

# Epidemiological Investigation among Middle School Students in Haicheng City, Liaoning Province

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**Objective** To investigate the incidence and characteristics of scoliosis among middle school students and adolescents in Haicheng City, Liaoning Province, to enrich the epidemiological data of the disease in our city and provide theoretical basis for clinical prevention and treatment. **Methods** From October 10, 2019 to December 12, 2019, under the organization of the Haicheng Education Bureau of Liaoning Province, students from 37 schools in the city's junior and senior high schools were screened, and all the subjects were tested in turn. Screening methods, namely the first inspection visual method, Adam bending test, second inspection scoliosis measurement rulers, third inspection standing position spine full length anterolateral X-ray examination, X-ray examination found that Cobb's angle  $\geq 10^\circ$  The patient was diagnosed with scoliosis. Results the number of students screened in this screening were 29,314, and the number of confirmed cases was 289 (0.99%). Among the confirmed numbers were 115 males (39.79%) and 174 females (60.21%). The prevalence of females was higher than that of males ( $X^2=27.789$ ).  $P=0.0000$ . Among the confirmed cases, 245 cases had Cobb's angle  $\leq 19^\circ$ , 28 cases had Cobb's angle  $20^\circ-29^\circ$ , 10 cases had Cobb's angle  $30^\circ - 39^\circ$ , and 6 cases had Cobb's angle  $\geq 40^\circ$ . **Conclusion** The incidence of scoliosis among middle school students in Haicheng City, Liaoning Province is higher in the junior high school group than in the high school group. The incidence of female students is higher than that of male students, which should be taken seriously.

**Keywords:** Scoliosis Cell, Prevalence, Epidemiology, Cross-sectional Study  
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Scoliosis is a complex three-dimensional deformity in which one or several segments of the spine deviate from the midline on the coronal plane, accompanied by horizontal vertebral rotation and a decrease or increase in the physiological lordosis or kyphosis angle on the sagittal plane<sup>1</sup>. During adolescence, due to the faster physical development of adolescents, scoliosis, if early intervention measures are not implemented, will lead to lung diseases caused by thoracic deformities<sup>2-4</sup> and severe psychological disorders<sup>5-7</sup>, it can also cause long-term waist pain, which greatly reduces the quality of life<sup>5,8</sup>.

In 1958, an Italian scholar first advocated the application of imaging methods to screen school-age adolescents for scoliosis<sup>9</sup>. In the 1960s,

Hensinger et al.<sup>10</sup> first carried out school screening for scoliosis in Delaware, USA, and then expanded it to other areas. At the same time, many foreign scholars suggested to conduct intra-school scoliosis screening<sup>10,11</sup>, which gradually attracted people's attention to this disease. As of 2003, 21 states in the United States passed legislation requiring intra-school scoliosis screening, and publish the implementation standards. There are many policies and regulations related to scoliosis screening in schools in Europe, and the recommendations for scoliosis screening in schools in most countries are independently selected by different teaching units<sup>12,13</sup>. Canada and Australia were gradually terminated after a period of time due to cost and other reasons. Singapore and some parts of Japan

have passed legislation to include scoliosis screening in schools as part of the national health screening<sup>14</sup>.

The screening of scoliosis in schools in China began in 1980 and is only included in a sub-item of routine physical examination. In 1990, the “School Health Regulations” approved and issued by the State Council required schools to deal with common diseases such as spine curvature. Group prevention and correction work. However, due to the limited attention paid to the disease, the lack of relevant systematic training of the inspectors, and the lack of an accurate evaluation system, the positive rate of screening results is very low. Around 2000, many schools discontinued in-school screening for adolescent scoliosis<sup>15</sup>. In recent years, with the increase in learning intensity and lack of exercise in junior and senior high school groups, the incidence of adolescent scoliosis has increased significantly. It has become the third most common disease after obesity and myopia. The prevention and control situation are extremely severe. Many domestic scholars have realized that epidemiological investigations are of great significance to the prevention and treatment of adolescent scoliosis<sup>16</sup>. Among the relevant Chinese and English literatures available, Beijing (Tongzhou District), Tianjin, Shanghai (Jing'an District, Chongming Island), Xi'an, Xining, Wuxi, Wenzhou and other cities have all carried out large-scale data collection, and proposed prevention and treatment plans. In the National Two Sessions held in 2020, the Central Committee of the Peasants and Workers Party submitted a proposal for the prevention and control of scoliosis in children and adolescents as soon as possible. It is recommended that the government include adolescent scoliosis screening in the national routine physical examination and screening program for primary and secondary school students. The awareness of scoliosis rose to a new level.

From October 10, 2019 to December 12, 2019, the Haicheng City Education Bureau of Liaoning Province sent some medical staff to conduct a comprehensive physical examination of the city's junior and senior middle school students. Our hospital is responsible for the comprehensive screening of the juvenile scoliosis project and for data statistics, the current statistics report is as follows:

## MATERIALS AND METHODS

**General information** A total of 29,314 students were enrolled in 37 schools in Haicheng City, Liaoning Province, including 20,494 junior high school students, 11490 boys, 9004 girls, 8820 high school students, 4751 boys and 4069 girls. The inspector consists of a five-person team consisting of 3 medical staff and 2 data statisticians. In order to improve the pass rate of the inspection, the staff in the group have undergone professional training such as physical examination, measurement, recording, and statistics.

**Inspection method** Use the three-inspection screening method of scoliosis, namely, the first-inspection visual method and Adam bending test, the second-inspection scoliosis measurement instrument, and the third-inspection standing position spine full length positive and lateral X-ray.

**First check screening:** visual checkup and Adam forward bending check. Students are required to maintain a normal standing state, with feet apart, shoulder width apart, looking forward, with arms drooping. Observe and record the state of the students. If the width of the shoulders of the examinee is the same, the subscapular angle remains at the same level, the lumbar recesses on both sides are symmetrical, the height of the biiliac crest is the same, and the spinous process line does not deviate from the central axis., Indicating that the student's spine is in good condition, without any scoliosis, the student's spine is facing the light source, the whole body is relaxed, and the subject's waist is bent forward. Observe whether the height of both sides of the back are equal at this time. Any of these indicators is abnormal That is to say, the spine is abnormal and the record is positive. And register the general information and contact information of students with positive results in a database.

**Screening of the second examination:** measurement of scoliosis with a measuring ruler, determination of the inclination angle of the back, and a group of students who have a positive screening result of the first examination will be organized to our hospital at the weekend, and the medical staff in the group will determine their height, weight, with data such as sitting height and arm span length, students are instructed to remove their tops completely. The Adam flexion examination was performed again and the maximum inclination angle of the back of the student was measured with a scoliosis measuring

rule. If the inclination angle of the back is  $\geq 5^\circ$ , the record is positive. Record the general information and data of all students with positive secondary tests in the form of a database.

Screening of the third inspection: X-ray inspection, call parents to collect the students with positive results of the second inspection to the imaging department of our hospital, and take X-rays of the anterolateral and lateral views of the whole spine according to the results of the X-ray inspection. Cobb's angle measurement method was used to measure the angle of scoliosis. Students with a Cobb's angle  $\geq 10^\circ$  are positive and are diagnosed with scoliosis, and they will be guided and treated by our spinal doctors. Establish a detailed health file database for the students who are positive in the three tests, and follow up.

Statistical method: Divide the confirmed person's school level into 2 groups (junior high school group and high school group), use Spass23.0 statistical software to analyze, count data is expressed in frequency, and perform X2 test on the data respectively, all hypothesis tests are It is considered to be significant at  $p < 0.05$ .

**RESULT**

Basic situation the number of students screened this time was 29,314. The prevalence statistics by age group are shown in Table 1. Among the subjects examined were 16,241 males, 13073 females, 814 (2.78%) were positive for the first test, 597 came to the hospital for the second test, and 487 (1.67%) were positive for the second test. All those who were positive for the second test received imaging examinations for the third test. 289 cases

were finally diagnosed, and the positive detection rate was 0.99%. The difference was statistically significant ( $P < 0.05$ ) in the incidence of different age groups. After three inspections, no thoracic deformities were found.

The prevalence of middle school students in Haicheng City, Liaoning Province, by age and gender is shown in Table 2. Among the 289 confirmed cases, 115 were boys (39.79% of the confirmed number) and 174 cases were girls (60.21% of the confirmed number). It is significant ( $P < 0.05$ ).

The prevalence of scoliosis among middle school students in Haicheng City, Liaoning Province, in the junior high school group and high school group is shown in Table 3. There were 219 cases (75.78%) in the junior high school group and 70 cases (24.22%) in the high school group, respectively. The number of confirmed cases in the junior high school group More than the high school group, the difference was statistically significant ( $P < 0.05$ ).

Middle school students in Haicheng City, Liaoning Province, according to different age groups and different scoliosis Cobb's angle

The distribution is shown in Table 4. Among the confirmed cases, 245 cases (84.78%) with Cobb's angle  $\leq 19^\circ$ , 28 cases (9.69%) with Cobb's angle  $20^\circ - 29^\circ$ , and 10 cases (3.46%) with Cobb's angle  $30^\circ - 39^\circ$ , 6 cases (2.08%) with Cobb's angle  $\geq 40^\circ$ .

Middle school students in Haicheng City, Liaoning Province, according to the Cobb's angle of junior high school, high school and scoliosis

The distribution is shown in Table 5.

**Table 1.**  
**The prevalence of scoliosis screening for middle school students (junior and senior high schools) in Haicheng City, Liaoning Province by age and number**

Age	Screened number	Number of patients	Constituent ratio (%)	Prevalence rate (%)
13	6741	80	27.68	1.19
14	7356	44	15.23	0.60
15	6397	95	32.87	1.49
16	3215	35	12.11	1.09
17	2958	24	8.30	0.81
18	2647	11	3.81	0.42
total	29314	289	100	0.99

**Table 2.**  
**Comparison of prevalence of middle school students by age and sex in Haicheng City, Liaoning Province**

Age	Male			Female		
	InspectedNumber of people	Number of patients	Prevalence rate(%)	InspectedNumber of people	Number of patients	Prevalencerate(%)

13	3928	38	0.97	2813	42	1.49
14	3621	19	0.52	3735	25	0.67
15	3132	31	0.99	3265	64	1.96
16	1503	14	0.93	1712	21	1.23
17	1502	9	0.60	1456	15	1.03
18	1391	4	0.29	1256	7	0.56
<b>total</b>	15077	115	0.76	14237	174	1.22

**Table 3.**  
The prevalence of scoliosis among middle school students in Haicheng City, Liaoning Province

Group	Age	Inspected Number of people	Number of patients	Prevalence rate(%)
Junior highschool	13 - 15	20494	219	1.07
High school	16 - 18	8820	70	0.79%
<b>total</b>		29314	289	0.99

**Table 4.**  
Distribution of Cobb's angle of scoliosis among middle school students in Haicheng City, Liaoning Province according to different age groups

Age	10° - 19°	20° - 29°	30° - 39°	≥40°	Total
13	64	13	2	1	80
14	39	2	1	2	44
15	85	6	3	1	95
16	34	0	1	0	35
17	16	5	2	1	24
18	7	2	1	1	11
<b>Total</b>	245	28	10	6	289

**Table 5.**  
Distribution of Middle School Students in Haicheng City, Liaoning Province by Cobb's Angle of Junior High School, High School and Scoliosis

Group	10° - 19°	20° - 29°	30° - 39°	≥40°	total
Junior high school	188	21	6	4	219
High school	57	7	4	2	70
<b>total</b>	245	28	10	6	289

## DISCUSSION

Adolescence is a period of rapid growth of body bones. During this period, bone construction and bone turnover are faster, and bone mass increases steadily<sup>17</sup>. Studies have shown that the accumulated bone mass during adolescence accounts for 40% to 60% of adulthood. By the end of about 18 years old, 90% of the peak bone mass can be accumulated and completed<sup>18</sup>. In addition, the growth and development of bones is significantly related to gender. During the period of 9 to 13 years, the bone growth and development of girls is faster than that of boys, reaching a linear peak at about 12 years old, while the linear peak of boys is about 15 years old, but compared with that of girls. Thicker, higher peak bone mass, longer growth period, and faster growth rate<sup>19</sup>. In view of the above, the bones are in the rapid growth stage during the middle school students, which is also the stage of scoliosis, which requires orthopedics or pediatricians to be more vigilant against this disease<sup>20,21</sup>. A retrospective cohort study found that the

sensitivity of school screening is high, the referral rate is low, and early detection is not surgical treatment<sup>22</sup>. Missing early prevention and intervention measures will lead to the appearance of spine side with age. Convex symptoms have become more obvious<sup>6</sup>.

Up to now, the main methods of screening for scoliosis worldwide include Adam bending test, Moire local measurement method, measuring rule inspection method, rib carina measurement method, Moire image method, laser scanner, laser three-dimensional reconstruction Method, Scoliometer for iPhone's smartphone, etc.<sup>23-25</sup>. This study takes into account the large number of inspected persons and the protection of students' privacy. Students are in the examination room during the first screening. Wear thin clothes. During the second inspection, the measuring ruler will record the Cobb's angle  $\geq 5^\circ$  as positive, so as to prevent missed diagnosis when entering the third inspection.

This study found that the incidence of scoliosis among middle school students (13-18 years old) in Haicheng City, Liaoning Province was 0.99%, and

the reported prevalence in other parts of mainland China ranged from 0.11 to 2.52%<sup>14,26</sup>, and the results were basically Consistent. The incidence rates reported in other countries are as follows: Australia (3.1%)<sup>27</sup>, Greece (1.7%)<sup>28</sup>, Saudi Arabia (0.78%)<sup>29</sup>, Minnesota in the United States (1.2%)<sup>30</sup>, Brazil ( 1.4–2.2%)<sup>31</sup>, Nigeria (1.2%)<sup>32</sup>. Singapore (0.38 to 1.2%)<sup>33</sup>, Japan (0.87%)<sup>34</sup>, Iran (1.4%). The above reports except for the screening criteria used in Australia which is Cobb's angle $>5^{\circ}$ , the other criteria are Cobb's angle $>10^{\circ}$ .

This study shows that the incidence of scoliosis among middle school students and adolescents in Haicheng City, Liaoning Province is significantly correlated with gender. The incidence of girls is significantly higher than that of boys ( $X^2=27.789$ ,  $P=0.0000$ ). The ratio of the number of men and women diagnosed in this study is about 1: 1.51, which is basically similar to the 2016 study in Shanghai, China (1:1.5) and Shanxi Province, China (1:1.2)<sup>14,35</sup>, compared with other studies (Singapore 1:4.6, Greece 1:2.1, Japan 1:11.6)<sup>28,36,37,38</sup>, the male prevalence rate is higher.

Among the 245 cases of adolescent scoliosis diagnosed by middle school students in Haicheng City, Liaoning Province, the number of Cobb's angles between  $10^{\circ}$  -  $19^{\circ}$  was 245, accounting for 84.78% of the confirmed cases. This finding is similar to Japan<sup>34</sup> and South Korea.<sup>37</sup> The report is basically the same.

In this study, the first inspection was carried out in schools, and the second and third inspections were completed in the hospital. The number of patients who finally received the third inspection imaging examination was 487, accounting for 1.66% of the total number (487 of 29314). Other countries reported accepting imaging The percentage of the number of students in the total number of screening is about 0.9-9.6%<sup>30,35-37</sup>, which is a relatively low proportion within the normal range, which also shows that the screening personnel are very serious about the disease. The consequences of the publicity were not strong enough, which led to some parents' lack of understanding of the district adolescents with scoliosis, and did not realize the serious consequences of this disease to middle school students. In addition, in this study, 59.82% of the people who were positive for the first test came to the hospital for the second test (487 out of 814). After telephone communication with their parents,

there were still 217 cases of people who were positive for the first test but did not go to the hospital for the next screening. The error in the final result is large.

## CONCLUSION

Current research shows that the prevalence of scoliosis among middle school students in Haicheng City, Liaoning Province is 0.99%. We found that the prevalence of scoliosis among middle school students in this region is 0.76% for males and 1.22% for females, which is significantly correlated with gender. The number of people who participated in the second inspection was 217 fewer than that of the first inspection, indicating that the parents of the students have less knowledge about the disease. The incidence of scoliosis in the junior high school group is higher than that in the high school group, and the incidence of junior high school girls is higher than that of boys. This indicates that adolescent scoliosis should be prevented as early as possible, especially for girls, to avoid missing the best treatment period. In addition, this finding It also helps local education departments and health departments to formulate targeted policies and early intervention measures.

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