

Preplanned Studies

School-Based Scoliosis Screening Among Children and Adolescents — Wusu City, Xinjiang Uygur Autonomous Region, China, January 2026

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Summary

What is already known about this topic?

School-based scoliosis screening can identify children needing further evaluation and is increasingly promoted nationally, yet real-world screening evidence from multi-ethnic populations in northwestern China remains limited.

What is added by this report?

In a real-world school screening program in Wusu City, northern Xinjiang Uygur Autonomous Region, that included 18,631 students, the artificial intelligence-assisted screen-positive rate was 5.36%, whereas the final screen-positive rate after specialist review was 2.62%. Age was the most consistent signal, with positivity highest in junior and senior high school (P for trend <0.001). However, only 24.59% of final screen-positive students completed radiography, among whom 62.50% had a Cobb angle $\geq 10^\circ$.

What are the implications for public health practice?

In resource-limited settings in northwestern China, priority referral and follow-up mechanisms targeting junior and senior high school students are needed to translate front-end screening into definitive evaluation and management.

City, northern Xinjiang.

Methods: This cross-sectional screening study was conducted in 16 schools in Wusu City, Xinjiang, in January 2026. Students aged 8–18 years underwent a three-stage pathway: 1) AI-assisted surface screening using a 3D electronic spine measuring instrument to acquire the angle of trunk inclination (ATI) during the Adams forward bend test (ATI $\geq 6^\circ$ was defined as positive); 2) specialist clinical review to exclude postural scoliosis; 3) standing full-spine radiography for final screen-positive students (Cobb angle $\geq 10^\circ$). Screen-positive rates were compared across demographic and screening characteristics using chi-square tests and Cochran–Armitage trend tests.

Results: Among 22,479 registered students, 18,631 completed screening (82.88%). The AI-assisted screen-positive rate was 5.36% [95% confidence interval (CI): 5.05, 5.69], and the final screen-positive rate after specialist review was 2.62% (95% CI: 2.40, 2.86); both increased with age and school segment (trend $P < 0.001$). Urban and Han students had higher positivity rates. AI-assisted screen positivity was higher in female students, whereas the sex difference in final screen positivity was not statistically significant. Only 24.59% of final screen-positive students completed radiography, among whom 62.50% had a Cobb angle $\geq 10^\circ$.

Conclusion: Junior and senior high school students should be prioritized in school-based scoliosis screening. In resource-limited settings, improving referral completion after an abnormal screen is as important as expanding screening coverage.

ABSTRACT

Introduction: Scoliosis is a common spinal deformity affecting approximately 1.20% of school-age children in China. Amid the national scale-up of school-based spinal screening, evidence from multi-ethnic populations in northwestern China remains limited, and real-world data from Xinjiang Uygur Autonomous Region are lacking. This study reports AI-assisted and specialist-reviewed screening positivity rates in a multi-ethnic school population in Wusu

Scoliosis is a major public health concern among children and adolescents. Curve progression during periods of rapid growth may cause visible deformity,

pain, psychosocial distress, and functional impairment, imposing a substantial societal burden (1–2). School-based screening has therefore become increasingly common, consistent with the national "Five-Health" initiative for children and adolescents (3).

Recent studies have reported a pooled prevalence of adolescent scoliosis of approximately 1.20% in China (4). Despite extensive research, regional differences and possible demographic patterns remain incompletely characterized (5–8), and real-world screening evidence from multiethnic school populations in northwestern China, particularly in Xinjiang Uygur Autonomous Region, remains relatively scarce. Wusu City in northern Xinjiang, which has both Han and ethnic minority populations, provides a real-world setting for evaluating a school-based screening pathway in a resource-limited area but is not representative of the entire Xinjiang Uygur Autonomous Region.

Therefore, data from the Wusu City School Screening Program were analyzed to report the artificial intelligence (AI)-assisted and final screen-positive rates after specialist review, with the aim of informing targeted prevention and control strategies.

This cross-sectional screening study was conducted in January 2026 at 16 primary, junior high, and senior high schools in Wusu City, Xinjiang Uygur Autonomous Region, China. Participants were students aged 8–18 years. Students who had received previous treatment for spinal deformity; who had known congenital, neuromuscular, or syndromic spinal deformity; or who were absent or declined to participate on the screening day were excluded.

This screening pathway included three stages. In the first stage, AI-assisted surface screening, trained personnel used a three-dimensional (3D) electronic spine measuring instrument (MW01/MW02, Hunan Mawei Kang Cheng Technology Co., Ltd. Hunan, China; nominal angle accuracy $\pm 1.00^\circ$) during the Adams forward bend test; the instrument scanned the body-surface contour from C7 to the lumbosacral region, and an embedded algorithm automatically acquired and recorded the angle of trunk inclination (ATI) in real time and provided an on-site AI grade. The AI algorithm was designed only for body-surface data acquisition, automated measurement, and on-site grading, and did not directly diagnose scoliosis; the radiographic Cobb angle remains the gold standard for confirmation. An ATI of $\geq 6^\circ$ was defined as a positive AI screen, in accordance with the screening protocol of the 3D electronic spine measuring instrument used in this program; this cut-off lies within the 5° – 7° angle-

of-trunk-rotation range commonly used for scoliometer-based school screening and referral to radiography (9–10), and was adopted to reduce possible false-positive referrals from highly sensitive surface measurements while maintaining adequate sensitivity for clinically meaningful trunk asymmetry. This threshold is a screening criterion rather than a diagnostic standard.

In the second stage, specialist review, two spine specialists examined AI-positive students using postural inspection, palpation, and repeated forward bend tests, to assess shoulder asymmetry, scapular prominence, lumbar triangle asymmetry, pelvic obliquity, and paraspinal muscle tension (9–10). All specialists had received standardized training on the screening protocol, and ATI was remeasured with the same model of 3D electronic spine measuring instrument (MW01/MW02). Discrepancies were resolved by consensus discussion, and if consensus could not be reached, the more experienced specialist made the final determination. During the review, postural (non-structural) scoliosis arising from poor posture or transient positioning was excluded by correcting posture and re-testing after activity; only students with a fixed structural abnormality persisting on re-testing were defined as final screen positive and referred for imaging, whereas AI-positive students whose asymmetry resolved on re-testing were classified as marginal (borderline) cases and were not referred. In the third stage, hospital imaging, referred students underwent standing full-spine anteroposterior and lateral X-ray examination at the designated hospital, with a Cobb angle $\geq 10^\circ$ taken as suggestive of scoliosis (1,9) (Figure 1). Cobb angles were measured by a single spine surgeon using standard digital radiography software, and a second reader independently remeasured 10% of the images for quality control.

Variables included sex, school segment, residential or school district (urban/rural), ethnicity (Han/minority), age group ($<13/\geq 13$ years), dietary pattern, and AI grade. AI grade was defined by ATI as grade 0 ($<5^\circ$), grade 1a (5° to $<6^\circ$), grade 1b (6° to $<7^\circ$), grade 2 (7° to $<10^\circ$), and grade 3 ($\geq 10^\circ$). Dietary pattern (halal/non-halal) was used only as a crude sociocultural marker and was not interpreted as a direct nutritional exposure or a causal factor. The two primary outcomes were final screening positivity among all screened students and radiographic confirmation among those who underwent radiography in the primary analysis.

Continuous variables were summarized as means and standard deviations, and categorical variables were

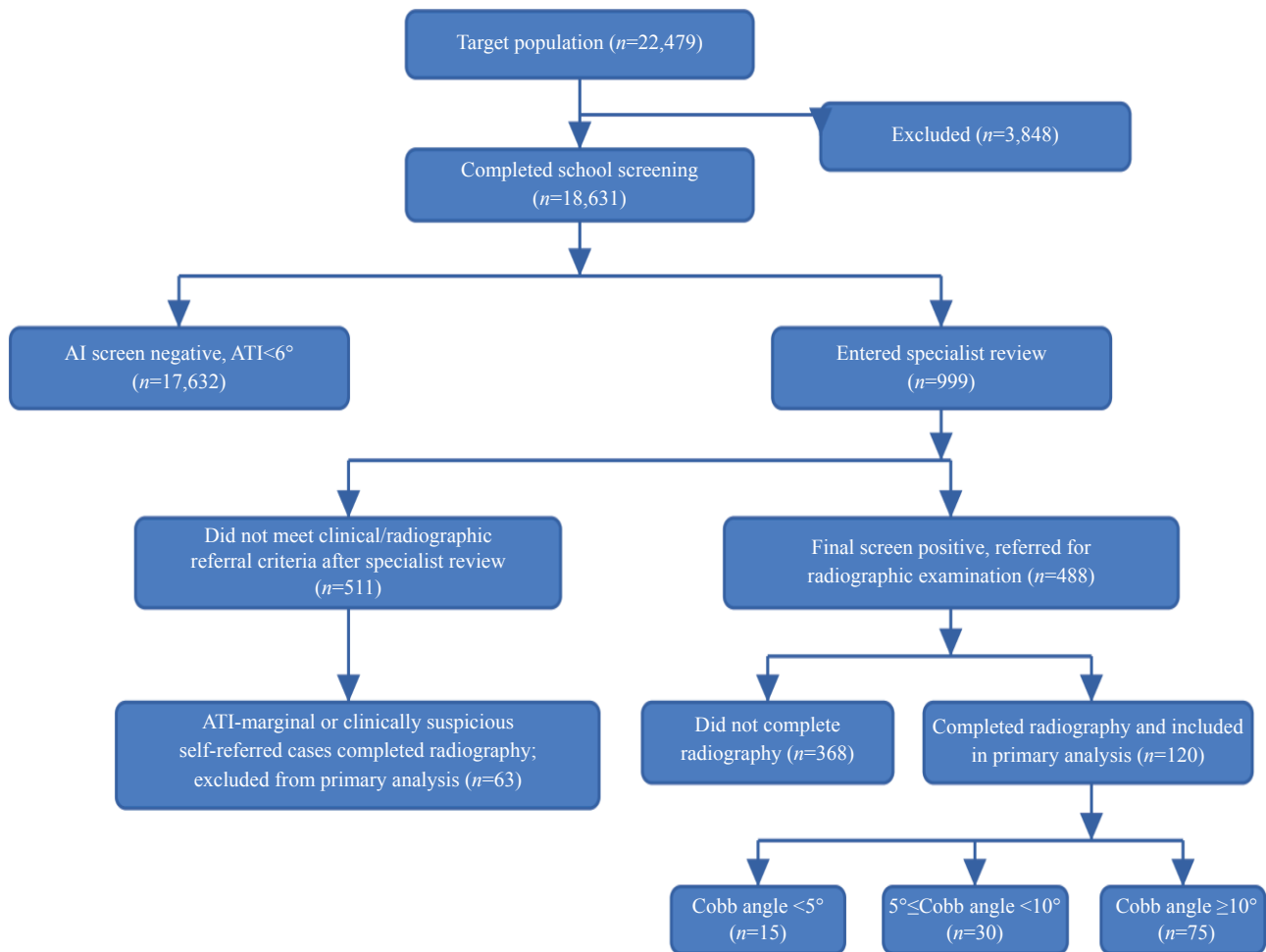


FIGURE 1. Scoliosis screening, specialist review, and radiographic confirmation pathway among students aged 8–18 years — Wusu City, Xinjiang Uygur Autonomous Region, China, January 2026.

Note: The 63 self-referred marginal cases were not included in the primary radiographic confirmation analysis.

Abbreviation: AI=artificial intelligence; ATI=angle of trunk inclination.

summarized as frequencies and percentages. AI-assisted and final screen-positive rates were calculated and stratified by sex, school segment, age group, urban/rural area, ethnicity, and AI grade, and subgroups were compared using Pearson chi-square tests, with Fisher's exact test when expected frequencies were small. Trends in screen-positive rates across the ordered variables — of age (in single years) and school segment (primary, junior high, senior high) — were assessed using the Cochran–Armitage trend test. All chi-square and trend tests were unadjusted (crude). Because age group was highly correlated with school segment, stratified analyses focused on age group, with school segment used descriptively. Statistical significance was set at $P < 0.05$. Primary analyses were performed using IBM SPSS Statistics (version 26.0; IBM Corp., Armonk, NY, USA) and R (version 4.3.1; R Foundation for Statistical Computing, Vienna,

Austria).

Among the 22,479 enrolled students, 18,631 (82.88%) completed screening. The 3,848 students (17.12%) who did not complete screening comprised those absent on the screening day (e.g., illness, personal leave, or off-campus activities), those whose parents declined participation, and a small number excluded for known spinal deformity or prior treatment; detailed reasons were not systematically recorded for every non-screened student. The mean age was 12.36 years, and female students accounted for 50.19% of the participants. Primary, junior high, and senior high school students accounted for 38.49%, 39.79%, and 21.72% of the participants, respectively. Han students represented 71.50% of the participants, and 90.75% were from urban schools or areas.

AI-assisted screening identified 999 positive students, with an AI positivity rate of 5.36% [95%

confidence interval (CI): 5.05, 5.69]. After specialist review, 488 students were classified as final screen positive, and the final screen-positive rate was 2.62% (95% CI: 2.40, 2.86) (Table 1). Among all screened students, 16,753 (89.92%) had an AI grade of 0, 879 (4.72%) grade 1a, 457 (2.45%) grade 1b, 419 (2.25%) grade 2, and 123 (0.66%) grade 3.

A total of 183 students completed imaging, including 120 referred from the final screen-positive group (24.59% of the 488) and 63 self-referred marginal cases that had been AI-positive but not classified as final screen positive after specialist review and therefore not formally referred; they presented for radiography on their own initiative. Among the 120 referred final screen-positive students who completed radiography, 75 (62.50% of these 120 students) had a Cobb angle $\geq 10^\circ$, 15 had a Cobb angle $< 5^\circ$, and 30 had a Cobb angle of 5° to $< 10^\circ$.

Among the 63 marginal (borderline) cases — not referred after specialist review but self-presenting for imaging— none had a Cobb angle $\geq 10^\circ$: 7 had a Cobb angle $< 5^\circ$ and 56 had a Cobb angle of 5° to $< 10^\circ$. This pattern suggests that specialist review reduced false-

positive referrals after front-end AI screening; however, these self-referred cases cannot be used to formally estimate sensitivity or specificity.

Screening abnormalities increased with age and school segment. AI positivity increased from 2.80% at 8 years of age to 10.28% at 16 years of age, and the final screening positivity increased from 1.07% to 5.68% (all P for trend < 0.001 , unadjusted). The final screen-positive rates in primary, junior high, and senior high school students were 1.37% (95% CI: 1.12, 1.66), 2.50% (95% CI: 2.16, 2.88), and 5.07% (95% CI: 4.43, 5.78), respectively (Figure 2).

Urban students had higher AI-assisted and final screen-positive rates than rural students [5.57% *vs.* 3.36%; 2.75% (95% CI: 2.51, 3.01) *vs.* 1.33% (95% CI: 0.89, 2.00)]. Han students had higher rates than minority students [AI 5.70% *vs.* 4.52%; final 2.80% (95% CI: 2.53, 3.09) *vs.* 2.17% (95% CI: 1.81, 2.59)]; these urban–rural and ethnic differences were statistically significant in unadjusted analyses. Female students had a slightly higher crude positivity than male students, but the difference in the final screen-positive rate by sex was not statistically significant

TABLE 1. Characteristics and scoliosis screening results among students aged 8–18 years — Wusu City, Xinjiang Uygur Autonomous Region, China, January 2026.

Characteristic	Screened students, <i>n</i>	AI-positive students, <i>n</i> (%)	Final screen-positive students, <i>n</i> (%)
Overall	18,631	999 (5.36)	488 (2.62)
Sex			
Male	9,281	462 (4.98)	222 (2.39)
Female	9,350	537 (5.74)	266 (2.84)
<i>P</i>		0.020	0.053
School segment			
Primary school	7,172	217 (3.03)	98 (1.37)
Junior high school	7,413	379 (5.11)	185 (2.50)
Senior high school	4,046	403 (9.96)	205 (5.07)
<i>P</i> for trend		< 0.001	< 0.001
Area			
Urban	16,907	941 (5.57)	465 (2.75)
Rural	1,724	58 (3.36)	23 (1.33)
<i>P</i>		< 0.001	< 0.001
Ethnicity			
Han	13,321	759 (5.70)	373 (2.80)
Minority	5,310	240 (4.52)	115 (2.17)
<i>P</i>		0.001	0.014

Note: AI-positive: ATI $\geq 6^\circ$. Final screen-positive: abnormal after specialist review and referred for radiography. *P* values from Pearson's chi-square test (sex, region, ethnicity) or Cochran–Armitage trend test (school segment). All analyses unadjusted. Percentages are row percentages.

Abbreviation: AI=artificial intelligence; ATI=angle of trunk inclination.

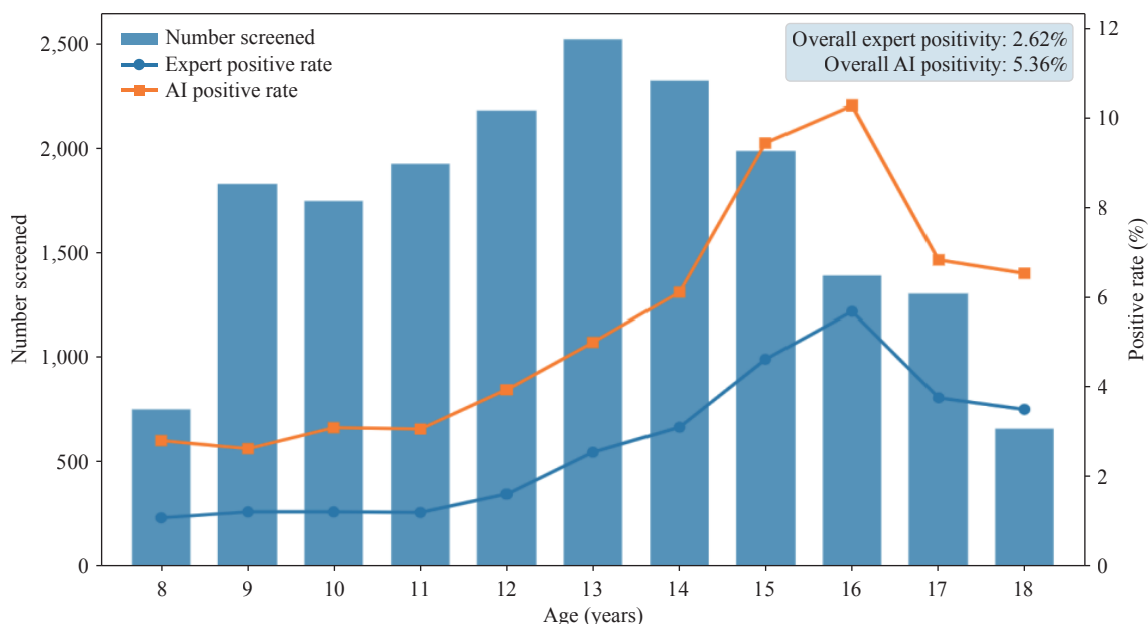


FIGURE 2. Age-specific numbers screened and scoliosis screen-positive rates among students aged 8–18 years — Wusu City, Xinjiang Uygur Autonomous Region, China, January 2026.

Note: Bars represent the number of screened students by age (left Y-axis). Lines represent age-specific positive rates (right Y-axis): AI-assisted (orange, squares) and final after specialist review (blue, circles). Both rates increased with age (P for trend <0.001), peaking at 15–16 years. The overall AI-assisted and final screen-positive rates were 5.36% and 2.62%, respectively.

Abbreviation: AI=artificial intelligence.

($P=0.053$, unadjusted).

Of the 488 final screen-positive students, only 120 (24.59%) completed radiographic examination and 368 (75.41%) did not. As shown in Table 2, completers and non-completers differed significantly by age group ($\chi^2=7.99$, $P=0.005$) and by urban/rural region (Fisher's exact test, $P=0.013$) in unadjusted analyses: students aged <13 years (31.67% vs. 19.29%) and rural students (9.17% vs. 3.26%) were more likely to complete imaging. No significant differences were observed by sex, school segment, ethnicity, dietary pattern, or AI grade (all $P>0.05$).

DISCUSSION

In this multiethnic school population in Wusu City, northern Xinjiang, AI-assisted screening identified 5.36% of students as screen-positive, decreasing to 2.62% after specialist review. This reduction suggests that specialist review excluded postural abnormalities and reduced false-positive referrals. AI-assisted screening therefore served as a triage rather than a diagnostic tool, with radiographic Cobb angle assessment used for confirmation. Because few screen-positive students completed radiography, population-level confirmed prevalence could not be estimated. The

analysis therefore focused on AI-assisted and final screen-positive rates and their distribution across subgroups to inform school-based screening strategies in multiethnic areas.

Across this screening cascade, age was the most consistent factor associated with both AI-assisted and final screen-positive rates. Both rates increased markedly after 13 years of age and peaked at 15–16 years. This pattern is consistent with the pubertal growth spurt, during which spinal growth accelerates and vertebral biomechanics and neuromuscular control may become transiently imbalanced, potentially contributing to scoliosis onset or progression (2). These age-related findings may also inform screening strategies: when resources are limited, review, referral, and follow-up could prioritize students aged ≥ 13 years, especially those in junior and senior high schools (2,9).

Urban and Han students had higher screen-positive rates than their rural and minority counterparts. However, these differences more likely reflect the composition of the screened population, school distribution, and healthcare-seeking behavior rather than true etiological variation (5–8); the binary Han/minority classification also simplifies the region's multi-ethnic diversity (6). Subgroup differences should therefore be viewed as clues for identifying high-

TABLE 2. Characteristics of final screen-positive students by X-ray completion status — Wusu City, Xinjiang Uygur Autonomous Region, China, January 2026.

Variable	Completed X-ray (n=120), n (%)	Not completed (n=368), n (%)	χ^2	P
Sex			3.29	0.070
Male	46 (38.33)	176 (47.83)		
Female	74 (61.67)	192 (52.17)		
School segment			4.05	0.132
Primary	28 (23.33)	70 (19.02)		
Junior high	51 (42.50)	134 (36.41)		
Senior high	41 (34.17)	164 (44.57)		
Ethnicity			0.10	0.751
Han	93 (77.50)	280 (76.09)		
Minority	27 (22.50)	88 (23.91)		
Region			—	0.013*
Rural	11 (9.17)	12 (3.26)		
Urban	109 (90.83)	356 (96.74)		
Dietary pattern			0.04	0.834
Halal	25 (20.83)	80 (21.74)		
Non-halal	95 (79.17)	288 (78.26)		
Age group			7.99	0.005
<13 years	38 (31.67)	71 (19.29)		
≥13 years	82 (68.33)	297 (80.71)		
AI grade			0.46	0.793
Grade 1b	31 (25.83)	104 (28.26)		
Grade 2	65 (54.17)	199 (54.08)		
Grade 3	24 (20.00)	65 (17.66)		

Note: P values from Pearson's chi-square test except region. "—" denotes "not applicable"; no χ^2 statistic is reported because Fisher's exact test was used. All analyses unadjusted. Percentages are column percentages. AI grade 1b = ATI 6° to <7°; grade 2 = ATI 7° to <10°; grade 3 = ATI ≥10°.

Abbreviation: AI=artificial intelligence; ATI=angle of trunk inclination.

* Fisher's exact test.

priority groups for follow-up rather than as evidence of causal risk factors.

These findings further point to a key implementation challenge: incomplete radiographic follow-up. Only 120 (24.59%) of final screen-positive students completed radiography, whereas 368 (75.41%) did not, limiting the transition from initial screening to definitive imaging evaluation and subsequent management (9–10). Reasons for non-completion may include parental concern about children's exposure to ionizing radiation (11); the costs, time, and travel required for hospital-based radiography; and limited awareness of scoliosis and consequent low prioritization. These factors were not systematically collected in this study. Because completers were disproportionately young and from rural areas (Table 2), the 75 imaging-confirmed cases may not be

representative of all final screen-positive students. Therefore, the 62.50% with a Cobb angle ≥10° among those who completed radiography should not be extrapolated to all 488 final screen-positive students or used to estimate population-level prevalence.

This study has two main limitations. First, the low radiographic follow-up rate precluded estimation of population-level confirmed prevalence, a common constraint in school screening programs driven by parental concern about radiation and healthcare accessibility. Second, inter-observer agreement for specialist review and Cobb angle measurement was not formally assessed, and non-completion of screening may introduce selection bias, although the completion rate compares favorably with similar programs. Despite these limitations, this study provides real-world data on a multi-ethnic school screening pathway in

northwestern China and indicates that improving referral completion is central to realizing the benefits of screening. In resource-limited settings, raising parental awareness of scoliosis and the importance of post-screening follow-up is essential to improving referral completion. Age-stratified screening strategies should prioritize junior and senior high school students (aged ≥ 13 years), the highest-risk group. Establishing targeted follow-up mechanisms for key populations offers a practical pathway for implementing the national "Five Health Priorities" spinal screening campaign.

Conflicts of interest: No conflicts of interest.

Ethical statement: Approved by the Scientific Research Ethics Committee of Shanghai University of Sport (approval no. 102772024RT100). Written informed consent was obtained from the participants' parents or legal guardians.

Funding: Supported by the National Key Research and Development Program of China project "Establishment of a Precision Diagnosis and Treatment System and Development of Key Technologies for Neural Tube Defects Across the Entire Disease Course Based on Functional Preservation and Reconstruction": Development of a Precision Diagnosis and Treatment System for Neural Tube Defects and Key Technologies (Clinical Research Type) (Grant Number 2025YFC2511500) and the National Natural Science Foundation of China project "The Role and Mechanism of RUNX1-Mediated Ferroptosis in Paravertebral Muscle Fibro/Adipogenic Progenitor Cells (FAPs) in the Pathogenesis of Adolescent Idiopathic Scoliosis" (Grant Number 82572701).

doi: 10.46234/ccdcw2026.190

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Submitted: May 12, 2026

Accepted: September 10, 2026

Issued: September 18, 2026

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