



# SCHOOL SCREENING OF ADOLESCENT IDIOPATHIC SCOLIOSIS IN 7928 TURKISH CHILDREN

## 7928 TÜRK ÇOCUĞUNDA ADOLESAN İDİOPATİK SKOLYOZ OKUL TARAMASI

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### SUMMARY:

The aim of the present study was to identify the prevalence of adolescent idiopathic scoliosis in Kartal, which was a sub-province of İstanbul that could represent the overall demographic structure of Turkey that did not have a comprehensive scoliosis-screening program. The study included 60 schools with a mean age of 13. The scoliosis screening covered 7928 students. Screening was done based on the Adam's forward bending test, measurements by a scoliometer, shoulder pelvic obliquity, height and weight as well as arm, leg and body length measurements. 451 of the students were diagnosed with scoliosis (5.68%). The prevalence rate for patients with a 7 to 16 degree-curve was 0.0156%, while the prevalence rate for patients with a curve higher than 10 degrees was found as 0.0065%. 88.4% of the scoliotic patients were girls. In 76% of the scoliotic students vertebral imbalance was on the left side. This study will shed light on the future studies, since it is the first comprehensive scoliosis screening conducted in the Republic of Turkey to cover all schools in the selected district.

**Key words:** scoliosis, epidemiology, school screening.

**Level of evidence:** epidemiologic study, Level III.

### ÖZET:

Bu çalışmanın amacı Türkiye'nin demografik yapısını temsil edebilecek İstanbul'un Kartal ilçesinde adolesan idiopatik skolyozun prevalansını belirlemektir. Bu çalışmaya 60 okul dahil edildi. Yaş ortalaması 13 olan 7928 çalışmaya dahil edildi. Çalışmada Adam'ın öne eğilme testi, skolyometre ile ölçüm, omuz-pelvis eğikliği, ağırlık, boy dışında kol- bacak ve gövde uzunluğuna da bakıldı. 451 öğrenciye skolyoz tanısı konuldu (%5.68). 7 ile 16 derece arasında eğriliği olanların prevalansı %0.0156, 10 dereceden fazla eğriliği olanların prevalansı ise %0.0065 olarak belirlendi. Skolyozu olan hastaların %88.4'ü kızdı. Skolyozu olan öğrencilerin %76'sının gövde imbalansı sola doğruydü. Bu çalışma Türkiye Cumhuriyeti'nde ilk kez yapılan okul skolyoz taraması olması nedeni ile gelecekte yapılacak çalışmalara ışık tutacaktır.

**Anahtar Kelimeler:** Skolyoz, epidemiyoloji, okul taraması

**Kant Düzeyi:** Epidemiyolojik çalışma, Düzey III.

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## INTRODUCTION:

The incidence rate of Adolescent Idiopathic Scoliosis (AIS) varies around 0,5 to 3%<sup>18</sup>. The incidence rate of curves equal to or greater than 10 degrees varies between 1 to 3%, whereas the incidence rate of curves equal to or greater than 30 degrees, which require treatment, is as low as 0.15 to 0.3%. The ratio of women to men is 1.4/1 for degrees equal to or greater than 10 degrees, while the ratio of women to men increases up to 5/1 in curves equal to or greater than 30 degrees<sup>17</sup>. An asymmetrical body interferes with the shoulder and arm asymmetry<sup>5</sup>.

The scoliosis screening revealed some valuable information concerning the prevalence, natural course and aetiology of scoliosis. School screening programmes are useful for the early diagnosis of AIS and collection of data on the aetiology. Use of braces after early diagnosis was reported to provide effective results<sup>5,21</sup>.

The optimum age range for the scoliosis screening programme is still controversial. The screening programmes are usually practiced at 10 to 14 years of age<sup>26</sup>. The Adam forward bending test and scoliometer measurements are the easy, fast, effective and cheapest methods for detecting the curve<sup>15</sup>.

This study aims at investigating the incidence rate of scoliosis among the 13-year-old junior high school students. This is the first comprehensive scoliosis screening study to cover all schools in the selected district within the Republic of Turkey.

## MATERIAL – METHOD:

### The study design:

Before the study was initiated, necessary approvals and permits were obtained from the Governorate of Istanbul and Provincial Directorate of National Education. Once the schools to be screened were identified, they were visited and the officials of the schools were informed about the screening to be performed.

For a standard assessment, the study staff 103 was trained about how to perform the scoliosis screening. The physicians performed the scoliometry and the Adam's forward bend test while the assisting medical staff performed the anthropometric measurements. The idiopathic scoliosis screening was applied on 7928 students at the age of 13, attending junior high schools in the Kartal district of Istanbul. The measurements were made by a team comprising of 4 neurosurgeons, 1 orthopaedic surgeon, 4 public health specialists and 6 health-care officers.

Sampling in the scoliosis screening target population the number of girls was comparable to the number of boys. The screening was administered by the specialist doctors and health-care officers. The observers received one-day training on AIS. They were informed about the Adam forward bending test and scoliometric measurement. Information was

given about how to measure the shoulder and pelvic obliquity along with the height, weight and arm, leg and body lengths.

### The Measurements:

Posterior views of the back, Adam forward bending test and scoliometric measurements (OSI119 scoliometer Orthopaedic Systems Inc, Hayward, California, USA) were used under the student screening programme<sup>29</sup>. Furthermore, all students were measured for their arm, leg and body lengths. They were checked for their height and weight, and body mass indices were calculated.

To investigate the presence of congenital scoliosis, all students were checked for hirsutism in the midline, and for nevus and cafe-au-lait spots, as these are the findings of closing problems at the midline. To investigate any hereditary deformities, all students were checked for family histories of claudication or hunchback.

Diagnosis criteria and treatment Students with Cobb angle  $> 10^\circ$  were diagnosed with AIS according to the Scoliosis Research Society diagnosis criteria<sup>26</sup>. Patients with a curve of 10 to 20 degrees were planned for follow-up with new plain radiographs 6 months later, whereas patients with Cobb angle  $> 20$  degrees were sent for a new X-Ray to determine the Risser Sign.

### Statistical Analysis:

The results were statistically compared. The gender distribution was comparable within the target student population. Numerical data were analyzed using a t-test, while categorical data were analyzed by using a chi-square test.

## RESULTS:

The 7928 students screened for scoliosis had a comparable gender distribution. Within the target population, there were 3854 (48.55 %) girls and 4084 (51.45 %) boys. As a result of the screening 451 students were diagnosed with scoliosis (5.7 %). Among the scoliotic student population, there were 399 girls (88.4 %), and 52 boys (11.6 %). A comparison of the gender within the scoliotic student population revealed that scoliosis was more common among girls, and the difference was statistically significant ( $p < 0,001$ ) (Table-1).

87 of the scoliotic students had kin marriage in their parents, whereas 364 did not have the kin marriage history. There was no statistically significant link between kin marriage and the incidence of scoliosis ( $P = 0,113$ ) (Table-2).

A comparison of the scoliotic and non-scoliotic students with family histories of claudication and hunchback did not reveal any significant differences. These values were found as  $p = 0,628$  and  $p = 0,835$ , respectively (Table-3,4).

**Table-1.** Distrubiton of scoliosis according to gender.

			Scoliosis		Total
			-	+	
Gender	Boy	Number	4027	52	4079
		% within gender	98,7%	1,3%	100,0%
	Girl	Number	3450	399	3849
		% within gender	89,6%	10,4%	100,0%
Total		Number	7477	451	7928
		% within gender	94,3%	5,7%	100,0%

**Table-2.** Scoliosis and the relationship between kin marriage

			Scoliosis		Total
			-	+	
Kin Marriage	yes	Number	1227	87	1314
		% within KM	93,4%	6,6%	100,0%
	no	Number	6241	364	6605
		% within KM	94,5%	5,5%	100,0%
Total		Number	7468	451	7919
		% within KM	94,3%	5,7%	100,0%

**Table-3.** Scoliosis and the relationship between family history of huncback

			Scoliosis		Total
			-	+	
FH of huncback	Number	77	3	80	
		% within FHH	96,3%	3,8%	100,0%
	Number	7400	448	7848	
		% within FHH	94,3%	5,7%	100,0%
Total		Number	7477	451	7928
		% within FHH	94,3%	5,7%	100,0%

**Table-4.** Scoliosis and the relationship between family history of claudication

			Scoliosis		Total
			-	+	
FH of claudication	Number	139	9	148	
		% within FHC	93,9%	6,1%	100,0%
	Number	7340	442	7782	
		% within FHC	94,3%	5,7%	100,0%
Total		Number	7479	451	7930
		% within FHC	94,3%	5,7%	100,0%

The physical examination with inspection revealed that the nevus and cafe-au-lait spots, all of which had hair formation in the 451 scoliotic students, were statistically insignificant (Table-5).

449 students with scoliosis had spinal imbalance, while only two of them did not suffer from the spinal imbalance. 347 (76 % of the scoliotic students) students had the spinal imbalance on the right side, while 102 students (22.3 % of the scoliotic students) had it on the left side. The difference between the non-scoliotic population with spinal imbalance and the scoliotic population with spinal imbalance was found statistically significant ( $p < 0,001$ ).

73 (16 %) scoliotic students had right shoulder imbalance, while 349 (77 %) scoliotic patients had left shoulder imbalance (Table-6).

The difference between the non-scoliotic population with shoulder imbalance and the scoliotic population with shoulder imbalance was found statistically significant ( $p < 0,001$ ).

The average body length was 97,89 cm in the scoliotic population, while it was 97,17 cm for the non-scoliotic population. The difference between these two groups was not found statistically significant ( $p = 0,159$ ).

The average arm length was 152,64 cm in scoliotic population, while the average length for the right leg was 95,66 cm and it was 95,86 cm for the left leg. The non-scoliotic population had an average arm length of 152,28 cm, and an average right leg length of 95,74 cm and a left leg length of 96,68 cm. These values did not reveal any significant differences between the two groups ( $p$  values were  $p = 0,713$ ,  $p = 0,901$  and  $p = 0,869$ , respectively)

The Body Mass Index (BMI) was 20,08 in the 171 scoliotic population, while it was 20,24 in the non-scoliotic population. The two groups did not display a statistically significant difference (Table 7).

**Table-5.** Scoliosis and the relationship between physical examination

		Scoliosis		Total
		-	+	
	Number	7454	451	7905
	% within PE	94,3%	5,7%	100,0%
	Number	4	0	4
	% within PE	100,0%	,0%	100,0%
	Number	18	0	18
	% within PE	100,0%	,0%	100,0%
Total	Number	7476	451	7927
	% within PE	94,3%	5,7%	100,0%

**Table-6.** Scoliosis and the relationship between shoulder imbalance

			Scoliosis		Total
			-	+	
Shoulder imbalance	-	Number	1648	2	1650
		% within SI	99,9%	,1%	100,0%
	Right	Number	258	346	604
		% within SI	42,7%	57,3%	100,0%
	Left	Number	95	101	196
		% within SI	48,5%	51,5%	100,0%
	Total	Number	2001	449	2450
		% within SI	81,7%	18,3%	100,0%

**Table-7.** Average of body, arm, right and left leg lengths and BMI of the screening students.

	Scoliosis		N	Mean
Body Length	dimension1	-	7477	97,1736
		+	451	97,8914
Arm length	dimension1	-	7473	153,2834
		+	451	152,6475
Right Leg Length	dimension1	-	7474	95,7410
		+	450	95,6689
Left Leg Length	dimension1	-	7475	95,6800
		+	451	95,8647
BMI	dimension1	-	7470	20,2437
		+	451	20,0809

**DISCUSSION:**

The incidence rate of AIS was reported to vary between 1 to 13 %<sup>3,6</sup>. An incidence rate of 0.5 to 3 % is usually reported for the population of school students. The prevalence rates of scoliosis at school screening vary from country to country (Table-8).

The mean prevalence rate in Singapoure at school screening was found to be 0,59 %<sup>31</sup> while it was reported to be 1,47 % in Taipei (Taiwan)<sup>15</sup>. On the other hand, the study on the prevalence of scoliosis in Helsinki (Finland) revealed a

very high prevalence rate, which was found to be 12,0 %<sup>23</sup>. Similarly, the prevalence rate was reported to be 6,40 % in Dublin (Ireland)<sup>9-10</sup>, 2,03 % in Wisconsin (USA)<sup>11</sup>, 3,21 % in Malmo (Sweden)<sup>30</sup>, and 2,20 % in Montreal (Canada)<sup>25</sup>.

It is underlined that the high prevalence of AIS at northern latitudes beyond 30 degrees might be associated with delayed menarche<sup>12</sup>. Our screening led to a scoliosis incidence rate of 1,5. The prevalence of scoliosis greater than 10 degrees was found to be 0,65 %. There are also other studies conducted in our country in which scoliosis screening has been performed (Table-9)<sup>1,8,16,27,32</sup>.

**Table-8.** Scoliosis prevalence studies

Author	No of Cases	City and Country	Prevalence (%)	Age
Wong HK et al.	72,699	Singapoure	0,59	6-14
Huang SC et al.	33,596	Taipei (Taiwan)	1,47	10-12
Gore DR et al.	8,393	Wisconsin (USA)	2,03	5-10
Rogala EJ et al.	26,947	Montreal (Canada)	2,20	12-14
Willner S et al.	17,181	Malmo (Sweden)	3,21	7-16
Goldberg C et al.	604	Dublin (Ireland)	6,40	10-14
Nissinen M et al.	1,060	Helsinki (Finland)	12,0	10-14

**Table-9.** Scoliosis screening in Turkey

Author	Place	Year	Method	Number	Prevelans
Adak B et al.	Van	1998	Adams	11983	%0,61
Cilli K et al.	Sivas	2006-2007	Adams ,SP	3175	%0.47
Ugraş A et al.	İstanbul/Fatih	2008-2009	Adams	4259	%0,25
İbişoğlu Y.U. et al	İzmir/Bornova	2008-2009	Adams	8207	%0,48
Yılmaz H et al.	Çanakkale	2010-2011	Adams, SPS	2604	%0,31

Adams :The forward bending test SP: Spine palpation S: Scoliometer

In a study conducted by Cilli et al<sup>8</sup> 3175 students from 6-8th grades, selected by systematic sampling method from 11 primary schools, were applied Adam's forward bend test along with vertebral palpation and the prevalence was found as 0.47 %. In another school screening study in which Adam's test and vertebral palpation are used, conducted on 8207 students from 57 primary schools by İbişoğlu et al<sup>16</sup>. the prevalence was reported as 0.48 %. A third school screening program was carried out by Yılmaz H. et al. in Çanakkale Turkey by the use of scoliometer and posture analysis. Of 2604 school children between 7-14 years of age from 12 schools, they reported AIS prevalence as 0,31 %<sup>32</sup>. In a different study performed by applying Adam's test in Van, scoliosis prevalence was found as 0,61 % in 11983 students from 10 primary schools<sup>1</sup>.

Finally, in a study conducted in Istanbul region, 4259 children from six schools which were randomly selected out of 41 schools were screened by performing physical examination and forward bending test, the prevalence was reported as 0,25 %<sup>27</sup>. Cluster sampling method was used in these limited number of studies that were mainly conducted at local level. In the majority of these studies Adam's forward bend test was performed, whereas in only one study the scoliometer was used. In our study, we screened all 7th grade students at public and private primary schools.

The students in Kartal sub-province of Istanbul represent a diverse demographic structure; therefore, the prevalence in this group can reflect the overall situation of the entire country. Anthropometric measurements were also performed in addition to the Adam's forward bend test and scoliometer. This study conducted in 2007-2008 was the first and the most comprehensive scoliosis screening in Turkey that included all the schools in the sub-province.

The effectiveness of scoliosis screening programmes is still controversial. Some controversial issues include no symptoms observed in majority of the scoliotic cases detected by the screening, high rate of false positive results and measurement variations introduced by different factors<sup>24</sup> Improvement of

scoliosis screening programmes will be useful for reducing the amount of false positive results.

The Scoliosis Research Society, American Academy of Orthopaedic Surgeons, the Paediatric Orthopaedic Society of North America, and the American Academy of Paediatrics suggest scoliosis screening, whereas the Canadian Task Force on the Periodic Health examination, the British Orthopaedic Association, and the British Scoliosis Society do not suggest scoliosis screening<sup>24</sup>.

The optimum age range for the screening is also controversial 6 School screening programmes are usually run for ages of 10 to 14. Screening must be carried out for the girls during the early years of menstruation, while the boys must follow the girls with one or two years of delay. Adam's forward bending test is the most common and also an easy, fast and cheap method for scoliosis screening. The FBT (Forward bending test) requires the patient to bring both hands together and try to touch his feet by bending forward with straight knees. In the meantime, the observer stands behind the patient and checks for rip hump formation. If there is a rip hump test is positive (+)<sup>29</sup>.

The device called the scoliometer was developed to determine the degree of body rotation angle in FBT (+) patients. While the patient is bent forward for scoliometric measurement, the scoliometer is positioned to the apex of the curve and parallel to the ground plane for determining the body rotation angle<sup>5</sup>.

The most common method employed in scoliosis screening is the Adam's forward bend test. Although it is a rapid and easy-to-use method, there are debates about its sensitivity and specificity. It was reported in a school screening for scoliosis in Singapore that the Adam's forward bend test might result in 25 % to 82 % of false positivity depending on the screening method and criteria<sup>31</sup>. Goldberg et al<sup>9-10</sup>. argued that this test was very sensitive and its specificity was 0.99 , while Grosman et al<sup>13</sup> stated that the sensitivity varied between the researchers. However, Howell et al<sup>14</sup> reported that the margin of error was 26 % when the nurses performed the screening while it was found to be 13 % when it was performed



by physiotherapists. In another study, 181 patients were referred to the radiology department following the screening performed by an orthopedist experienced in scoliosis, and only 4 of these patients had false positive test results; whereas this rate was reported to be much higher when the school doctor performed the screening<sup>19</sup>. The specificity of the Adam's test was reported to rise from 56 % to % 86 when combined with the scoliometric measurements<sup>4</sup>. It was aimed to minimize the margin of error in our study through the performance of the Adam's forward bend test and the scoliometry by the physicians.

Advanced techniques of measurement help determining the risk of curve progression in immature children. Maturity is radiologically determined by the Risser sign in Adoper's study based on the plain radiograph of the left hand and wrist. The sensitivity and specificity of the screening method for scoliosis detection depend on the person administering the method and degree of the curve. In scoliometric measurements sensitivity applies to cases with a Cobb angle > 20°<sup>29</sup>. The sensitivity of scoliometric measurements for detecting a curve of 5° is 100 %, while specificity is 47 %<sup>28</sup>. Detection of the curve based on visual and forward bending test depends on the degree of the curve<sup>7</sup>.

A scoliometric measurement of 7° leads to 3 % referral, while the referral rate goes up to 12 % if 5° is measured<sup>5</sup>. Studies reported that referral rate based on scoliosis screening should be around 2 to 3 %<sup>5,24</sup>. Adopar's study reported a referral rate of 1.5% for measurements conducted on 12-year-olds<sup>2</sup>.

There are some studies indicating that body and shoulder imbalance, and differences in arm and leg lengths can also accompany scoliosis<sup>22</sup>. However, measurements made in our study did not reveal any statistically significant body and shoulder imbalance or differences in arm and leg lengths.

The cost of scoliosis screening is yet another controversy. Various ideas have been suggested on the cost of scoliosis screening and the results obtained<sup>20</sup> However, the total cost of scoliosis screening for 7928 junior high school students was not more than 5.000 YTL (\$2300). Thus, detection of even one mature case with adolescent idiopathic scoliosis with possible curve progression will cost a lot less than any prospective surgery.

This study will shed light on the future studies, since it is the first comprehensive scoliosis screening conducted in the Republic of Turkey to cover all schools in the selected district. Screening has been useful for the early treatment of scoliotic patients. Early diagnosis and treatment will contribute to the medical, social and economic improvement of scoliotic patients.

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