliometer. Importantly, scoliosis is not merely a lateral deviation in the coronal plane but a three-dimensional (3D) deformity, involving spinal rotation and loss of normal curvature in the sagittal plane, thus requiring 3D measurement and analysis. In this study, in order to diagnose AIS accurately, we used a 3D structural analysis method (Formetric 4D, Diers Biomedical Solutions, Germany) that measures both the spinal curvature and body alignment to obtain the torso and pelvic tilt, spinal curvature, and Cobb angle. A brief survey of each subject's general characteristics, living conditions, habits, symptoms, and pain was also conducted.

Overall 387, elementary school girls were en-

rolled for study inclusion in Incheon City; before taking measurements, we provided the students and teachers with a thorough explanation of the purposes of our research study and obtained their written consent.

For data coding and analysis, we used SPSS 25.0 (IBM Corp., Armonk, NY, USA) and performed a binary logistic regression to analyze the factors affecting symptoms of idiopathic scoliosis. Then, we implemented a hierarchical regression model, with the presence or absence of scoliosis as the dependent variable, and subjects' characteristics, living conditions and habits, pain, and symptoms as the independent variables.

The subjects' general characteristics were as follows (mean±standard deviation): age 11.19±1.22 yr, height 144.36±9.64 cm, weight 38.10±9.02 kg, body mass index 18.07±2.78 kg/m^2, and Cobb angle 11.33±4.69 degrees. There were 227 subjects with a Cobb angle ≥10 degrees, and their mean Cobb angle was 14.25±3.82 degrees (Table 1). The results showed that compared to that in the obese group, the AIS risk was the highest in the overweight group, followed by the normal-weight and low-weight groups; especially, the risk was 12-fold higher for the overweight group than for the obese group. Moreover, changes in scoliosis-related factors, such as the torso and pelvic tilt and angle and thoracic kyphosis and lumbar lordosis angles were all associated with a significantly higher risk of scoliosis. In particular, the risk of scoliosis increased by 1.179 times with every 1-degree increment in the torso lean angle.

Table 1: Results of the logistic regession model

Factor	*B*	*SE*	*Wald*	*df*	*P*	*Exp (B)*
BMI†			5.790	3	.122	
~ 18.5	1.918	10.50	3.340	1	.068	6.807
18.5 ~ 22.9	1.937	.959	4.084	1	.043	6.939
23.0 ~ 24.9	2.493	1.044	5.705	1	.017	12.094
Trunk Torsion	.165	.040	17.005	1	.000	1.179
Pelvic Obliquity	.158	.062	6.464	1	.011	1.171
Pelvic Torsion	.178	.085	4.344	1	.037	1.195
Kyphotic Angle	.031	.014	2.7.39	1	.048	1.032
Lordotic Angle	.033	.016	4.097	1	.043	1.034
Constant	-4.285	1.243	11.896	1	.001	0.014
-2 logL			479.620			

†; Classification according to WHO's Asian-Pacific Obesity Diagnostic Standards

The present study's results are consistent with those of previous studies, which demonstrated that AIS is related to lifestyle and dietary habits and growth asymmetry due to rapid growth. Future research will need to compare the incidence of AIS by sex and to consider even more environmental factors, such as family history and physical activity.

Conflict of interest

The authors declare that there is no conflict of interest.

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