Original Article

Scoliosis screening results of primary school students (11–15 years old group) in the west side of Istanbul

Tuğba Kuru Çolak, PT, PhD[1)]*, Adnan Aptı, PT, MSc[2)], E.Elçin Dereli, PT, PhD[3)], Arzu Razak Özdinçler, PT, PhD[2)], İlker Çolak, MD[4)]

[1)] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Marmara University: Istanbul, Turkey
[2)] Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Istanbul University, Turkey
[3)] Department of Physiotherapy and Rehabilitation, School of Health Sciences, Istanbul Bilgi University, Turkey
[4)] Department of Orthopedics and Traumatology, Dr Lütfi Kırdar Kartal Education and Research Hospital, Turkey

Abstract. [Purpose] The present study aimed to find out the scoliosis prevalence 11–15 years old children and to create awareness about scoliosis. [Subjects and Methods] All of the children were assessed using the Adams Forward Bendings Test and a scoliometer. Sagittal plane changes such as kyphosis, lordosis, hypokyphosis, hypolordosis and anterior head tilt were screened. Children with trunk rotation angles (ATR) of 4 degrees or more were suspected of having scoliosis, and were evaluated for a second time for gibbosity height, arm-trunk distance, and ATR. [Results] A total of 2,207 children were screened and the evaluation revealed there were 11 girls (0.49%) with a Cobb angle of 10 degrees and more. The maximum Cobb angle was 43° (right thoracic-left lumbar) and the maximum ATR was 12°. Two children had kyphosis and lordosis, and one had hypokyphosis and was diagnosed as having idiopathic scoliosis. [Conclusion] Families should regularly check their children, even if they are not diagnosed as having scoliosis in school screenings. It is our opinion that our study increased the awareness of the families about scoliosis by screening, brochures and posters. In the future, if school screenings were performed as a routine procedure and scoliotic students were followed over the long term, the actual effectiveness of screening would be able to be detected.
Key words: Scoliosis, School screening, Prevalence

INTRODUCTION

Scoliosis is defined as a three-dimensional deformity with lateral deviation and additional sagittal plane changes in the vertebrae[1–3]. There are three main factors involved in the curve progression. They are gender, growth potential, and the degree of curvature when scoliosis is first diagnosed[4, 5]. Scoliosis occurring in adolescents or juveniles is thought to progress till bone maturation is complete when it is not treated[5]. School scans to diagnose early spinal deformities have been recommended by scientific committees such as the American Orthopeadic Surgeons Academy, and the Scoliosis Research Society[6–8]. Early diagnosis of scoliosis gained importance in the1960s[9].

Scoliosis is a common problem. Some school scan studies performed in different cities report that the prevalence of scoliosis ranges between 0.2% and 0.61%[10–13]. The present study was aimed to find out the prevalence of scoliosis in primary school children between 11 and 15 years of age and to create awareness about scoliosis by giving information to families, caregivers and teachers.

SUBJECTS AND METHODS

The prevelance of scoliosis was investigated in school children aged between 11 and 15 years of age (6–8th school years) living in the Silivri region of Istanbul, between January 2012 and June 2012.

Silivri is located on the European side of Istanbul. According to the most recent data, 134,660 people live there[14].

The procedure of the study was priorly explained in detail to the principals of the schools where the screening was to be performed after the required permissions had been granted by the District National Education Directorate of Silivri. The teachers were asked to inform the students about the screening study that was to be performed. Information post-

*Corresponding author. Tuğba Kuru Çolak (E-mail: tugbakuru@gmail.com; cktugba@gmail.com)

ers were displayed on school notice boards, and informed consent forms were sent to the students' families. The study was financially supported by the Municipality of Silivri.

According to the District National Education Directorate of Silivri there were 39 primary schools in the region with 6,112 students enrolled in the 2011–2012 academic year. The families of 2,207 students gave their consent to participation in the study.

The assessment form was composed by the authors. Photographs were included in the assessment forms for postural analysis and the detection of scoliosis and kyphosis. Data about each child's age, height, weight, school year, school bag carrying style, and weight of the school bag were also recorded on the form.

Screening for scoliosis in our study was performed by a team including 3 physiotherapists experienced in scoliosis and 8 final-year physiotherapy students, a total of 11 researchers. Tests were performed by two experienced physiotherapists and final-year physiotherapy students helped with the process of filling in the assessment forms for data collection and preparing the children for the tests. The final-year physiotherapy students were included in this study as part of a social responsibility and awareness of work program. They helped to fill in the forms with physiotherapists before the start of screening. All preparations were completed before the study.

Male and female students were assessed in front of a posture paper in separate classrooms, behind screens with their clothes removed. All the students were assessed using the Adam's Forward Bending Test (FBT) and a scoliometer. FBT is a well known and commonly used test by health professionals. Spinal deformity can be evaluated subjectively and quantitatively using this test. The use of physical measurements helps to quantitatively evaluate the deformity and provides objective reference criteria which increases the efficiency of test. In the FBT, the feet are placed parallel (15 cm apart), the knees and elbows are extended, the shoulders relaxed, the palms are positioned in front of the knees, and the spine of the students was observed in the anterior, posterior and lateral views, and assessed using a scoliometer[15]. The scoliometer, is an easy to use, cheap, reliable, and specially designed inclinometer which is used in the clinical assessment of scoliosis[16]. A minimum trunk rotation angle (ATR) of 5 degrees determined by a scoliometer has been shown to be a good criterion for identifying a Cobb angle of 20 degrees in computer analyses[17–19]. The scoliometer is placed above the spinous processes of the vertebrae and perpendicularly follows the spine in the measurement.

Frontal plane changes, sagittal plane changes such as kyphosis, lordosis, hypokyphosis, hypolordosis, and anterior tilt of the head were screened in the students participating in the study. When all 3 physiotherapists agreed to the presence of any of these deformities this was accepted and reported on the form. Assessment forms were completed for all of the children and their contact addresses were also recorded on this form. It took approximately 4.5 minutes to complete an assessment for each student.

Children with an ATR of 4 degrees or more were suspected of having scoliosis and were recalled for a second assessment. They were not directly informed about our suspicions

while the screening was being carried, but their families were informed by phone calls. The posture of children who were suspected of having scoliosis were evaluated a second time and their gibbosity height, arm-trunk distance and ATR by scoliometer were measured. Gibbosity height was measured in centimeters while the children bent forward keeping the scapulae and pelvis on the same line. The measurement was performed to find out the distance from the concave side of the curve, and a rigid 30 cm ruler was placed on the highest point of gibbosity[20]. The distances between the arm and waist on both sides were recorded in centimeters as the arm-waist distance. A rigit 30 cm ruler was used for this measurement. The difference between the sides is used as an indicator of waist asymmetry[20]. The children suspected of having scoliosis, who had an ATR of 4 degrees or more at any point on the spine in sitting or standing were referred to a hospital for X-ray examination, and spinal curvatures on the X-rays were evaluated using the Cobb method[5]. The families of the children who were diagnosed as having scoliois after the clinical and radiological evaluations were informed and referred to the required clinics for appropriate treatment. A specialised exercise program was taught to the children whose family approved, and they were asked to visit for control 6 months later.

SPSS for Windows version 15.0 was used for data analysis in this study. Values were accepted as statistically significant for values of p≤ 0.05 (two tailed). A 95% confidence interval and a 0.05 significance level were used. Descriptive statistics were used to determine the mean, percentage distribution and standard deviation.

RESULTS

Gender, age groups, education grade, school bag carrying style and sagittal plane changes based on observational postural analysis of the students included in our study are presented in Table 1. Demographic characteristics and the mean weight of the school bags carried by the study sample are shown in Table 2.

The average weight of a school bag was 4.1±1.3 kg for 6th year students, 3.8±1.4 kg for 7th year students, and 3.5±1.5 kg for 8th year students.

Three hundred four adolescents who had findings suggestive of scoliosis during screening (an ATR of ≥4 degrees in the cervical, thoracic, thoracolumbar, lumbar or sacral region) were invited to return for a second assessment by calling their caregivers. Eighty-one families did not want to attend a second assessment and four of them reported that they consulted at another center.

The results of the second assessment showed that 70 children did not have any scoliosis signs or symptoms. One hundred forty-nine children had findings that were suggestive of scoliosis, so they were referred to Silivri State Hospital, Department of Orthopaedics and Traumatology. Sixty-two of them did not attend a radiologic evaluation or give information about the result.

Children who were referred to hospital were radiologically evaluated by anterior-posterior full spine X-ray in an erect position. The results showed that there were 11 girls (0.49%) with a Cobb angle ≥10 degrees, and the maximum

Table 1. Gender, age, class, school bag carrying styles of the study sample

Variables		Frequency	Percent	Total
Gender	Female	1,246	56.5%	n= 2,207
	Male	961	43.5%	100%
Age (years)	11–12	893	40.5%	n= 2,207
	13–14	1,249	56.6%	100%
	15–16	65	2.9%	
Education grade	Class 6	782	35.4%	n= 2,207
	Class 7	757	34.3%	100%
	Class 8	668	30.3%	
Carrying styles of book bags	Bilateral	1,272	57.6%	n= 2,207
	Right shoulder	779	35.3%	100%
	Left shoulder	143	6.5%	
	Handcart bag	3	0.1%	
	Cross strap bags	10	0.4%	
Changes in sagittal plane	Anterior tilt of head	21	0.95%	
	Kyphosis	52	2.35%	n= 126
	Hypokyphosis	28	1.26%	5.70%
	Lordosis	16	0.72%	
	Hypolordosis	9	0.40%	

Table 2. Demographic characteristics and weight of school bags of the study sample

Variables	Mean±SD[b] (min–max[c])
Age (years)	12.9±1.0 (10–16)
Average age of menarche (year, n=941)	11.8±2.2 (10–16)
Onset of menarche (months, n=941)	6.0±7.8 (1–101)
Height (cm)	154.5 ± 9.0 (127.0–184.0)
Weight (kg)	48.9±12.3 (24.0–119.7)
BMI[a] (kg/cm²)	20.3± 3.9 (12.9–41.3)
Weight of school bag (kg)	3.8 ±1.4 (0.7–8.6)

[a]BMI: Body Mass Index; [b]SD: Standard Deviation; [c]min-max: minumum-maximum

Table 4. Types of the spinal curvature

Types of the curves	Frequency	Percent
Right thoracic	2	18%
Left thoracic	1	9%
Right lumbar	0	-
Left lumbar	2	18%
Right thoracalumbar	0	-
Left thoracalumbar	1	9%
Right thoracal, left lumbar	3	27%
Left thoracal, right lumbar	2	18%
Total	11	100%

Table 3. Cobb angle, and ATR, height of the hump, and the waist asymmetry of the cases diagnosed with scoliosis

Variables	Mean±SD[a] (min–max[b])	Distirubution and frequency n=21		
Cobb angle ° (degree)	10.4±10.0 0.0–43.0	0–10 °	9 children	(42.8%)
		11–20 °	7 children	(33.3%)
		21–30 °	3 children	(14.2%)
		43 °	1 child	(4.7%)
Maximum ATR (degree)	5.0±3.9 0.0–12.0	4 °	8 children	(38%)
		5–10 °	11 children	(52.3%)
		12 °	2 children	(9.5%)
Maximum height of hump (cm)	0.5 ± 0.7 0.0–2.3	0–0.9	13 children	(61.9%)
		1–2	7 children	(33.3%)
		2.3	1 child	(4.7%)
Waist asymmetry (cm)	0.8±0.9 0.0–2.8	0–9	13 children	(61.9%)
		10–19	5 children	(23.8%)
		20–28	3 children	(14.2%)

[a]SD: Standard Deviation; [b]min–max: minumum–maximum

Cobb angle found was 43 degrees.

Two of children diagnosed with idiopathic scoliosis had kypholordosis and one had hypokyphosis. The Cobb angles and ATRs and height of the hump and waist asymmetry in cm are presented in Table 3. The types of scoliosis are summarized in Table 4.

The children with a Cobb angle of >10 degrees were female. The average time after their menarche was 6.0±7.8 months. Maximum ATR detected by the scoliometer was 10 degrees for the thoracal and lumbar regions during the school screening, and the maximum ATR was found to be 12 degrees in thoracic and thoracolumbar regions in the second assessment.

DISCUSSION

In the literature, different prevalence rates of adolescent idiopathic scoliosis (AIS) have been reported. Most studies point out that the prevalence of AIS with a Cobb angle of 10 degrees and more is 2%[21]. The prevalence of AIS in Norwegian children was reported as 0.55%, based on a school screening program[22]. In Turkey, the school screening studies have reported prevalence rates of 0.48%[13] and 0.47%[12]. The prevalence rate of the present study was similar to these earlier studies, the prevalence rate of AIS being 0.49% in primary school children aged between 11–15. In our opinion, the sample size needs to be increased to determine the true prevalence since the onset of puberty and age of scoliosis are different for each adolescent. AIS is more common and may be more progressive in girls[5, 13, 22, 23]. The Minnesota Department of Health Scoliosis School Screening Workgroup members concluded that one year before menarche is the optimal time to screen girls[24] and 1–2 years later for boys[22]. The aim of the school screening is to detect clinically significant curves which can be progressive in female[22]. Ibisoglu and colleagues reported that among 40 children diagnosed with AIS, 31 (77.5%) were female[13]. Another study found that 10 (66.7%) of 15 children with AIS were females[12]. In

this study, all children with Cobb angles of 10 degrees or more were females.

The optimal age to perform school screening for scoliosis is still under discussion. Scoliosis screenings are performed under school health screening programs between the ages 10–14 in growing children. We included children aged 11–15 in our screening. Their mean age at menarche was 11.84 years, and it had started 6.03 months before the screening. So, we can say that performing an examination 1 year earlier especially for girls may be more beneficial.

Eighty-seven children with a suspicion of scoliosis were evaluated in the standing position by anteroposterior X-ray and, 11 of them had a Cobb angle greater than 10 degrees, and 10 of them had a Cobb angle less than 10 degrees. The sensitivity and specificity of scoliosis screening depends on the knowledge and experience of the examiner, the methods used in the examination, and the magnitude of the curve[15, 22]. In this study physiotherapists with experience of scoliosis made the examinations of the children. Cases with ATR ≥4 degrees as measured by a scoliometer were considered to be suggestive of scoliosis. It has been shown that a scoliometer is sensitive and specific for Cobb angles of 20 degrees or more[16]. Amendt et al. investigated the screening ability of the scoliometer, especially at the 5 degrees ATR level. They reported that at 5 degrees ATR, the sensitivity and predictive value of a negative test for double curves was 100%, and at 10 degrees, the specificity and predictive value of a positive test for double curves was 100%[16]. Ashworth et al. suggested that a scoliometer reading of 5 degrees is 100% sensitive and 47% specific for scoliosis and an ATR of 7 degrees as measured by a scoliometer has a sensitivity of 83%, and the specificity increases to 86%[25]. Our study results show that all the children with Cobb angles ≥20 degrees had an ATR higher than 5 degrees, and two children with Cobb angles of ≥10 degrees had an ATR of 7 degrees.

The magnitude of the curve, scoliosis prevalence, and the examiner's evaluation skill cause variations in the positive predictive value (PPV) of visual inspection and the FBT[26, 27]. The PPV shows an inverse relationship with the amount of curvature, and it is more common to see smaller curves a the larger ones. In the literature, it was reported that the PPV was 78% for spinal curvature over 5 degrees with an estimated prevalence of 3%[26]. Yawn et al. reported that the PPV of the school program was 0.05 and the sensitivity and PPV were higher for the presence of scoliosis of at least 20° or 40° or more (0.07–0.17)[28].

Morais et al. reported that the PPV of the forward bending test was 42.8% for curves greater then 5 degrees, 17.9% for curves greater than 10 degrees and 3.5% for curves greater than 20 degrees[27]. Adobor et al. reported the PPV was found to be 37% using the accepted >10 degrees definition of scoliosis[22]. Amendt et al. reported that the scoliometer has a sensitivity of 96–98%, specificity of 29–68%, and reliability coefficients of 0.86–0.97 in detecting a Cobb angle of 20° or more[16]. In this study, we used the forward bending test and a scoliometer, and the PPV was estimated as 12.64% for spinal curvature over 10 degrees. Our PPV value was lower than other studies' findings, and this difference can be explained by our selection cretierion of an ATR of 4 or more degrees.

It has been reported in the literature that carrying heavy

school bags affects the posture[29] and anteroposterior load distribution of the upper thoracic region[30], and that there is a relationship between bag carrying style and anteroposterior pressure distribution under the feet[31]. It has also been shown that EMG activities of the supraspinatus and bilateral upper trapezius muscles increase when carrying bag weights around 1–3 kgs; however these activities are not related with load or bag-carrying style[32]. In the present study the school bags were heavy for children of school age and 41.9% of the children carried their bag unilaterally. However, we did not examine the relationships among bag carrying style, bag weights and posture of the children. There are different costs for school screening. Lee and colleagues examined 115,190 students and followed them during the adolescent period, from 12 years old until they were 19 years old or left school. They reported the total cost of screening increased steadily from USD 380,930 to USD 2,417,824, and the costs of screening and diagnosing one child during adolescence were USD 17.94 and USD 2.08. Two hundred sixty-four of these children required a brace and thirty-nine children needed a scoliosis surgery during the screening process, and the cost of the medical care averaged USD 34.61 per child. The results of Lee's study show that the cost of detecting and treating one child with a Cobb angle ≥20 degrees ranged between USD 4475.67 and 20,768.29[33].

In a study which screened 2,197 students, the authors reported that 92 of them had a suspicion of scoliosis, and 5 students were treated and followed until the age of 19. They claimed case-detection and screening costs of $24.66 per child, and $3,386.25 per child with a Cobb angle ≥20 degrees, and a cost of $10,836.00 per child treated for scoliosis[34].

Twelve municipality personnel conducted the present study together with volunteer physiotherapists. The screening of the 2,207 students lasted 22 working days, and second detailed examination of the students with a suspicion of scoliosis lasted 12 working days. The total cost of screening was TL 12,000, 5.43 (≈$9.82) per student. Since the current study was a project study and was required to be performed whitin a limited amount of time, a cost analysis of scoliosis treatment could not be performed. Future studies may be planned to address this limitation.

There is a need to conduct controlled prospective studies showing that screened children have better results than unscreened ones to provide evidence for the efficacy of school screening programs. There is not enough information about scoliosis; however, some studies have suggested that patients with scoliosis diagnosed by screening had a lower rate of scoliosis surgery[19, 35, 36]. In the literature, some studies have reported that patients diagnosed by screening were younger, had smaller spinal curvature, decreased risk of progression up to 45 or more degrees, and a lower surgery rate. On the other hand, number of patients attending scoliosis clinics increased since the screening programs were performed[36–38].

In the present study, we planned to screen 6,112 students, but only 2,207 students could be screened. The number of students screened and diagnosed with scoliosis was small, and we could not follow treated students, all of which can be accepted as limitations of our study. Families or caregivers should regularly check their children even if they are not

diagnosed with scoliosis in school screenings. It is our opinion that our study project increased families' and teachers' awareness of scoliosis through the scoliosis screening, and the distribution and display of brochures and posters. In the light of our clinical observations, lack of knowledge about scoliosis and associated symptoms might be considered as the primary reasons why families miss their children's scoliosis. A second reason might be that when a child starts to bathe alone, parents do not see the child's naked body, and they only have a chance to notice scoliosis when visiting swimming pools or beaches together with their children. Most families notice their children's scoliosis when they are in swimsuits in the summer time or when someone, who is experienced and knows well about scoliosis, warns the family after noticing the deformities such as gibbosity or hip or shoulder level asymmetry.

In the future, if the school screenings are performed as a routine procedure and students with scoliosis are followed over the long term, then the actual effectiveness of screening would be able to be detected. The awareness of families, caregivers and teachers may be helpful for the early recognition of the existence of scoliosis in a child, and this may result in early treatment before spinal curvature progresses which would be an advantage of school screening programs. School screening programs might also increase the success of conservative treatment for scoliosis when a child still has a small angle of spinal curvature.

There is also a need for people specialised in this area, and time, and labor can also be considered as disadvantages of school screening programs. The training of health professionals working in schools and the provision of opportunities for them to perform screenings for scoliosis in their work schedule may help to resolve these disadvantages.

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