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Original Article

Discrepancy between self-awareness and actual diagnosis and treatment of the conditions among adolescent with scoliosis in middle-school age

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Abstract. [Purpose] The purpose of this research was to determine the awareness of the actual conditions of the diagnosis and treatment of scoliosis by focusing on middle-school students in order to provide a basis for active education and treatment of scoliosis. [Subjects and Methods] The survey was conducted among 4,782 students. The students performed Adam's forward bend test, and some of the students who showed predictive features of scoliosis were further examined for the spine structure with rasterstereography. [Results] The proportion of students with awareness about scoliosis appeared to be 71.47%. Among the students, 50.84% knew the definition of scoliosis and 4.37% were diagnosed as having scoliosis, of whom 46.37% underwent treatment. It was a significant difference between to get a diagnosis and the predictive scoliosis or the scoliosis. [Conclusion] The results showed that the students in the second grade of middle school had high awareness levels, but about 50% of them did not know the definition of scoliosis. More than 50% of them did not receive treatment after diagnosed as having scoliosis. Therefore, active education and school screening for scoliosis should be provided to adolescent students.
Key words: Scoliosis, Awareness, Diagnosis

INTRODUCTION

Scoliosis is a three-dimensional developmental deformity of the spine on the sagittal, frontal, and transverse planes. The spine alignment and trunk are bent lateral, frontal, or backward, with horizontal rotation of the vertebrae. Therefore, this deformity results in the abnormal alignment of the head and upper and lower limbs[1–4]. The prevalence of scoliosis observed in school screening in several current studies was 0.47–5.2%[3].

A study reported an 8 year prevalence of 3.26% in the Korean population of 1,134,890 schoolchildren aged 10 to 14 years who underwent school screening. The authors observed a gradual increase from 1.66% to 6.17% between 2000 and 2008, except for the year 2002[5]. Despite the efforts of many researchers, the identifiable causes of scoliosis are not known in>80% of scoliosis cases what are termed "idiopathic scoliosis". It is classified according to age as infantile (ages 0–3 years), juvenile (ages 4–10 years), adolescent (ages 11–18 years), and adult idiopathic scoliosis (ages>18 years). Among these, adolescent idiopathic scoliosis (AIS) is considered the most important. Dimeglio and Canavese (2013) reported that AIS does not have a sudden onset but a slow progressing onset, forestalled by an incubation phase. Therefore, the measurements should be carefully recorded and repeated at regular intervals over 2 years, beginning at the age of bone development, which is 11 years for girls and 13 years for boys. The 2 years of rapid growth is called the acceleration phase, and observation or intervention is highly important in this period[6].

The Cobb technique is considered the gold standard assessment method for scoliosis. AIS is classified into three grades

according to Cobb's angle as follows: mild (10–29°), moderate (30–44°), and severe (>45°). Moderate and severe cases of AIS exhibit an abnormal appearance when viewed from the side, front, or back. Some cases of severe AIS can lead to reduced lung function because of diminishing lung capacity and pressure on the heart due to distorted ribs. In addition, these abnormalities restrict patients' physical activities, create stress, and detract patients' quality of life (QoL)[7–10]. On the other hand, mild AIS generally exhibits a normal appearance and has no noticeable symptoms such as pain or neurological abnormalities, making mild AIS difficult to diagnose[8–10]. Some cases of severe AIS require interventions such as surgery and bracing in order to obtain curve correction and to relieve respiratory and circulatory system problems. Treatment costs are about $29,955–$60,754 per person, which depend on Lenke curve type, including implants, intensive care unit stay and inpatient room costs, operating room time, and bone grafts. In addition, the economy loss for intervention and treatment costs is about $3,386–$10.836 per person, even though the AIS is mild or moderate[11]. Therefore, efforts toward early detection and early optimal intervention are needed for mild AIS before it progresses and worsens the associated deformities in order to reduce the number of patients who require surgical treatment. Hence, several researchers and physicians recommend school screening for scoliosis, but this entails unnecessary excessive costs[12–15]. In South Korea, the screening program has been subsidized by the government or hospitals; however, results are available only for some areas and suggest only prevalence[16]. A study reported the awareness level and treatment status of scoliosis by conducting a survey, but they did not perform an objective assessment[17].

Therefore, the purpose of this research was to assess the awareness and the prevalence of the diagnosis of scoliosis and the treatment assessed by a survey. The research will also compare the reported prevalence of diagnosis with the actual prevalence confirmed by objective tests.

SUBJECTS AND METHODS

The 4,782 students enrolled in this study were among 4,990 students in the second grade of middle schools in Changwon. We analyzed the survey results from 4,216 students who responded to the survey, after excluding 565 subjects who did not respond to the questionnaire items. The students performed the Adam's forward bend test (FBT) to identity scoliosis predictors[14, 18], and some of them who showed predictive features of scoliosis were examined with spine structure measurement by using rasterstereography. The survey was conducted by the health education teacher in each school, and a physical therapist with at least six years of experience, who was well trained in the measurements conducted in this study and did not know the survey result, performed the assessments what are the FBT and the spine structure. Written informed consent has been obtained from each student. The participants included in this study are presented in the general characteristics in Table 1.

The questionnaire, which was a modification of the questionnaire developed by Kim and Ham (2011), was composed of seven items about the actual conditions of the diagnosis and treatment of scoliosis.

FBT was used for detecting the predictive parameters of scoliosis in this study. The participants bent forward by 90° at the waist, with feet together, arms hanging, and knees extended. The appraiser looked from behind, along the horizontal plane of the column vertebrae, and measured the trunk rotation deformity or rib hump with a scoliometer. A deformity of $> \pm 5°$ was defined as predicted scoliosis[14, 18].

The predictive parameters of scoliosis were measured based on the spine structure by using rasterstereography (Formetric 4D, Diers International GmbH, Schlangenbad, Germany). Rasterstereography is a reliable method of measuring for three-dimensional measurement of the spine by projecting a halogen light source and avoiding radiation exposure[19–22]. The participant stood at a distance of about 2 m in front of the height-adjustable four-dimensional scanning device. The measurement was performed for 6 seconds, and the average value was analyzed. A deformity of >17° was defined as scoliosis, based on an article what they said the difference of 7° between the rasterstereographic and radiographic measurements[22].

Data were analyzed by using SPSS version 22 (SPSS Inc., Chicago, IL, USA). A p value of <0.05 was considered statistically significant. The general characteristics of the subjects were processed by using descriptive statistics. Comparative analyses were performed by using McNemar's test to determine the difference between paired data.

Table 1. General characteristics of the study participants

	Male (n=2299)	Female (n=1917)
Age (years)	14.9 ± 0.3	14.9 ± 0.3
Height (cm)	165.3 ± 7.2	158.7 ± 5.1
Weight (kg)	56.3 ± 12.2	49.5 ± 7.8
BMI (kg/m^2)	20.5 ± 3.7	19.6 ± 2.8

Data are presented as mean ± SD.
BMI: body mass index

RESULTS

The number of students aware of scoliosis was 3,009 (71.37%) (males, 1,573 [68.42%] and females, 1,436 [74.91%]). To the question, "What do you know about the definition of scoliosis?," 50.84% correctly answered, "The spine has a sideward curve that appears as an 'S' or 'C' shape." Other answers included "The spine bent like a shrimp" (29.23%), "One shoulder appears higher than the other" (8.33%), and "One hip appears higher than the other" (5.09%), and "A rib hump on one side of the back" (4.69%). Of the students, 184 (4.37%) answered "Yes" to the question, "Have you been diagnosed with scoliosis?," among whom 53.63%, 26.26%, and 20.11% did not receive treatment, received treatment, and stopped treatment, respectively. To the question about the kind of treatment received (multiple responses possible), 39.76%, 21.69%, 13.25%, 13.25%, 6.02%, 0.00%, and 3.61% answered "therapeutic exercise," "electrical stimulation," "manual therapy or chiropractic," "traditional Korean medicine," "bracing," "surgery," and "other," respectively. To the question, "Why have you never gotten any treatment after the diagnosis?" (multiple responses possible), the answers included "no pain and no obstacle for living" (26.04%), "no need for any treatments" (21.88%), "not enough time to undergo treatment" (21.88%), "no information about where I can get treatment" (14.58%), "concerned of the treatment cost" (3.13%), "fear of getting treatment" (2.08%), and "other" (15.63%). Furthermore, to the question, "Why have you stopped the treatment?" (multiple responses possible), the answers included "not enough time to undergo treatment" (52.78%), "no improvement despite the treatment" (25.00%), "no need for any treatments" (16.67%), "not satisfied with the treatment" (0.00%), and "other" (16.67%).

Among the 559 students (13.26%) who had deformities >5° in the FBT, 35 (6.26%) were diagnosed as having scoliosis and 524 (93.74%) were not. Of the 3,656 students (86.74%) who had deformities <5° in the FBT, 149 (4.08%) were diagnosed as having scoliosis and 3,507 (95.92%) were not. The difference between these groups of students was significant ($p=0.000$).

310 (7.35%) consented to undergo spine structure measurement and 65 (20.97%) had a scoliosis angle of >17°. Eight (12.31%) were diagnosed as having scoliosis, and 57 (87.69%) were not. Moreover, among the 245 students (79.03%) who had a scoliosis angle of <17°, 14 (5.71%) were diagnosed as having scoliosis and 231 (94.29%) were not, indicating a significant difference ($p<0.000$; Table 2).

DISCUSSION

AIS progresses slowly from onset. Thus, observation and care are greatly important to prevent deformities from developing in the acceleration phase. Therefore, school screening for scoliosis is suggested in the growth period, especially during the age of bone development, which is 11 years for girls and 13 years for boys, to minimize economy loss[13, 15]. The purpose of this research was to assess the actual conditions of the diagnosis and treatment of scoliosis by focusing on middle-school students in order to provide a basis for active education and treatment of scoliosis through school screening.

Of the 71.37% students who reported that they know the scoliosis, 50.84% correctly defined scoliosis. The remaining students had misconceptions about scoliosis, such as a kyphosis or an imbalance in the height of the shoulder or pelvis. These results were different from those of the study by Kim and Ham (2011), who reported that 59.6% of middle-school students were aware of scoliosis. However, the results are in close agreement knowing the definition correctly as 57.5%. This indicates that students display more interest now than in the past about scoliosis, its related appearance, and its associated posture. However, we can infer that education about scoliosis is still lacking, although the situation differs depending on the area and sample size of the earlier studies. In addition, 46.37% of the students did not undergo treatment among the students who were diagnosed as having scoliosis (4.37%). The reasons given included "no feeling of discomfort in daily living" (26.04%), "no need for treatment" (21.88%), and "not enough time to undergo treatment" (21.88%). Therefore, the reasons of the students for discontinuing treatment (20.11%) included "not enough time to undergo treatment" (52.78%), "treatment had no effect" (25.00%), and "no need for treatment" (16.67%). The reason for this result is that the participants had mild and moderate AIS. The latest review article reported the pain and scoliosis is not strongly linked and pain has not shown a significant correlation with severity of spine curve[23]. Accordingly, mild and some moderate cases of AIS may seem to have no effect on QoL and not to require medical or special treatment. Conservative treatment of scoliosis includes observation, therapeutic exercise, and bracing for mild and moderate AIS. Therefore, ongoing monitoring and therapeutic intervention are necessary during the

Table 2. Association between diagnosis of scoliosis and FBT score or scoliosis angle

		FBT		p	Scoliosis		p
		Angle<5°	Angle>5°				Angle<17°
Diagnosis	No	3,507 (95.92)	524 (93.74)	0.000	231 (94.29)	57 (87.69)	0.000
	Yes	149 (4.08)	35 (6.26)		14 (5.71)	8 (12.31)	
	Total	3,656	559		245	65	

Data are presented as number (%).
FBT: forward bend test

growth period even if muscular or neurologic abnormalities are absent. Hard orthoses such as a brace should be applied for an average of 18–23 hours throughout the growth period to be effective and removed when the curves are reduced. In addition, various methods, including physical therapy and special exercises, have been proposed for cardiac vascular and respiratory system problems or pain, but no evidence has indicated their efficacy for inhibiting the progression of curves or reducing curves. The evidence level of the treatments available is level III (case-control study) but is lower in most of the studies. In addition, manual therapy, chiropractic, acupuncture, and massage are not based on evidence of their abilities to inhibit the progression of curves or reduce curves[24]. The results of this study indicate that about 50% of the students who were diagnosed did not undergo treatment with electrical stimulation, manual therapy or chiropractic, or traditional Korean medicine. Therefore, a guideline for conservative treatment is needed for individual patients based on age, degree and pattern of the curve, and scoliosis type. Among the students who showed predictive features of scoliosis (13.26%) with a scoliosis angle of >5° in the FBT, 57.78% consented to undergo spine structure measurement. In the 65 students with AIS, the prevalence was presumed to be 2.67% and the female-to-male ratio was 1.76:1. These results are in close agreement with the results of an earlier study that reported that the female-to-male ratio was 1.4:1 for those with curves ranging from 10° to 20°[3].

This study demonstrated a significant difference between the students were diagnosed and those who underwent raster-stereographic assessment for scoliosis. A large number student with AIS did not get themselves diagnosed, although their screening result was positive for AIS. School screening is the only tool for detection of scoliosis at an early stage, when spinal curves are still mild or moderate, and can be effectively treated conservatively[25]. In the future, implementation of school screening for scoliosis that is aimed at the growth period should be considered. The limitations of this study were conducted in some parts of Korea and only the self-awareness of the diagnosis and treatment of adolescents was examined. Further research should be conducted on adolescents in various regions and will need to investigate parents' perceptions of their child's diagnosis.

In conclusion, active education about scoliosis should be provided to adolescent students and school screening is necessary to proactively promote awareness of scoliosis at an early stage.

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