ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

Epidemiological Characteristics of Adolescent Scoliosis in Southern Shanxi Region, 2024

Wen Ji[1], Liu Hualv[1], Gao Yuhao[1], Qin Shilei[1], Han Pengfei[2], Xu Yunfeng[1,*]

[1]*Changzhi Spine Disease Research Institute, Changzhi, Shanxi, 046000, China*
[2]*Heping Hospital Affiliated to Changzhi Medical College, Changzhi, Shanxi, 046000, China*
**Corresponding Author*

Abstract: *This study seeks to understand the epidemiological characteristics, including incidence, severity, high-risk age, and gender distribution, of adolescent scoliosis in Southern Shanxi, thus providing data support and a foundation for adolescent health initiatives. In 2024, the Southern Shanxi region, primarily 45 elementary and secondary schools in the municipal district and Luzhou district of Changzhi City, along with pilot classes from one special school, were selected as the target population for this project to conduct a scoliosis monitoring campaign. Using pilot classes as units, entire classes were randomly selected from each grade as survey subjects, totaling 26,824 students. Scoliosis screening and related factor questionnaire surveys were conducted. Data analysis was performed using SPSS 24.0 statistical software. Count data were expressed as numbers and rates, and comparisons were made using the chi-square test or Fisher's exact test. A P-value < 0.05 was considered statistically significant. Analysis of the prevalence characteristics of spinal curvature abnormalities: In terms of educational stage trend, the overall prevalence showed an inverted V-shaped distribution: junior high school (peak) > high school > elementary school (P < 0.05). The junior high school group was the peak for all types of scoliosis: Grade I scoliosis: junior high school (4.10%) > high school (3.39%) > elementary school (3.53%) (P < 0.05); Grade II scoliosis: junior high school (0.78%) was significantly higher than other stages (P < 0.05); Grade III scoliosis: increased with age, high school group (0.21%) > junior high school (0.11%) > elementary school (0.03%) (P < 0.05), all differences were statistically significant. In terms of gender differences, there was no overall gender difference (4.53% vs. 4.53%, P=0.981), which was not statistically significant. By educational stage: elementary school (female 3.96% vs. male 3.94%), junior high school (female 5.33% vs. male 4.67%), high school (male 4.41% vs. female 3.85%), the differences were not statistically significant. In terms of severe case evolution, the incidence of Grade III scoliosis showed a significant age-accumulation effect, with the high school group accounting for 50% (15/30 cases) of total severe cases, suggesting that advanced stages require strengthened management of late-stage cases. The detection rate of scoliosis among elementary and secondary school students in the Southern Shanxi region is relatively high, with junior high school students being the key focus group.*

Keywords: *Children; Adolescents; Scoliosis; Epidemiological characteristics*

1. Introduction

Influencing factors Adolescent scoliosis has become an increasingly serious public health problem. Internationally, the incidence of adolescent scoliosis in North America and Europe generally ranges between 2% and 4%. [1] [2]Although there is no unified national incidence data for Chinese mainland, the incidence in Hong Kong, China, is as high as 3% to 4%, and Singapore has reported similar trends after 15 years of school screening [3], suggesting that Adolescent Idiopathic Scoliosis (AIS) may have a relatively high baseline incidence in East Asian populations. The "Clinical *P*ractice Guideline for TCM Rehabilitation · Adolescent Idiopathic Scoliosis in Children and Adolescents" issued in 2023 explicitly recommends "carrying out regular and professional scoliosis screening" and emphasizes the importance of early referral and correction, reflecting China's increasing attention to the public health burden of AIS. [4]Studies show significant gender differences in scoliosis, with the incidence significantly higher in females than males, reaching ratios of 1:9 or even 1:10 in some areas, and the curvature is more likely to worsen in females. [5] In terms of age of onset, the peak period for disease progression is during puberty (ages 10-12 for girls, 124 for boys). [6] [7]

Given that scoliosis has an insidious onset with no obvious symptoms initially, it is easily overlooked. However, without timely intervention, the curvature can gradually increase, severely affecting the normal

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

physical development of adolescents, such as causing thoracic deformation and impacting cardiopulmonary function, and can also negatively affect their mental health, leading to issues like low self-esteem. [8]Therefore, this study focuses on adolescent scoliosis in the Southern Shanxi region, aiming to gain an in-depth understanding of the incidence, severity, high-risk age, gender distribution, and other information, thereby providing data support and guarantees for the prevention and treatment of adolescent scoliosis in this region, and offering a sample and typical case for scoliosis prevention and treatment in other parts of China and the world. [9]

2. Objects and Methods

2.1 Objects

In 2024, the Southern Shanxi region, primarily 45 elementary and secondary schools in the municipal district and Luzhou district of Changzhi City, along with pilot classes from one special school, were selected as the service objects for this project to conduct a scoliosis monitoring campaign. This included 10 elementary schools, 19 junior high schools, 16 high schools, and one special school as monitoring points. Using pilot classes as units, entire classes were randomly selected from each grade as survey subjects [10], totaling 26,824 students, including 9,655 elementary students, 9,585 junior high students, 7,277 high school students, and 307 special school students. The physical examination items involved in this study are routine projects required by the state [11], launched through a joint document issued by the General Office of the Changzhi Municipal Committee of the C*P*C and the General Office of the Changzhi Municipal *P*eople's Government [12]. Changzhi Medical College commissioned Changzhi Yunfeng Hospital to implement the project specifically. The scoliosis screening plan and questionnaire survey obtained informed consent from students, parents, and schools [13].

2.2 Methods

Based on "GB/T 16133-2014 Screening for Spinal Curvature Abnormalities in Children and Adolescents" and the "2023 National Technical Manual for Monitoring and Intervention of Common Diseases and Health Influencing Factors Among Students" (hereinafter referred to as the "Manual") [2], the following were organized and carried out:*P*hysical Examination: Items included height, weight, extracurricular activity time, etc., to understand the health and physical development of the pilot subjects. Evaluation Examination: Using instruments such as human morphology charts and spinal X-rays, on-site professional assessments including frontal view, lateral view, dorsal view, spinal screening, and flexibility were conducted for all students in each class. The result "no scoliosis" was considered as the absence of scoliosis. "Grade I scoliosis (Cobb angle 10°-24°), Grade II scoliosis (Cobb angle 25°-39°), Grade III scoliosis (Cobb angle ≥40°)" were considered as scoliosis. [14]

2.3 Quality Control

An expert working group was organized to conduct evidence-based medical on the screening plan, and reliability and validity tests of the standardized questionnaire were completed. A project team consisting of spine surgery/orthopedic specialists (≥2) and public health professionals was formed, and specialized training including modules on physical measurement standards, equipment calibration methods, and data entry standards was conducted. Initial and re-screening were independently completed by physicians or nurses with orthopedic qualifications, using the electronic spinal measuring instruments and posture assessment tools specified in the "Manual". Daily, 5% of the examined subjects were randomly selected for immediate re-testing. Measurement consistency was verified using Bland-Altman analysis, ensuring an intra-group correlation coefficient >0.95 (error threshold <5%). An electronic data capture (EDC) system was used to simultaneously record key parameters such as Cobb angle and axial trunk rotation (ATR) angle, which were uploaded to the Yunfeng Hospital Student Health Monitoring *P*latform after double verification [10]. After the project, the physical examination and evaluation results were compiled and analyzed.

2.4 Statistical Methods

Data analysis was performed using S*P*SS 24.0 statistical software. Count data were expressed as numbers and rates, and comparisons were made using the chi-square test or Fisher's exact test. A *P*-value < 0.05 was considered statistically significant.

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

3. Results

3.1 Basic Information

This screening covered 26,824 students. The detection rate of spinal curvature abnormalities was 4.53% (1,213 cases), significantly higher than the regional average. Breakdown by type showed: Grade I accounted for 3.84% (1,029 cases), Grade II 0.57% (154 cases), and Grade III 0.11% (30 cases). In the gender comparison, the total prevalence rate was 4.53% for both males (13,573 individuals) and females (13,215 individuals), but there were differences by type: the prevalence of Grade I was higher in males (3.92% vs. 3.76%), while the proportions of Grade II (0.62% vs. 0.53%) and Grade III (0.14% vs. 0.08%) were more prominent in females. (Table 1)

Table 1 Demographic Analysis of Scoliosis Screening in Elementary and Secondary School Students

Survey Content	Negative (n=25611)	*P*ositive (n=1213)	X^2 Value	*P* Value
Gender [n(%)]			0.001	0.981
Male	12958 (95.47)	615 (4.53)		
Female	12617 (95.47)	598 (4.53)		
Total	**25611 (95.48)**	**1213 (4.52)**		

3.2 General Overview

This screening covered the elementary school group (9,655 individuals), junior high school group (9,585 individuals), high school group (7,277 individuals), and the special school group (307 individuals). The total detection rate showed significant stage-specific characteristics. The junior high school group had the highest total prevalence rate at 5.00%, followed by the high school group at 4.12%, and the elementary school group at 3.94%.

3.3 Analysis by Educational Stage

3.3.1 Elementary School Group (3.94%)

Gender difference: The prevalence rate was slightly higher in girls (3.96%) than in boys (3.94%).

Characteristics by type: Grade I accounted for the highest proportion (3.53%), while Grade III was only 0.03%.

Gender breakdown by type: Girls had higher proportions in Grade I (3.61% vs. 3.48%) and Grade III (0.04% vs. 0.02%), while Grade II was more prominent in boys (0.44% vs. 0.30%). (Table 2)

Table 2 Demographic Analysis of Scoliosis Screening in Elementary School Students [n(%)]

Survey Content	**Negative (n=9275)**	***P*ositive (n=380)**	**X^2 Value**	***P* Value**
Gender [n(%)]			0.002	0.968
Male	4775 (96.06)	196 (3.94)		
Female	4464 (96.04)	184 (3.96)		
Total	**9275 (96.06)**	**380 (3.94)**		

3.3.2 Junior High School Group (5.00%)

Gender difference: The prevalence rate was higher in girls (5.33%) than in boys (4.67%).

Characteristics by type: The detection rate of Grade II (0.78%) was the highest among all stages.

Gender breakdown by type: The proportion of Grade I was higher in boys (4.11% vs. 4.09%), but Grade II (1.05% vs. 0.52%) and Grade III (0.19% vs. 0.04%) were significantly more prominent in girls. (Table 3)

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

Table 3 Demographic Analysis of Scoliosis Screening in Junior High School Students [n(%)]

Survey Content **Gender [n(%)]**	**Negative (n=9106)**	***P*ositive (n=479)**	**X^2 Value** 2.229	***P* Value** 0.153
Male	4615 (95.33)	226 (4.67)		
Female	4491 (94.67)	253 (5.33)		
Total	**9106 (95.00)**	**479 (5.00)**		

3.3.3 High School Group (4.12%)

Gender difference reversal: The prevalence rate was higher in boys (4.41%) than in girls (3.85%).

Characteristics by type: The detection rate of Grade III (0.21%) reached the peak for the stages.

Gender breakdown by type: Boys had advantages in Grade I (3.65% vs. 3.15%) and Grade II (0.56% vs. 0.48%), while Grade III was slightly higher in girls (0.22% vs. 0.19%). (Table 4)

Table 4 Demographic Analysis of Scoliosis Screening in High School Students [n(%)]

Survey Content **Gender [n(%)]**	**Negative (n=6977)**	***P*ositive (n=300)**	**X^2 Value** 1.481	***P* Value** 0.224
Male	3401 (95.59)	157 (4.41)		
Female	3576 (96.15)	143 (3.85)		
Total	**6977 (95.88)**	**300 (4.12)**		

3.4 Statistical Result Analysis

3.4.1 Spinal Curvature Abnormalities in Adolescents in Southern Shanxi

The special school group, due to the specific nature of its sample (307 individuals), had a detection rate of 17.59% (Table 5), but due to potential systematic errors, it was not compared with the other three groups.

The prevalence of spinal curvature abnormalities increased significantly with age, with the junior high school group having the highest prevalence. The prevalence in the elementary school group was < high school group (X^2 =14.448, P<0.05), the difference was statistically significant, indicating that the prevalence of spinal curvature abnormalities in males peaks during junior high school; for males, the prevalence was highest in junior high school, elementary school prevalence < high school prevalence (X^2 =3.195, P>0.05), the difference was not statistically significant; for females, the prevalence was highest in junior high school, and the elementary school prevalence was significantly lower than the high school prevalence (X^2 =14.448, P<0.05), indicating that the prevalence of spinal curvature abnormalities in females peaks during junior high school. (In this statistical analysis, due to special reasons, the special school group had large systematic errors and was not included in the comparative analysis.) (Table 6)

Table 5 Demographic Analysis of Scoliosis Screening in Special School Students [n(%)]

Survey Content **Gender [n(%)]**	**Negative (n=253)**	***P*ositive (n=54)**	**X^2 Value**	***P* Value**
Male	167 (82.27)	36 (17.73)		
Female	86 (82.69)	18 (17.31)		
Total	**253 (82.41)**	**54 (17.59)**		

Table 6 Comparison of Scoliosis Screening Results among Students with Different Demographic Characteristics [n(%)]

Academic Stage	**Number of Cases**	**Male (n=1166)**		**Female (n=1203)**		**Total (n=2369)**	
		Negative	*P*ositive	Negative	*P*ositive	Negative	*P*ositive
Elementary School	9655	4775 (96.06)	196 (3.94)	4464 (96.04)	184 (3.96)	9275 (96.06)	380 (3.94)
Junior High School	9585	4615 (95.33)	226 (4.67)	4491 (94.67)	253 (5.33)	9106 (95.00)	479 (5.00)

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

High School	7277	3401 (95.59)	157 (4.41)	3576 (96.15)	143 (3.85)	6977 (95.88)	300 (4.12)
***X^2* value**			3.195		14.600		14.448
***P* value**			0.202		<0.001		<0.001

3.4.2 Comparison of Spinal Curvature Abnormalities by Gender

In this examination, there was no significant difference in the overall prevalence rate between males and females (X^2 =0.001, P=0.981>0.05) (Table 1), the difference was not statistically significant; in the elementary school group, the prevalence rate in boys was less than that in girls (X^2 =0.002, P=0.968>0.05) (Table 2), the difference was not statistically significant; in the junior high school group, the prevalence rate in girls was higher than that in boys (X^2 =2.229, P=0.153>0.05) (Table 3), the difference was not statistically significant; in the high school group, the prevalence rate in boys was higher than that in girls (X^2 =1.481, P=0.224>0.05) (Table 4), the difference was not statistically significant. (In this statistical analysis, due to special reasons, the special school group had large systematic errors and was not included in the comparative analysis.)

3.4.3 Comparison of Spinal Curvature Abnormalities by Severity

In this examination, the prevalence of Grade I scoliosis was highest in the junior high school group, and the prevalence in the elementary school group was less than that in the high school group (X^2 =6.163, P<0.05), the difference was statistically significant, indicating that the prevalence of Grade I scoliosis peaks during junior high school; the prevalence of Grade II scoliosis was highest in the junior high school group, and the prevalence in the elementary school group was less than that in the high school group (X^2 =14.258, P<0.05), the difference was statistically significant, indicating that the prevalence of Grade II scoliosis peaks during junior high school; with increasing age, the incidence of Grade III scoliosis increased significantly, high school group incidence > junior high school incidence > elementary school incidence (X^2 =11.714, P<0.05), the difference was statistically significant. (Table 7)

Table 7 Distribution of Scoliosis Types by Degree among Positive Students in Different Academic Stages [n(%)]

Scoliosis Degree / Group	**Elementary School Group**	**Junior High School Group**	**High School Group**	***X^2* Value**	***P* Value**
No Scoliosis	9275 (96.06)	9106 (95.00)	6977 (95.88)		
Grade I Scoliosis	341 (3.53)	393 (4.10)	247 (3.39)	6.163	0.046
Grade II Scoliosis	36 (0.37)	75 (0.78)	38 (0.52)	14.258	<0.001
Grade III Scoliosis	3 (0.03)	11 (0.11)	15 (0.21)	11.714	0.003
Total	**9655 (100)**	**9585 (100)**	**7277 (100)**		

4. Results and Discussion

As one of the three major health threats to children and adolescents, the prevention and treatment of scoliosis requires widespread social attention. With the promotion of China's spinal health screening system [15], the 2024 screening data of 26,824 elementary and secondary school students in the Southern Shanxi region shows: the overall positive rate was 4.53%, showing a stage-specific distribution (elementary school 3.94%, junior high school 5.00%, high school 4.12%). The positive rate in the special education population was as high as 17.59%. This rate is higher than that reported in Guangdong *P*rovince (3.73%) [16] and Beijing's Tongzhou District (0.24%) [17], but lower than that in Qinghai *P*rovince (5.63%) [18], Jiaxing City, Zhejiang *P*rovince (9.02%) [19], and Shijiazhuang City, Hebei *P*rovince (5.47%) [20], suggesting that regional factors such as geographical latitude and nutritional structure may influence the epidemiological characteristics of the disease [21].

Gender difference analysis showed that in the basic education stage (elementary school, junior high school), the positive rate was higher in females than males, consistent with global multi-center research conclusions. Aulisa et al. [22] revealed through genetic research the "Carter effect" mechanism – males require the accumulation of more susceptibility genes to develop the disease (male-to-female ratio 1:3.3). At the same time, the skeletal development disadvantage caused by lower sports participation among females is also an important contributing factor [22]. Furthermore, girls generally have lower enthusiasm and initiative for physical activities, leading to reduced physical activity, which is detrimental to bone health [23]. Notably, a gender reversal phenomenon was observed in the high school stage in Southern Shanxi (male 4.41% vs. female 3.85%), which may be related to biomechanical changes caused by delayed growth spurts in males during puberty [24], as well as increased awareness of body image management among females during puberty [25].

In the screening across academic stages, junior high school students had the highest positive rate. The possible reasons are that compared to elementary or high school students, junior high school students are in puberty, characterized by vigorous hormone secretion and rapid height changes [26], and it may also be related to the current trend of the disease affecting younger ages[27].

Looking at the statistics of scoliosis severity across academic stages, the prevalence rates of both Grade I and Grade II scoliosis were highest in the junior high school stage, while the prevalence of Grade III scoliosis was highest in the high school stage, and all severity levels were lowest in the elementary school stage. This may be related to the fact that scoliosis, if left uncontrolled, tends to worsen with increasing height, age, and other factors [28].

Changzhi Special School undertakes the nine-year compulsory education for blind, deaf, and mute children from 13 counties and districts in Changzhi City. All students in the school have disabilities, and their physical and mental health status differs significantly from that of regular elementary and secondary school students. In this examination, the prevalence of scoliosis at all stages was significantly higher than in the other three groups of regular students, and the systematic error was large. Therefore, it was not included in comparative statistical analysis with the other three groups.

The survey found that a very small number of students had received treatment, including wearing braces and surgery. Specifically, three students wore braces after seeking medical attention; two students underwent surgical treatment and had no scoliosis post-operation; one student had limb deformity but did not receive any treatment. These data indicate that very few students in the Southern Shanxi region are aware of scoliosis and have received corresponding treatment measures. This also indirectly confirms that the penetration rate of health knowledge regarding scoliosis prevention and treatment among students, parents, and schools in the Southern Shanxi region is still relatively low.

The cross-sectional design of this study has heterogeneity in the distribution of samples across academic stages (bias in the weight of samples from older age groups). Future research needs to establish longitudinal cohorts, control for confounding variables such as growth rate and sexual maturation stage, and focus on analyzing the interaction mechanisms of multiple factors like biomechanical load and hormonal regulation to clarify the pathogenic attribution pathways for positive scoliosis screening.

In summary, the positive rate of scoliosis screening among elementary and secondary school students in the Southern Shanxi region in 2024 is relatively high. The junior high school stage is the high-incidence period for scoliosis, with the total prevalence rate increasing by 26.9% compared to the elementary school group, and the detection rate of Grade II scoliosis (0.78%) is the highest among all stages. The trend from elementary to high school shows a gender reversal from "female high, male low" to "male high, female low". The total prevalence rate in high school boys is 14.5% higher than that in girls. [29] The proportion of Grade III scoliosis increases with the academic stage, accounting for 52% (15/29 cases) of severe cases in the high school group. The junior high school stage is the key period for prevention and control, while the high school stage requires focused attention on the development of severe cases. It is recommended to establish a prevention and control system focusing on "key screening in junior high school and tracking intervention in high school". Gender differences suggest the need for targeted prevention plans. The influence of pubertal development factors on spinal health deserves in-depth study. Being female, increasing age, increasing height, being in junior high school, and being in a general high school are risk factors for positive scoliosis screening. It is crucial to build a "school-medical-family" tripartite linked spinal health record tracking system, focus on monitoring posture changes during the growth spurt period (especially in junior high school), establish an early screening and warning mechanism [28], urge students to develop good sitting and standing postures, and promote balanced nutrition and active exercise.

Acknowledgements

Fund project: Shanxi *P*rovince Health Industry High-Quality Development Research *P*roject "Investigation and Multifactorial Study of Scoliosis among Middle School Students in Southern Shanxi

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

Region". Project Number: DJKZXKT2023205

References

[1] ALMAHMOUD O H, BANIODEH B, MUSLEH R, et al. Overview of adolescent idiopathic scoliosis and associated factors: a scoping review[J/OL]. International Journal of Adolescent Medicine and Health, 2023, 35(6): 437-441. DOI:10.1515/ijamh-2023-0166.
[2] GORIJALA V K, SHAIK L, THIRUMALA P, et al. Diagnostic Accuracy of Somatosensory Evoked Potential monitoring during Scoliosis correction surgery in the Pediatric Population: A Systematic Review[J/OL]. NEUROLOGY, 2023, 100(17). DOI:10.1212/WNL.0000000000202423.
[3] Li Weiping et al. Investigation of the prevalence of scoliosis among children and adolescents in Guangzhou at different times. China Tissue Engineering Research and Clinical Rehabilitation 14.46 (2010):8712-8716.
[4] Chen Yujuan, Li Li, Yang Huiling, et al. Analysis of the current situation and influencing factors of scoliosis in children in Shijiazhuang[J/OL]. Chinese Journal of School Health, 2021, 42(11): 1674-1678. DOI:10.16835/j.cnki.1000-9817.2021.11.017.
[5] Li Yingxian et al. Screening for scoliosis among primary and secondary school students in Chongming District, Shanghai and analysis of influencing factors. China Health Education 39.09 (2023):796-801. DOI: 10.16168/j.cnki.issn.1002-9982.2023.09.005.
[6] Tang Zhan Ying et al. Investigation and Analysis of the Current Status of Scoliosis Among Primary School Students in Shanghai. Proceedings of the Second Session of the Fourth Conference of the Orthopedics Branch of the Chinese Association of Traditional Chinese Medicine. Edited by: Department of Rehabilitation Medicine, Longhua Hospital Affiliated to Shanghai University of Traditional Chinese Medicine; Institute of Spinal Diseases, Shanghai University of Traditional Chinese Medicine. 2007,703-705.
[7] Zou Y, et al. Advances in screening and intervention for scoliosis in children and adolescents. Preventive Medicine 31.10 (2019):1017-1021. DOI: 10.19485/j.cnki.issn2096-5087.2019.10.010.
[8] Dong Bin, and Huo Zhuoping. Prevention and treatment of spinal curvature abnormalities in children and adolescents. China School Health 29.12 (2008):1163-1165.
[9]Zeng Xiaodong et al. Investigation of abnormal spinal curvature in 21,668 primary and secondary school students in Quanzhou City. China Public Health 08 (2006):912.
[10]Li Yan, et al. Epidemiological characteristics and influencing factors of scoliosis in children and adolescents in Huaiyin District, Jinan City. Preventive Medicine Forum 30.06 (2024):421-426. DOI: : 10.16406/j.pmt. ISSN: 1672-9153.2024.6.05.
[11] Proposal on Accelerating the Implementation of Scoliosis Prevention and Control Measures for Children and Adolescents. Forward Forum. 07(2020):60.
[12] The Technical Guidelines for the Prevention and Control of Abnormal Spinal Curvature in Children and Adolescents, and Ma Jun. Interpretation of the Technical Guidelines for the Prevention and Control of Abnormal Spinal Curvature in Children and Adolescents. "China School Health 43.02 (2022):165-170+175. DOI: 10.16835/j.cnki.1000-9817.2022.02.002.
[13] Chu Liting, et al. Screening and influencing factors analysis of scoliosis among primary and secondary school students in Shanghai. China School Health 44.08 (2023):1134-1139. DOI: 10.16835/j.cnki.1000-9817.2023.08.004.
[14] Chen Junze et al. Advances in Screening and Intervention for Scoliosis in Children and Adolescents. Heilongjiang Journal of Traditional Chinese Medicine 50.02 (2021):406.
[15] Jiang Zhicheng, et al. Advances in screening for abnormal spinal curvature in children and adolescents. China School Health 42.02 (2021):312-315+320. DOI: 10.16835/j.cnki.1000-9817.2021.02.037.
[16] Li Meng, Qu Yabin, Sun Yi, et al. Analysis of prevalence characteristics and influencing factors of scoliosis among primary and secondary school students in Guangdong Province[J/OL]. Chinese Journal of School Health, 2022, 43(02): 29395. DOI:10.16835/j.cnki.1000-9817.2022.02.030.
[17] Wang Yanhui, Chen Xueming, Yuan Xin, et al. Epidemiological investigation of scoliosis among middle school students in Tongzhou District, Beijing[J]. Chinese Journal of Spine and Spinal Cord, 2018, 28(07): 667-669.
[18] ZHOU L, YANG H, HAI Y, et al. Scoliosis among children in Qinghai-Tibetan Plateau of China: A cross-sectional epidemiological study[J/OL]. Frontiers in Public Health, 2022, 10: 983095. DOI:10.3389/fpubh.2022.983095.
[19] Jia Juanjuan, Lin Yun, Zhu Guoying, et al. Survey on scoliosis among primary and secondary school students in Jiaxing City[J/OL]. Preventive Medicine, 2022, 34(08): 782-787. DOI:10.19485/j.cnki.issn2096-5087.2022.08.006.

ISSN 2616-5791 Vol. 6, Issue 9: 71-78, DOI: 10.25236/AJMHS.2025.060911

[20] Chen Yujuan, Li Li, Yang Huiling, et al. Analysis of the current situation and influencing factors of scoliosis in children in Shijiazhuang[J/OL]. Chinese Journal of School Health, 2021, 42(11): 1674-1678. DOI:10.16835/j.cnki.1000-9817.2021.11.017.
[21]Xu Shuai et al. Chinese mainland characteristics of scoliosis in primary and secondary school students: A meta-analysis of 72 studies. China Spine Journal 31.10 (2021):901-910.
[22] AULISA A G, GIORDANO M, GUZZANTI V, et al. Effectiveness of school scoliosis screening and the importance of this method in measures to reduce morbidity in an Italian territory[J/OL]. Journal of Pediatric Orthopedics. Part B, 2019, 28(3): 271-277. DOI:10.1097/BPB.0000000000000611.
[23] Li Guangdong. How to motivate high school girls to participate in physical activities[J/OL]. Modern Education Science, 2011(12): 154. DOI:10.13980/j.cnki.xdjykx.gjyj.2011.12.077.
[24] Pan Qile. A tracking study on the height growth trend of healthy children and adolescents[C]//Abstracts of the 13th National Sports Science Conference - Poster Exchange (Physical Fitness and Health Branch) (II). Shanghai Research Institute of Sports Science (Shanghai Anti-Doping Center); 2023: 313-314.
[25] Zhu Ruizhen, Chen Jue. Correlates of body dissatisfaction (review)[J]. Chinese Mental Health Journal, 2023, 37(10): 906-912.
[26] Wang Yujie. A longitudinal study on the relationship between early life related factors and pubertal development in children in a district of Chongqing[D]. Chongqing Medical University, 2024.
[27] Gou Ping, Song Zihao. Early pubertal development: how to take the first step in sex education correctly[J]. Educator, 2023(50): 30-31.
[28] SAURI-BARRAZA J C. Early-onset scoliosis: pathophysiology, diagnosis and treatment[J]. Acta Ortopedica Mexicana, 2023, 37(2): 99-105.
[29] Wang Shuo, Guo Xin, Zhao Yuechao, et al. Analysis of the allocation of classroom desks and chairs in primary and secondary schools nationwide[J/OL]. Chinese Journal of School Health, 2022, 43(09): 1416-1419. DOI:10.16835/j.cnki.1000-9817.2022.09.033.