ISSN 2096-7071 (Print)
ISSN 2096-3101 (Online)
CN 10-1629/R1

CHINA CDC WEEKLY

Vol. 7 No. 6 Feb. 7, 2025

CCDC weekly

中国疾病预防控制中心周报

Preplanned Studies

Review

Notifiable Infectious Diseases Reports

ISSN 2096-7071
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Preplanned Studies

Physical Activity Patterns Across Life Domains in Chinese Older Adults Aged 60–79 Years — China, 2020

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Summary

What is already known about this topic?

Physical inactivity among older adults is increasing globally. Analyzing the characteristics and influencing factors of physical activity patterns (PAPs) can inform the design of targeted physical activity (PA) promotion strategies for diverse subgroups.

What is added by this report?

Analysis of national data from 2020 revealed three distinct PAPs among Chinese older adults across life domains: low activity (LA) cluster (53.3%), active leisure (AL) cluster (31.4%), and active home (AH) cluster (15.3%). The AL cluster demonstrated superior psychological status, physical fitness, and built environment conditions compared to both AH and LA clusters. The AH cluster exhibited better physical fitness and built environment characteristics than the LA cluster.

What are the implications for public health practice?

The distinct characteristics among clusters suggest that targeted interventions and policies may be beneficial for each subgroup. These interventions should incorporate enhanced psychosocial support, built environment modifications, and evidence-based guidance for physical fitness improvement, specifically tailored to each cluster's unique characteristics and needs.

ABSTRACT

Introduction: Physical inactivity among older adults represents a growing global concern. Understanding the characteristics and determinants of physical activity patterns (PAPs) is crucial for developing targeted physical activity (PA) promotion strategies for diverse subgroups.

Methods: This study analyzed data from 39,957 adults aged 60–79 years recruited from 31 Provincial-level administrative divisions (PLADs) through the 2020 Chinese National Survey on Adults' Fitness. Participants completed comprehensive questionnaires and underwent physical fitness assessments. The self-administered questionnaire captured demographic characteristics, living environment conditions, life satisfaction, and stress levels. PA was evaluated under normal conditions using a domain-specific questionnaire that measured weekly activity across leisure, occupational, transport, and home domains, along with sedentary behavior. Physical fitness measurements encompassed anthropometric parameters (height, weight, body fat percentage), cardiorespiratory fitness (lung capacity, 2-minute step test), muscular strength (grip strength), flexibility (sit and reach test), functional capacity (30-second chair stand test), balance (one-leg standing with eyes-closed test), and neuromuscular function (reaction time test). K-means clustering analysis is used for identifying PAPs.

Results: K-means clustering analysis identified three distinct PAPs among Chinese older adults: low activity (LA) cluster (*n*=21,291, 53.3%), active leisure (AL) cluster (*n*=12,543, 31.4%), and active home (AH) cluster (*n*=6,123, 15.3%). The AL cluster demonstrated superior psychological status, physical fitness, and built environment conditions compared to both AH and LA clusters, while the AH cluster exhibited better physical fitness and built environment characteristics than the LA cluster.

Conclusions: These findings reveal distinct PA profiles across various life domains among older adults. The observed inter-cluster differences suggest that targeted intervention strategies and policies may benefit different elderly subgroups, particularly through enhanced sociopsychological and built environment support, coupled with precise guidance for promoting physical health.

Maintaining good physical activity (PA) behavior among older adults ensures their quality of life and confers long-term health benefits. PA occurs in at least four life domains: leisure, job, transport, and home. Research on PA among older adults primarily focuses on moderate-to-vigorous physical activity (MVPA) duration in different life domains or the proportion of individuals with insufficient PA and those meeting recommended PA guidelines, as well as their relationships with diseases (*1*). However, research on physical activity patterns (PAPs) among older adults remains limited despite the potential for identifying PAP across multiple life domains to inform the design of interventions and policies (*2*). Our data originate from the 2020 Chinese National Survey on Adults' Fitness, the largest nationally representative survey of civilians in China. Cluster analysis was conducted with older adults aged 60–79 years to identify different PAPs based on self-reported MVPA across four life domains: leisure, job, transport, and home. Three PAP clusters were identified: low activity (LA) cluster (LA, *n*=21,291, 53.3%), active leisure (AL) cluster (AL, *n*=12,543, 31.4%), and active home (AH) cluster (AH, *n*=6,123, 15.3%). The AH cluster was more likely to comprise younger males, while the AL cluster was more likely to comprise individuals with higher education and professional occupations who were living with a partner. Psychological status, physical fitness, and the built environment were significantly better in the AL cluster than in the AH and LA clusters. Improvements in the physical fitness and built environment were greater in the AH cluster than in the LA cluster. Tailored interventions and policies targeting psychosocial factors, the built environment, and physical fitness for different subgroups should be implemented to increase PA levels among older adults.

This study employed a complex, stratified, multistage probability cluster sampling design approved by the National Bureau of Statistics in China, covering 31 provincial-level administrative divisions (PLADs) and achieving national representativeness, as previously described (*3*). In 2020, 39,957 participants aged 60–79 years completed comprehensive questionnaires and physical fitness assessments. A self-administered questionnaire collected data on demographic characteristics (sex, age, region, education, occupation, marital status), living environment, life satisfaction, and stress levels. PA was assessed using a self-administered questionnaire that measured weekly activity across leisure, job, transport, and home domains, along with sedentary time, under normal conditions. Physical fitness measurements included height, weight, body fat percentage, lung capacity, 2-minute step test count, 30-second chair stand test count, one-legged stance time with eyes closed, and reaction time. The study protocol received approval from the General Administration of Sport of China, with all participants providing written informed consent.

PAPs were identified using the K-means clustering algorithm, with cluster variables standardized to Z-scores to ensure equal contribution to the analysis. Statistical significance was established at a two-sided *P* value of less than 0.05. For continuous variables, results were expressed as mean and standard deviation (SD), while categorical variables were reported as proportions with 95% *CI*s. All analyses were conducted using SAS JMP 17.2 (SAS Institute Inc, Cary, NC, USA).

Among the 39,957 study participants, 19,783 (49.5%) were men and 20,174 (50.5%) were women. In 2020, younger male participants demonstrated significantly higher total minutes spent in transport, home, job, and leisure activities ($P<0.05$) (Table 1).

K-means cluster analysis revealed three distinct clusters (Silhouette Score=0.6) characterized by their weekly MVPA patterns across four life domains. These clusters were designated as LA, AL, and AH. Figure 1 illustrates the Z-score profiles of each cluster across life domains. The LA cluster exhibited activity levels ranging from −0.1 to −0.4 SDs below the sample mean across all domains, with participants averaging 38.3 minutes of daily MVPA. While classified as "moderate" according to the International Physical Activity Questionnaire Scoring Protocol (IPAQ-SP), this cluster demonstrated the lowest relative activity levels. The AL cluster showed leisure PA levels 0.8 SDs above the sample mean, with near-average levels in transport, home, and occupational domains. AL participants averaged 51.7 minutes of daily MVPA, approaching the IPAQ-SP "high" activity threshold. The AH cluster demonstrated home PA levels 1.8 SDs above the sample mean, with average levels in other domains. AH participants averaged 44.3 minutes of daily MVPA, exceeding the IPAQ-SP "moderate" threshold primarily through household activities.

Demographic analysis revealed distinct characteristics among clusters. The AH cluster predominantly comprised younger male participants with lower educational attainment and fewer professional occupations compared to AL and LA clusters. However, AH participants demonstrated superior physical fitness metrics compared to the LA

TABLE 1. Total weekly minutes for transport, home, job, leisure, and sedentary activities among Chinese older adults aged 60–79 years in 2020.

Items	Transport (min) M (SD)	Home (min) M (SD)	Job (min) M (SD)	Leisure (min) M (SD)	Sedentary (min) M (SD)
Overall (*n*=39,957)	345.6 (298.3)	450.8 (437.6)	131.4 (495.7)	42 (56.9)	692.7 (593.3)
Age group, years					
60–69 (*n*=20,515)	364.9 (312.7)*	490.9 (461.1)*	190.7 (606.0)*	46.8 (60.5)*	701.9 (595.1)*
70–79 (*n*=19,442)	325.3 (280.9)	408.5 (407.2)	68.9 (331.4)	37.0 (52.4)	683.1 (591.4)
Sex					
Male (*n*=19,783)	351.0 (305.4)†	367.3 (392.0)†	163.9 (564.9)†	42.0 (58.1)	718.9 (606.7)†
Female (*n*=20,174)	340.3 (291.1)	532.7 (463.8)	99.6 (414.3)	42.0 (55.8)	667.1 (578.9)
Urban-rural					
Urban (*n*=19,985)	375.3 (314.9)§	482.0 (450.2)§	81.4 (390.6)§	56.7 (63.3)§	770.2 (631.6)§
Rural (*n*=19,972)	315.9 (277.5)	419.6 (422.4)	181.4 (577.8)	27.3 (45.2)	615.3 (541.5)

Abbreviation: M=mean; SD=standard deviation.
* *P*<0.05 *vs*. 70–79 age group;
† *P*<0.05 *vs*. female group;
§ *P*<0.05 *vs*. rural group.

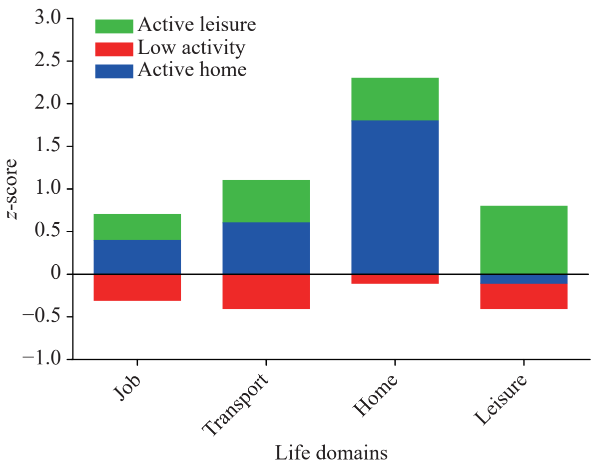

FIGURE 1. The profiles of LA, AL, and AH clusters expressed in Z-scores across life domains for each cluster sample.
Abbreviation: LA=low activity; AL=active leisure; AH=active home.

cluster, including lower body fat percentages and enhanced cardiopulmonary endurance, maximum lung ventilation, upper limb strength, flexibility, and balance. The AL cluster was characterized by higher educational attainment, professional occupations, partnership status, and superior environmental factors, including residence within 15-minute exercise circles and economically developed cities. AL participants also reported higher life satisfaction and lower perceived stress and demonstrated superior physical fitness across all measured parameters compared to both AH and LA clusters (Table 2).

DISCUSSION

Analysis of recent nationally representative data revealed three distinct PAPs across life domains among Chinese adults aged 60–79 years in 2020: an AL cluster, an AH cluster, and a LA cluster characterized by below-average activity levels. The AL cluster demonstrated significantly superior physical fitness, psychosocial status, and built environment conditions compared to both the AH and LA clusters. Additionally, the AH cluster showed greater PA engagement and physical fitness improvements relative to the LA cluster.

The PA clustering patterns identified in this study diverged from previous research findings. A study of 1,690 American adults (*2*) identified three distinct patterns through cluster analysis: active leisure, low activity, and active job (AJ) clusters. Our analysis revealed an AH cluster rather than an AJ cluster, likely reflecting cultural differences in activity patterns among older Chinese adults, who tend to engage more in leisure and home-based activities. Moreover, our study population consisted entirely of retirees, naturally limiting transport and occupational PA. Another study (*4*) employed a different approach, categorizing patterns based on frequency and duration combinations, yielding five distinct patterns: low frequency & short duration, low frequency & long duration, daily frequency & short duration, daily frequency & long duration, and high frequency & average duration. This methodology enabled the examination of various activity mode effects. These

TABLE 2. Characteristics of LA, AL, and AH clusters among Chinese older adults aged 60–79 years in 2020.

Characteristics	AL (*n*=6,123)	LA (*n*=21,291)	AH (*n*=12,543)
Demographic characteristics			
Age (year)*	67.1 (5)	69.3 (7)**	69.1 (5)§¶
Male proportion (%) †	65.9 (53.5, 71.4)	52.3 (49.1, 55.3)**	43.2 (39.2, 45.3)§¶
Urban proportion (%)†	42.9 (39.1, 44.3)	56.7 (55.4, 58.3)**	54.1 (52.9, 57.9)§¶
Highest education category (%)†	3.3 (2.9, 3.8)	7.4 (5.8, 9.1)**	15.3 (13.2, 18.1)§¶
Having a good profession (%)†	18.6 (14.3, 22.2)	23.3 (20.6, 25.5)**	44.6 (42.9, 46.3)§¶
Married proportion (%)†	98.2 (97.2, 99.4)	98.3 (97.5, 99.8)	98.0 (97.1, 99.6)
Living with spouse or partner (%)†	59.3 (54.7, 62.4)	57.1 (56.3, 58.4)**	62.4 (58.8, 65.4)§¶
Psychosocial			
Having a good Life satisfaction self-reported (%)†	77.2 (75.8, 78.5)	91.1 (89.8, 93.0)**	93.4 (90.1, 95.4)§¶
Having a good Stress self-reported (%)†	69.2 (64.2, 75.3)	73.9 (68.9, 76.3)**	83.0 (79.9, 86.4)§¶
Built environment			
Living with 15 minutes exercise circle (%)†	78.5 (77.2, 79.6)	75.2 (74.0, 76.6)**	87.9 (86.6, 88.8)§¶
Live in high economic development city (%)†	59.4 (58.3, 60.6)	54.3 (53.8, 55.0)**	59.8 (58.4, 61.2)¶
PA level			
MPA (min/week)*	300.8 (38.7)	263.2 (26.1)**	338.2 (48.3)§¶
VPA (min/week)*	19.1 (8.2)	14.6 (7.7)**	33.6 (9.7)§¶
MVPA (min/week)*	310.1 (46.4)	268.5 (25.5)**	362.5 (46.5)§¶
Sedentary (min/week)*	587.8 (444.6)	680.7 (478.8)**	720.3 (567.4)§¶
Physical fitness			
Body mass index (kg/m^2)*	24.7 (3.21)	24.8 (3.44)	24.5 (3.15)¶
Body fat percentage (%)*	28.8 (7.1)	27.7 (7.7)**	25.9 (7.9)§¶
Lung capacity (mmHg)*	1,976 (744)	1,917 (655)**	2,124 (687)§¶
2-minute step test (number)*	94 (44)	86 (31)**	101 (44)§¶
Grip (kg)*	29.7 (8.7)	27.8 (8.7)**	30.6 (9.0)§
Sit and reach test (cm)*	4.6 (9.4)	3.1 (8.7)	4.8 (9.1)§¶
30-second chair stand test (number)*	11 (4)	11 (4)	12 (3)§¶
Standing on one foot with eyes closed (minute)*	10.5 (8.9)	9.5 (7.7)**	10.1 (8.5)¶
Reaction (minutes)*	0.80 (0.25)	0.79 (0.22)**	0.76 (0.20)§¶

Note: Highest education category, proportion of college graduates and above; Good profession, proportion of first four categories (1=staff of government agencies and public institutions, 9=no occupation); Good life satisfaction self-reported, proportion of last two categories (1=very dissatisfied, 5=very satisfied); good stress self-reported, proportion of last two categories (1=always, 5=never); high economic development city, proportion of first category (1=economically developed city, 3=economically underdeveloped city).

Abbreviation: LA=low activity; AL=active leisure; AH=active home; MPA=moderate-intensity physical activity; VPA=vigorous-intensity physical activity; MVPA=moderate-to-vigorous physical activity; PA=physical activity.

* Geometric means and 95% confidence intervals (in parentheses) reported;

† Means and standard deviations (in parentheses) reported;

§ P<0.05 *vs*. AH group;

¶ P<0.05 *vs*. LA group;

** P<0.05 AH group *vs*. LA group.

findings demonstrate the versatility of data-driven approaches in identifying PAPs aligned with specific research objectives. While some research has dichotomized patterns into weekend warriors and regular exercise participants (*5*) based on exercise habits, our study provides a comprehensive analysis of patterns across multiple life domains. These insights can inform the development of targeted public health policies and health management strategies for distinct pattern subgroups.

The three PA pattern subgroups demonstrated significant differences in activity levels. Weekly MVPA durations were 338.2±48.3 minutes for the active leisure cluster, 300.8±38.7 minutes for the active home cluster, and 263.2±26.1 minutes for the low activity cluster (Table 2). All clusters exhibited minimal VPA and prolonged sedentary behavior. Although self-reported weekly MVPA in each cluster exceeded WHO guidelines — potentially due to self-reporting bias — daily VPA averaged only 3–6 minutes. Strengthening social and built environment supports for vigorous activity is crucial. Targeted interventions should expand both the range of vigorous activities (e.g., running, aerobic exercise) and available settings (e.g., fitness clubs, group classes) to increase participation opportunities (*6*). Notably, both active leisure and active home clusters maintained high sedentary time, indicating that increased PA did not necessarily reduce sedentary behavior — a key consideration for future intervention policies (*7*).

The three clusters exhibited distinct characteristics in demographics, psychological factors, built environment access, and physical fitness metrics. The active leisure cluster showed higher educational attainment and occupational status, with more participants living with partners, suggesting better access to lifestyle education and natural exercise partners (*8*). These social factors likely contributed to their active leisure classification (*9*). Furthermore, compared to the low activity cluster, both active clusters demonstrated superior built environment access, better social and psychological states, lower body fat percentages, and enhanced physical fitness measures. These findings align with ecological models suggesting that supportive social and architectural environments can increase PA through environmental engineering (*10*). Experimental evidence supports this conclusion, indicating that communities with comprehensive PA support facilities, positive aesthetics, and competitive opportunities can effectively benefit adults with low activity levels (*11*).

A key strength of this study lies in its utilization of contemporary data from all 31 PLADs in China, which enhances the representativeness and robustness of the PA pattern cluster analysis. The interpretation of the results from this study should take into account several limitations. The first limitation is the reliance on self-reported questionnaire data for PA classification rather than objective measurements, future investigations should incorporate objective PA measurements (*12*) and comprehensive health status assessment. Second, PA results were based on cross-sectional survey research and did not consider possible fluctuations over time. Third, this study primarily included Chinese older adults, which could restrict the applicability of these findings to other racial demographics and representative population samples.

In conclusion, this study provides a comprehensive evaluation of PAPs and their associated group characteristics among China's elderly population at the national level as of 2020. Future research directions should focus on investigating how different types and combinations of built environment features effectively support PA enhancement.

Conflicts of interest: No conflict of interest.

Funding: Supported by the Fundamental Research Funds for the China Institute of Sport Science (grant No. 23-21).

doi: 10.46234/ccdcw2025.031

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Submitted: November 12, 2024
Accepted: December 13, 2024
Issued: February 07, 2025

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Preplanned Studies

Prevalence, Risk Factors, and Relevant Consequences of Mobile Phone Dependence Among Middle School Students — Guangzhou City, Guangdong Province, China, 2023

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Summary

What is already known about this topic?

The risk factors for mobile phone dependence (MPD) remain inconsistent and debated in the literature. Previous studies in China reported MPD prevalence rates of 26.2% among junior high students and 27.9% among senior high students in 2012. A 2021 study in Guangzhou City found a prevalence of 13.5% among first-year senior high students.

What is added by this report?

This study reveals that the overall MPD prevalence among middle school students in Guangzhou was 10.0% in 2023, with distinct rates between junior high (7.3%) and senior high (12.4%) students. The research identifies key risk factors for MPD development and documents injury patterns associated with excessive phone use.

What are the implications for public health practice?

These findings provide an evidence base for developing targeted interventions to reduce both MPD occurrence and associated injuries among middle school students.

ABSTRACT

Introduction: With the popularity of smartphones, mobile phone dependence (MPD) has become a public health issue of great concern worldwide, especially among middle school students. It can not only lead to physical and mental health problems such as eyestrain, anxiety, and depression, but also increase the risk of safety accidents due to distraction. The aim of this study was to assess the prevalence of MPD among middle school students in Guangzhou in 2023, identify its risk factors, and examine the consequences associated with excessive phone use.

Methods: From April to May 2023, a total of 1,928 students from 4 junior high schools and 4 senior high schools in Guangzhou City, Guangdong Province, were recruited through multi-stage cluster random sampling. The Mobile Phone Dependence Scale for Middle School Students (MPD Scale), consisting of 16 items with a maximum score of 80, was used. A score above 48 indicates MPD. SPSS 26.0 was used for statistical analysis.

Results: A total of 1,928 questionnaires were collected, of which 1,883 were valid. The overall prevalence of MPD in this study was 10.0%, with 7.3% among junior high school students and 12.4% among senior high school students. Logistic regression showed that female sex, higher grade level, authoritarian paternal parenting style, extended phone usage duration, and specific motivations for phone use were associated with the risk of MPD. The prevalence of injury due to distraction by phone was 29.4% in the MPD group, which was significantly higher than that of the non-MPD group (10%).

Conclusions: This study provides up-to-date data on the prevalence of MPD among middle school students in Guangzhou and reveals multiple factors that are associated with its development. Females and high school students should be particularly concerned as high-risk groups. To reduce the risk of MPD occurrence, families are encouraged to adopt democratic parenting styles and promote students' healthy phone use habits. In addition, preventing MPD may help reduce the risk of unintentional injuries due to mobile phone distraction.

Mobile phones offer significant convenience but also introduce a range of negative health-related concerns, among which mobile phone dependence (MPD) is particularly alarming. MPD, also referred to as mobile phone addiction, mobile phone abuse, or problematic mobile phone use, is a growing concern worldwide. It can lead to symptoms such as eye strain, anxiety, and depression (*1*). Additionally, excessive mobile phone use poses safety risks, such as injuries due to distractions while walking or crossing streets (*2*). Middle school students are especially vulnerable to MPD due to their developmental stage and increased exposure to mobile technology. Research on the correlation between various factors, such as socioeconomic status, and MPD has yielded inconsistent results among adolescents, leading to ongoing debate (*3*). This study, which uses data from a cross-sectional survey conducted from April to May 2023 in Guangzhou City, Guangdong Province, China, aims to assess the current prevalence of MPD among middle school students, identify its risk factors, and examine the associated consequences.

This cross-sectional study was conducted from April to May 2023 in Guangzhou, where junior and senior high school students were selected through multi-stage cluster random sampling (Figure 1). Based on Guangzhou's economic development and anticipated high mobile phone ownership among middle school students, an MPD prevalence of 15.0% was estimated. This estimate was informed by Qiu et al.'s 2021 Guangzhou survey (*4*), which reported a 13.5% prevalence among senior one students. Using the formula $n = Z_{\alpha}^2 p(1-p)/d^2$ for simple random sampling (α=0.05, d=0.15p), the initial sample size was calculated. To account for the multi-stage cluster sampling design, we increased this estimate by 50%. Assuming a 90% response rate, the final minimum required sample size was 1,613 students. The study employed Wang's (*5*) Mobile Phone Dependence Scale for Middle School Students (MPD Scale), comprising 16 items with a maximum score of 80, where scores exceeding 48 indicate MPD. Demographic data, mobile phone usage patterns, and usage consequences were collected. Parenting style and parental care levels were self-reported through standardized questions after participants received clear explanations of response options. All investigators underwent comprehensive training, and school personnel provided support to ensure data quality and authenticity. Prior to survey administration, both participants and their legal guardians received detailed study information. Respondents who incompletely filled out the MPD Scale (allowing one missing item with mean value interpolation) or provided illogical or non-serious responses to multiple-choice questions were excluded.

Statistical analyses were performed using IBM SPSS Statistics (version 26.0; SPSS, Inc., Armonk, NY,

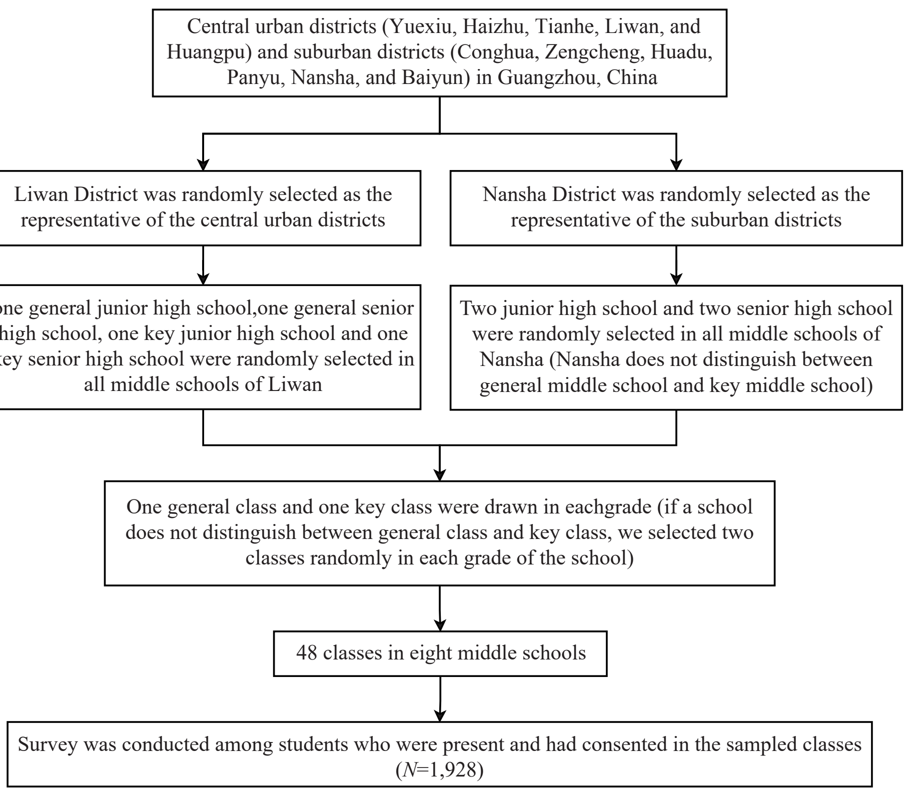

FIGURE 1. The flowchart of the sampling process in this study.

USA). Continuous data were presented as mean (standard deviation, SD) and median, and categorical variables were presented as counts and percentages. The Wilcoxon rank sum test compared MPD scale scores between MPD and non-MPD groups. Group comparisons utilized chi-square tests or Fisher's exact tests for univariate analyses. We employed stepwise binary logistic regression to identify MPD-associated factors, with variables selected based on previous research and preliminary statistical analyses. The odds ratios (*OR*s) and 95% confidence intervals (95% *CI*s) were calculated to quantify the impact of independent variables. Statistical significance was set at $P<0.05$ (two-tailed).

In this study, 1,928 questionnaires were collected, with 1,883 meeting eligibility criteria (97.67% effective rate). The MPD scale demonstrated good internal consistency with a Cronbach's alpha coefficient of 0.88. Participants had a mean age of 15.33 years (SD=1.71 years). The overall MPD prevalence among middle school students in Guangzhou was 10.0%, with differential rates between junior high (7.3%) and senior high students (12.4%). The mean total score on the MPD Scale was 35.74 (Table 1). Across all participants, including those diagnosed with MPD, scores were highest in the prominence dimension, followed by abstinence and compulsivity, with significant differences observed between MPD and non-MPD groups across all three dimensions.

The univariate analysis comparing MPD and non-MPD groups revealed significant differences ($P<0.05$) across multiple variables: sex, grade, personality, perceived study pressure, academic achievement, father's education level, father's parenting style, father's caring for their children, number of mobile phones owned, duration of mobile phone ownership, daily mobile phone usage time, motivation and application of mobile phone use, and monthly internet data usage. Notable disparities emerged in mobile phone use consequences between groups, particularly in injury occurrence due to excessive phone focus (29.4% in the MPD group *vs*. 10% in the non-MPD group) (Table 2). These findings indicate that excessive mobile phone use significantly increases the risk of physical injuries, including collisions with stationary objects and falls.

In the multivariable binary logistic regression analysis, using the non-MPD group as a reference, several significant risk factors for MPD development emerged. Female students demonstrated heightened susceptibility [adjusted *OR* (*aOR*)=1.772, 95% *CI*: 1.239, 2.532], as did high school students (*aOR*=1.479, 95% *CI*: 1.014, 2.155). Paternal authoritarian parenting style (*aOR*=2.023, 95% *CI*: 1.315, 3.111) and mobile phone usage exceeding 6 hours during rest days (*aOR*=3.115, 95% *CI*: 1.829, 5.307) were identified as substantial risk factors. Additionally, specific motivations for mobile phone use significantly increased MPD risk, including interpersonal communication or self-expression (*aOR*=2.197, 95% *CI*: 1.183, 4.079) and entertainment (*aOR*=2.527, 95% *CI*: 1.381, 4.624) (Table 3). A separate multivariable binary logistic regression model (not presented in tables) revealed that students with MPD exhibited a significantly higher likelihood of sustaining phone-related distraction injuries compared to those without MPD (*aOR*=3.359, 95% *CI*: 2.276, 4.957).

DISCUSSION

The prevalence of MPD in this study — 7.3% among junior high students and 12.4% among senior high students — was notably lower than rates reported

TABLE 1. Scores of each item at different dimensions and total score of MPD scale.

Dimensions*	All participants			Participants with MPD			Participants without MPD			*P*
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	
Abstinence	2.1	0.9	2.0	3.6	0.6	3.5	1.9	0.7	2.0	<0.001
Compulsivity	1.7	0.7	1.6	2.8	0.8	2.8	1.6	0.6	1.4	<0.001
Prominence	2.9	0.8	3.0	3.9	0.5	3.8	2.8	0.8	2.8	<0.001
Total score	35.7	10.6	35.0	55.1	5.9	54.0	33.6	8.7	34.0	<0.001

Abbreviation: SD=standard deviation; MPD=mobile phone dependence.

* Abstinence: This refers to the emotional reactions, such as anxiety and irritability, that occur when an individual is suddenly unable to use their phone or cannot use it normally. Compulsivity: This refers to an individual exhibiting a compelling desire and urge to use the mobile phone, finding it challenging to disengage, and potentially experiencing delusions associated with phone use. Prominence: This is when behavior is dominated by the use of the mobile phone, primarily manifested as overuse of the phone and excessive checking of the phone in daily life.

TABLE 2. Basic information, mobile phone use, and consequences of phone use among middle school students in Guangzhou, China.

Variables	Total (*n*=1,883)	Non-MPD group (*n*=1,694)	MPD group (*n*=189)	Fisher* /χ^2	*P*
Sex				8.473	0.004
Male	1,035 (55.0)	950 (56.1)	85 (45.0)		
Female	848 (45.0)	744 (43.9)	104 (55.0)		
Grade				13.200	<0.001
Junior high school	873 (46.4)	809 (47.8)	64 (33.9)		
Senior high school	1,010 (53.6)	885 (52.2)	125 (66.1)		
Academic performance†					
1%–25% in grade	585 (31.1)	529 (31.2)	56 (29.6)	13.503	0.004
26%–50% in grade	587 (31.2)	541 (31.9)	46 (24.3)		
51%–75% in grade	508 (27.0)	455 (26.9)	53 (28.0)		
76%–100% in grade	203 (10.8)	169 (10.0)	34 (18.0)		
Physical activity				5.161	0.156
Once a day	491 (26.1)	437 (25.8)	54 (28.6)		
4–6 times a week	848 (45.0)	777 (45.9)	71 (37.6)		
1–3 times a week	500 (26.6)	441 (26.0)	59 (31.2)		
Never play sports	44 (2.3)	39 (2.3)	5 (2.6)		
Perceived study pressure				22.593	<0.001
Low/no stress	61 (3.2)	53 (3.1)	8 (4.2)		
Appropriate stress	1,044 (55.4)	970 (57.3)	74 (39.2)		
Heavy/very heavy stress	778 (41.3)	671 (39.6)	107 (56.6)		
Father's Education§				10.497	0.033
Elementary school or below	100 (5.3)	84 (5.0)	16 (8.5)		
Junior high school	668 (35.5)	597 (35.2)	71 (37.6)		
Senior high/technical secondary school	636 (33.8)	588 (34.7)	48 (25.4)		
Junior college/vocational university	253 (13.4)	221 (13.2)	32 (16.9)		
Bachelor's degree or above	226 (12.0)	204 (12.0)	22 (11.6)		
Father's parenting style§				18.413	<0.001
Democratic	1,023 (54.3)	947 (55.9)	76 (40.2)		
Authoritarian	401 (21.3)	343 (20.2)	58 (30.7)		
Indulgent	442 (23.5)	389 (23.0)	53 (28.0)		
Spoiling	17 (0.9)	15 (0.9)	2 (1.1)		
Father's caring for their children§				12.475	0.002
Very caring	935 (49.7)	864 (51.0)	71 (37.6)		
Average	807 (42.9)	708 (41.8)	99 (52.4)		
Doesn't care	141 (7.5)	122 (7.2)	19 (10.1)		
Time spent on mobile phone on rest days				66.104	<0.001
0 to 2 hours	530 (28.1)	499 (29.5)	31 (16.4)		
More than 2 hours to 6 hours	960 (51.0)	884 (52.2)	76 (40.2)		
More than 6 hours	393 (20.9)	311 (18.4)	82 (43.4)		
Main motivation for using mobile phone				20.969	<0.001
Information access	334 (17.7)	319 (18.8)	15 (7.9)		
Interpersonal communication or self-expression	668 (35.5)	599 (35.4)	69 (36.5)		

Continued

Variables	Total (n=1,883)	Non-MPD group (n=1,694)	MPD group (n=189)	Fisher* /χ^2	P
Entertainment	816 (43.3)	713 (42.1)	103 (54.4)		
Others	65 (3.5)	63 (3.7)	2 (1.1)		
Finger fatigue, stiffness, or pain¶					
Yes	227 (12.1)	172 (10.2)	55 (29.4)	58.323	<0.001
No	1,646 (87.9)	1,514 (89.8)	132 (70.6)		
Eyes blurred or hurting¶				54.318	<0.001
Yes	630 (33.6)	522 (30.9)	108 (57.8)		
No	1,245 (66.4)	1,166 (69.1)	79 (42.2)		
Tinnitus¶				29.258	<0.001
Yes	150 (8.0)	116 (6.9)	34 (18.2)		
No	1,725 (92.0)	1,572 (93.1)	153 (81.8)		
Being injured because of phone distractions¶				60.423	<0.001
Yes	223 (11.9)	168 (10.0)	55 (29.4)		
No	1,646 (88.1)	1,514 (90.0)	132 (70.6)		

Abbreviation: MPD=mobile phone dependence.
* Fisher: Fisher exact test.
† The ranking of academic performance is self-reported, therefore the proportions are not perfectly divided into quartiles.
§ The corresponding variables for mothers do not show significant differences between the two groups.
¶ There are missing data: 10, 8, 8, and 14 missing values for the respective variables.

in 2012 and 2021 (*4*,*6*). Logistic regression analysis identified several significant risk factors associated with MPD development, including female sex, higher grade level, authoritarian paternal parenting style, extended phone usage duration, and specific motivations for phone use.

The results align with previous research indicating that females demonstrate higher susceptibility to MPD than males (*aOR*=1.772). This sex-based disparity may be attributed to adolescent females' heightened need for emotional fulfillment through social relationships and their tendency to express emotions via mobile phone messaging applications. The study also revealed that senior high school students exhibited greater vulnerability to MPD (*aOR*=1.479) compared to junior high students. This observation is consistent with research conducted among middle school students in Xiamen City, Fujian Province, China, which documented increased mobile phone dependency in senior high school cohorts (*7*). This elevated risk may stem from the intense academic pressures and college entrance examination stress faced by Chinese senior high school students, potentially leading to challenges in regulating mobile phone usage as a stress-coping mechanism (*7*). To address these concerns, we recommend that senior high schools implement regular psychological counseling services and optimize academic pressure management strategies to help students develop healthier coping mechanisms and reduce mobile phone dependency.

This study demonstrated that students whose fathers exhibited authoritarian parenting styles faced a significantly higher risk of developing MPD (*aOR*=2.023). This finding aligns with research from Indonesia that established a positive correlation between authoritarian parenting and mobile phone dependency (*8*). Moreover, existing literature indicates that family cohesion exhibits an inverse relationship with mobile phone dependency (*9*), while individuals raised in emotionally supportive, harmonious family environments are more likely to develop secure family attachments, thereby reducing their susceptibility to MPD (*10*). These findings underscore the critical role of family dynamics in MPD development and highlight the importance of considering familial environments when designing intervention strategies.

The analysis identified several behavioral risk factors for MPD, including mobile phone usage exceeding 6 hours during rest days (*aOR*=3.115), utilization primarily for interpersonal communication or self-expression (*aOR*=2.197), and entertainment-focused usage (*aOR*=2.527). The increased availability of free time may contribute to excessive mobile phone engagement. These findings emphasize the necessity of implementing targeted guidance for middle school students regarding appropriate technology usage patterns and fostering healthier attitudes toward digital device engagement.

TABLE 3. Results on multivariable binary logistic regression analysis of MPD.

Variables	*aOR**	95% *CI*	*P*
Sex			
Male (reference)			
Female	1.772	1.239, 2.532	0.002
Grade			
Junior high school (reference)			
Senior high school	1.479	1.014, 2.155	0.042
Father's parenting style†			
Democratic (reference)			
Authoritarian	2.023	1.315, 3.111	0.001
Indulgent	1.485	0.978, 2.255	0.064
Spoiling	1.527	0.321, 7.259	0.594
Time spent on mobile phone on rest days			
0 to 2 hours			
More than 2 hours to 6 hours	1.288	0.785, 2.115	0.316
More than 6 hours	3.115	1.829, 5.307	0.001
Main motivation for using mobile phone			
Information access (reference)			
Interpersonal communication or self-expression	2.197	1.183, 4.079	0.013
Entertainment	2.527	1.381, 4.624	0.003
Others	0.755	0.093, 6.129	0.793

Abbreviation: *aOR*=adjusted odds ratio; *CI*=confidence interval.

* Variables whose *P* value less than 0.05 in the univariate analysis were included to establish a multivariable binary logistic regression model.

† Democratic parenting style is one where parents engage in an equal and respectful relationship with their children, allowing for the full expression of their individual personalities. Authoritarian parenting style is characterized by absolute authority and a preference for control, which can inhibit the full expression of the child's individual personality. Permissive parenting style is characterized by a lack of enforced rules and restrictions, a high level of trust in the child's life and academic decisions, and the delegation of most control to the child. Indulgent parenting style is characterized by excessively fulfilling any needs of the child, over-pampering, allowing the child's temperament to dictate, and indulging the child.

Among the consequences related to MPD, our results revealed significantly higher rates of physical symptoms in the MPD group compared to the non-MPD group, including finger pain, ocular discomfort, and tinnitus, indicating substantial adverse physiological effects. Most notably, students with MPD demonstrated a markedly elevated risk of sustaining injuries due to phone-related distractions (*aOR*=3.359). The immersive nature of mobile content can significantly diminish environmental awareness, increasing susceptibility to falls, collisions, and potentially serious accidents. As mobile phone adoption and usage duration continue to rise, the incidence of such injuries may correspondingly increase (*11*). Therefore, implementing targeted interventions to mitigate MPD is crucial for preventing mobile phone-related injuries.

This study has several limitations. First, the reliance on self-reported data introduces potential information bias. Second, the cross-sectional design precludes definitive causal inference. Future research should employ longitudinal methodologies to address these limitations.

Nevertheless, this study provides contemporary data on MPD prevalence and identifies key risk factors for its development. Our findings indicate that female students and high school students require particular attention in intervention strategies. The promotion of democratic parenting styles within families may reduce MPD risk. Additionally, evidence-based educational programs should be developed to foster healthy mobile phone usage patterns. Most critically, reducing MPD prevalence could substantially decrease the risk of unintentional injuries caused by mobile phone-related distractions — an urgent public health concern requiring immediate attention to prevent accidents among middle school students. A comprehensive approach involving societal, educational, familial, and individual interventions is essential to effectively address MPD and protect adolescent health.

Conflicts of interest: No conflicts of interest.

Acknowledgments: We extend our gratitude to the staff involved in the field investigation and the relevant departments of various schools for their cooperation.

Ethical statement: Received ethical approval from the Ethics Committee of the Guangzhou Center for Disease Control and Prevention, China (approval number: GZCDC-ECHR-2021P0063).

Funding: This study was supported by the Medical Science and Technology Research Foundation of Guangdong (B2022109).

doi: 10.46234/ccdcw2025.032

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Submitted: October 17, 2024
Accepted: December 03, 2024
Issued: February 07, 2025

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Preplanned Studies

Detection Rate and Risk Factors of Abnormal Spinal Curvature Among Children and Adolescents — Jiangsu Province, China, 2021–2023

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Summary

What is already known about this topic?

Spinal curvature abnormalities have emerged as a major public health challenge for children and adolescents in China, with detection rates showing a concerning upward trend in recent years.

What is added by this report?

This population-based surveillance study revealed a 2.1% detection rate of abnormal spinal curvature among children and adolescents aged 6–17 years in Jiangsu Province. The findings emphasize the critical need for early intervention programs targeting modifiable risk factors, including insufficient physical activity, inadequate sleep duration, and improper reading and writing posture.

What are the implications for public health practice?

The increasing burden of abnormal spinal curvature requires targeted attention, particularly for high school students and females during growth spurts. A comprehensive approach combining early lifestyle interventions, such as adequate outdoor activities, with appropriate referrals to public health specialists and orthopedic surgeons may enhance risk mitigation. Success in addressing this challenge requires coordinated multisectoral collaboration and active parental engagement.

ABSTRACT

Introduction: In China, the prevalence of abnormal spinal curvature in children and adolescents is high and the number of cases is increasing in recent years, which seriously threatens physical and mental health of children and adolescents. Public health surveillance of these abnormalities is crucial for developing targeted interventions.

Methods: This study evaluated detection rates and risk factors of spinal curvature abnormalities among children and adolescents in Jiangsu Province, China. This study analyzed data from the population-based "Surveillance for Common Disease and Health Risk Factors Among Students" project, implemented annually from September to November during 2021–2023. Abnormal spinal curvature was assessed using the national "Technical Guide for Prevention and Control of Abnormal Spinal Curvature in Children and Adolescents." Detection rates were calculated, and associated factors were evaluated using multivariate logistic regression.

Results: Annual detection rates were 2.6%, 1.8%, and 2.3%, respectively, among children and adolescents aged 6–17 years. Detection rates increased with age and were significantly higher among females compared to males. Adequate physical activity, sufficient sleep, and correct reading and writing postures were protective factors against spinal curvature abnormalities, while low body weight was associated with increased risk.

Conclusion: The emerging burden of abnormal spinal curvature necessitates targeted public health interventions, particularly for high school students and females. Beyond implementing early lifestyle interventions such as sufficient outdoor activities, appropriate referrals to public health specialists and orthopedic surgeons may provide additional risk mitigation. Successful outcomes require multisectoral collaboration and parental engagement to achieve sustainable public health improvements.

Abnormal spinal curvature significantly impacts both the physical and mental well-being of children and adolescents. Adolescent idiopathic scoliosis (AIS) represents the most prevalent form of abnormal spinal curvature, affecting 1%–4% of adolescents with a notable predisposition toward females (*1*). In China, spinal curvature abnormalities have emerged as a major public health challenge, with detection rates among primary and secondary school students reaching 2.8% in 2019 (*2*). This study aimed to evaluate temporal trends in detection rates and identify risk factors associated with spinal curvature abnormalities among children and adolescents in Jiangsu Province, China. Systematic public health surveillance of spinal curvature abnormalities in this population is essential for developing targeted interventions.

This study utilized data from the "Surveillance for Common Disease and Health Risk Factors Among Students" program conducted across all 13 prefecture-level administrative regions in Jiangsu Province. The program methodology has been detailed elsewhere (*3*). The surveillance coverage expanded progressively: in 2021, a pilot study encompassed 26 districts and counties; in 2022, coverage increased to 88 districts; and by 2023, the program included all 98 districts and counties in Jiangsu. While a cohort design would have enabled incidence estimation, the current study employed cross-sectional sampling each year. Efforts to establish a longitudinal cohort for incidence rate calculations are ongoing and will be reported separately. This study implemented standardized training protocols for all field personnel and maintained rigorous quality control measures for data management. To validate temporal trends given the varying coverage, supplementary analyses were conducted using simple random sampling of two distinct districts per city annually. The questionnaire response rate achieved 97.7%.

Following the UN Convention on the Rights of the Child's definition of children as those aged 18 years and under, and considering the impact of growth spurts on spinal curvature development, this study adopted the term "children and adolescents" for this study. All variables, except abnormal spinal curvature and body mass index (BMI), were self-reported by participants. Spinal curvature abnormality was defined as spinal curvature exceeding normal physiological ranges, encompassing both scoliosis and sagittal spinal abnormalities. Screening procedures adhered to the national "Technical Guide for Prevention and Control of Abnormal Spinal Curvature in Children and Adolescents". BMI was calculated as weight in kilograms divided by height in meters squared, with measurements conducted by trained research associates using standardized equipment and protocols (height measured to 0.1 cm, weight to 0.1 kg). Detailed variable definitions are presented in corresponding table.

Statistical analyses were conducted using R Software (version 4.4.0; The R Foundation for Statistical Computing, Vienna, Austria). This study summarized categorical variables using frequencies and percentages, employing Chi-square tests to assess proportional differences. Risk factors associated with abnormal spinal curvature were evaluated using multivariate logistic regression, with variable selection informed by both lasso technique and existing literature. Statistical significance was set at $P<0.05$.

A total of 370,000 children and adolescents aged 6–17 years participated in the surveillance program during 2021–2023, comprising 47,310 participants in 2021, 150,387 in 2022, and 173,341 in 2023. The study population included 168,787 (45.5%) children aged 6–11 years and 202,251 (54.5%) adolescents aged 12–17 years, with a slight male predominance (193,518, 52.2% *vs.* 177,520, 47.8% females) and higher urban representation (197,654, 53.3% *vs.* 173,384, 46.7% rural). The annual detection rates of abnormal spinal curvature were 2.6%, 1.8%, and 2.3% for 2021, 2022, and 2023, respectively. Geographic variation in detection rates was observed across the 13 municipalities of Jiangsu Province (Table 1). Validation analyses confirmed that the temporal pattern of detection rates was consistent with the primary analysis (Supplementary Table S1, available at https://weekly.chinacdc.cn/). Age-stratified analyses revealed that detection rates increased with age, with males showing a marked increase at age 11 while females demonstrated an earlier increase at age 9 (Figure 1). Higher detection rates were observed among females compared to males (3.1% *vs.* 2.4%), senior high school students compared to primary and junior high school students (4.1% *vs.* 1.3% and 3.3%, respectively), students experiencing growth spurts compared to those who were not (2.8% *vs.* 2.0%), and students with insufficient physical activities compared to those with sufficient activities (2.8% *vs.* 1.9%) (Supplementary Table S1).

Detection rates of abnormal spinal curvature among children and adolescents in Jiangsu Province from 2021 to 2023 showed significant differences ($P<0.001$) across multiple factors, including region, district, gender, grade, BMI, growth and development period, physical activities, sleep, reading and writing posture, schoolbag habits, schoolbag weight, mattress softness, and sitting and standing posture (Table 2).

Multivariate analysis revealed protective effects associated with sufficient physical activities, adequate sleep, and correct reading and writing posture, each

TABLE 1. Detection rate of abnormal spinal curvature among children and adolescents across 13 municipalities in Jiangsu Province, 2021–2023.

Prefecture-level administrative regions	2021			2022			2023			Total		
	N	*n*	Rate (95% *CI*)	*N*	*n*	Rate (95% *CI*)	*N*	*n*	Rate (95% *CI*)	*N*	*n*	Rate (95% *CI*)
Nanjing	3,419	132	3.86 (3.21, 4.51)	13,485	196	1.45 (1.25, 1.66)	19,613	619	3.16 (2.91, 3.40)	36,517	947	2.59 (2.43, 2.76)
Wuxi	3,562	176	4.94 (4.23, 5.65)	12,776	218	1.71 (1.48, 1.93)	13,104	482	3.68 (3.36, 4.00)	29,442	876	2.98 (2.78, 3.17)
Xuzhou	3,684	54	1.47 (1.08, 1.85)	17,427	154	0.88 (0.74, 1.02)	17,862	152	0.85 (0.72, 0.99)	38,973	360	0.92 (0.83, 1.02)
Changzhou	3,669	122	3.33 (2.75, 3.91)	9,504	128	1.35 (1.12, 1.58)	12,293	311	2.53 (2.25, 2.81)	25,466	561	2.20 (2.02, 2.38)
Suzhou	3,613	66	1.83 (1.39, 2.26)	16,438	625	3.80 (3.51, 4.09)	18,880	736	3.90 (3.62, 4.17)	38,931	1,427	3.67 (3.48, 3.85)
Nantong	3,877	157	4.05 (3.43, 4.67)	9,646	537	5.57 (5.11, 6.02)	13,221	389	2.94 (2.65, 3.23)	26,744	1,083	4.05 (3.81, 4.29)
Lianyungang	3,657	67	1.83 (1.40, 2.27)	10,544	215	2.04 (1.77, 2.31)	10,884	332	3.05 (2.73, 3.37)	25,085	614	2.45 (2.26, 2.64)
Huai'an	3,702	10	0.27 (0.10, 0.44)	12,317	159	1.29 (1.09, 1.49)	12,435	382	3.07 (2.77, 3.38)	28,454	551	1.94 (1.78, 2.10)
Yancheng	3,612	23	0.64 (0.38, 0.90)	16,154	251	1.55 (1.36, 1.74)	15,393	126	0.82 (0.68, 0.96)	35,159	400	1.14 (1.03, 1.25)
Yangzhou	3,507	96	2.74 (2.20, 3.28)	8,722	39	0.45 (0.31, 0.59)	9,865	202	2.05 (1.77, 2.33)	22,094	337	1.53 (1.36, 1.69)
Zhenjiang	3,644	169	4.64 (3.95, 5.32)	10,699	119	1.11 (0.91, 1.31)	10,334	97	0.94 (0.75, 1.12)	24,677	385	1.56 (1.41, 1.71)
Taizhou	3,625	97	2.68 (2.15, 3.20)	3,662	11	0.30 (0.12, 0.48)	10,521	160	1.52 (1.29, 1.75)	17,808	268	1.50 (1.33, 1.68)
Suqian	3,739	55	1.47 (1.09, 1.86)	9,013	27	0.30 (0.19, 0.41)	8,936	79	0.88 (0.69, 1.08)	21,688	161	0.74 (0.63, 0.86)

Abbreviation: *CI*=confidence interval.

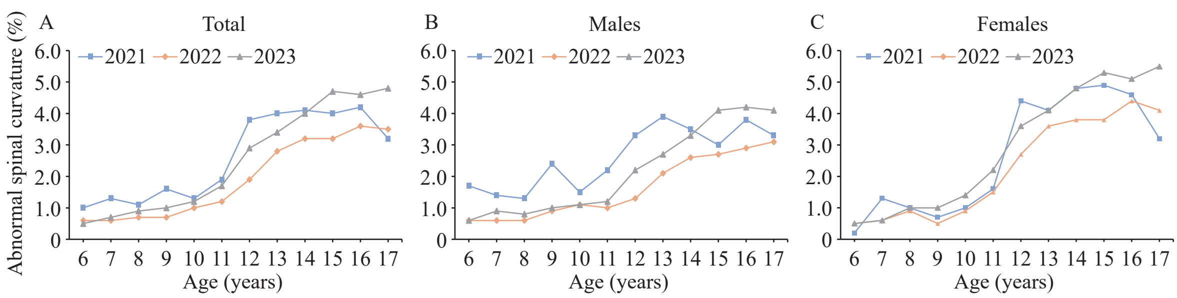

FIGURE 1. Age-specific detection rates of abnormal spinal curvature among children and adolescents aged 6–17 years in Jiangsu Province, 2021–2023. (A) All children and adolescents; (B) Males; (C) Females.

corresponding to lower odds of abnormal spinal curvature. Conversely, higher academic grades, female gender, and being underweight were associated with increased odds of abnormal spinal curvature (Figure 2).

DISCUSSION

The 3-year detection rate of spinal curvature abnormalities among children and adolescents aged 6–17 years in Jiangsu Province (2.1%) was lower than rates reported in Sichuan Province (3.4%) (*4*) and Inner Mongolia Autonomous Region (3.6%) (*5*). This regional variation may be attributed to differences in economic development levels and study sample sizes.

This study's observation of elevated detection rates of abnormal spinal curvature in higher academic grades aligns with previous findings that scoliosis prevalence in China increases with grade level (*6*). Adolescence represents a critical period for skeletal muscle development, during which persistent incorrect posture may lead to abnormal spinal curvature and scoliosis. Students in higher grades typically face increased academic workloads, potentially promoting sedentary behaviors that may contribute to spinal abnormalities.

Consistent with previous research (*7*), this study found higher detection rates of spinal curvature abnormalities in females compared to males. This gender disparity may be attributed to multiple factors,

TABLE 2. Detection rates of abnormal spinal curvature among children and adolescents in Jiangsu Province, 2021–2023.

Variables	2021				2022				2023				Total			
	N	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*
Region				<0.001				<0.001				<0.001				<0.001
Southern Jiangsu	12,934	571	4.41 (4.06, 4.77)		45,298	1,173	2.59 (2.44, 2.74)		54,188	2,067	3.81 (3.65, 3.98)		112,420	3,811	3.39 (3.28, 3.50)	
Central Jiangsu	7,940	328	4.13 (3.69, 4.57)		15,686	535	3.41 (3.13, 3.69)		24,216	680	2.81 (2.60, 3.02)		47,842	1,543	3.23 (3.07, 3.38)	
Northern Jiangsu	13,273	176	1.33 (1.13, 1.52)		46,401	692	1.49 (1.38, 1.60)		46,959	962	2.05 (1.92, 2.18)		106,633	1,830	1.72 (1.64, 1.79)	
District				<0.001				<0.001				<0.001				<0.001
Urban	19,091	383	2.01 (1.81, 2.21)		59,215	1,188	2.01 (1.89, 2.12)		67,693	2,154	3.18 (3.05, 3.31)		145,999	3,725	2.55 (2.47, 2.63)	
Rural	15,056	692	4.60 (4.26, 4.93)		48,170	1,212	2.52 (2.38, 2.66)		57,670	1,555	2.70 (2.56, 2.83)		120,896	3,459	2.86 (2.77, 2.96)	
Gender				0.153				<0.001				<0.001				<0.001
Male	17,742	535	3.02 (2.76, 3.27)		56,277	1,021	1.81 (1.70, 1.92)		65,229	1,628	2.50 (2.38, 2.62)		139,248	3,184	2.29 (2.21, 2.37)	
Female	16,405	540	3.29 (3.02, 3.56)		51,108	1,379	2.70 (2.56, 2.84)		60,134	2,081	3.46 (3.31, 3.61)		127,647	4,000	3.13 (3.04, 3.23)	
Grade				<0.001				<0.001				<0.001				<0.001
Primary school	13,161	218	1.66 (1.44, 1.87)		42,971	450	1.05 (0.95, 1.14)		47,568	649	1.36 (1.26, 1.47)		103,700	1,317	1.27 (1.20, 1.34)	
Junior High School	12,651	534	4.22 (3.87, 4.57)		40,432	1,131	2.80 (2.64, 2.96)		47,397	1,650	3.48 (3.32, 3.65)		100,480	3,315	3.30 (3.19, 3.41)	
Senior High School	8,335	323	3.88 (3.46, 4.29)		23,982	819	3.42 (3.19, 3.64)		30,398	1,410	4.64 (4.40, 4.87)		62,715	2,552	4.07 (3.91, 4.22)	
BMI*				<0.001				<0.001				<0.001				<0.001
Normal	19,946	715	3.58 (3.33, 3.84)		63,169	1,746	2.76 (2.64, 2.89)		72,390	2,691	3.72 (3.58, 3.86)		155,505	5,152	3.31 (3.22, 3.40)	
Underweight	1,220	48	3.93 (2.84, 5.03)		3,656	113	3.09 (2.53, 3.65)		5,935	296	4.99 (4.43, 5.54)		10,811	457	4.23 (3.85, 4.61)	
Overweight	6,521	172	2.64 (2.25, 3.03)		20,234	322	1.59 (1.42, 1.76)		22,558	417	1.85 (1.67, 2.02)		49,313	911	1.85 (1.73, 1.97)	
Obesity	6,460	140	2.17 (1.81, 2.52)		20,326	219	1.08 (0.94, 1.22)		24,480	305	1.25 (1.11, 1.38)		51,266	664	1.30 (1.20, 1.39)	
Growth and development period				<0.001				<0.001				<0.001				<0.001
No	17,777	415	2.33 (2.11, 2.56)		56,992	729	1.28 (1.19, 1.37)		100,871	2,851	0.62 (0.57, 0.67)		175,640	3,995	1.95 (1.86, 2.04)	
Yes	16,370	660	4.03 (3.73, 4.33)		50,393	1,671	3.32 (3.16, 3.47)		24,492	858	3.50 (3.27, 3.73)		91,255	3,189	3.49 (3.38, 3.61)	

Continued

Variables	2021				2022				2023				Total			
	N	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*
MVPA†				<0.001				<0.001				<0.001				<0.001
Insufficient	29,127	959	3.30 (3.09, 3.50)		91,005	2,166	2.38 (2.28, 2.48)		106,971	3,297	3.08 (2.98, 3.19)		227,103	6,422	2.83 (2.76, 2.90)	
Sufficient	5,020	116	2.31 (1.90, 2.73)		16,380	234	1.43 (1.25, 1.61)		18,392	412	2.24 (2.03, 2.45)		39,792	762	1.91 (1.78, 2.05)	
Sleep§				<0.001				<0.001				<0.001				<0.001
Insufficient	26,378	872	3.31 (3.09, 3.53)		82,306	1,991	2.42 (2.31, 2.52)		97,783	3,028	3.10 (2.99, 3.21)		206,467	5,891	2.85 (2.78, 2.93)	
Sufficient	7,769	203	2.61 (2.26, 2.97)		25,079	409	1.63 (1.47, 1.79)		27,580	681	2.47 (2.29, 2.65)		60,428	1,293	2.14 (2.02, 2.26)	
Reading and writing posture				0.055				<0.001				<0.001				<0.001
Incorrect	23,124	757	3.28 (3.05, 3.51)		75,489	1,846	2.45 (2.34, 2.56)		90,572	2,826	3.12 (3.01, 3.23)		189,185	5,429	2.87 (2.79, 2.94)	
Correct	11,023	318	2.88 (2.57, 3.20)		31,896	554	1.74 (1.59, 1.88)		34,791	883	2.54 (2.37, 2.70)		77,710	1,755	2.26 (2.15, 2.36)	
Schoolbag habits				0.002				0.004				<0.001				<0.001
On the chest	2,269	45	1.98 (1.41, 2.56)		6,763	112	1.66 (1.35, 1.96)		9,215	197	2.14 (1.84, 2.43)		18,247	354	1.94 (1.74, 2.14)	
On the back	26,466	844	3.19 (2.98, 3.40)		83,457	1,878	2.25 (2.15, 2.35)		96,696	2,901	3.00 (2.89, 3.11)		206,619	5,623	2.72 (2.65, 2.79)	
On one side	2,721	108	3.97 (3.24, 4.70)		8,617	220	2.55 (2.22, 2.89)		9,866	347	3.52 (3.15, 3.88)		21,204	675	3.19 (2.95, 3.42)	
Shoulder bag	2,248	65	2.89 (2.20, 3.58)		7,252	166	2.29 (1.94, 2.63)		8,158	232	2.84 (2.48, 3.20)		17,658	463	2.62 (2.39, 2.86)	
Schoolbag with wheels	443	13	2.93 (1.36, 4.51)		1,296	24	1.85 (1.12, 2.59)		1,428	32	2.24 (1.47, 3.01)		3,167	69	2.18 (1.67, 2.69)	
Schoolbag Weight				0.028				<0.001				<0.001				<0.001
Very light	3,165	72	2.27 (1.76, 2.79)		9,561	165	1.73 (1.46, 1.99)		14,234	391	2.75 (2.48, 3.02)		26,960	628	2.33 (2.15, 2.51)	
Relatively light	5,572	184	3.30 (2.83, 3.77)		17,617	417	2.37 (2.14, 2.59)		21,342	721	3.38 (3.14, 3.62)		44,531	1,322	2.97 (2.81, 3.13)	
Medium	17,368	584	3.36 (3.09, 3.63)		55,637	1,298	2.33 (2.21, 2.46)		60,984	1,857	3.05 (2.91, 3.18)		133,989	3,739	2.79 (2.70, 2.88)	
Relatively heavy	5,435	157	2.89 (2.44, 3.33)		17,026	389	2.28 (2.06, 2.51)		19,154	497	2.59 (2.37, 2.82)		41,615	1,043	2.51 (2.36, 2.66)	
Very heavy	1,879	57	3.03 (2.26, 3.81)		5,562	97	1.74 (1.40, 2.09)		6,861	174	2.54 (2.16, 2.91)		14,302	328	2.29 (2.05, 2.54)	
Unknown	728	21	2.88 (1.67, 4.10)		1,982	34	1.72 (1.14, 2.29)		2,788	69	2.47 (1.90, 3.05)		5,498	124	2.26 (1.86, 2.65)	

Continued

Variables	2021				2022				2023				Total			
	N	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*
Regular seat changes				0.067				0.214				0.114				0.077
No	13,052	382	2.93 (2.64, 3.22)		39,218	847	2.16 (2.02, 2.30)		52,736	1,513	2.87 (2.73, 3.01)		105,006	2,742	2.61 (2.51, 2.71)	
Yes	21,095	693	3.29 (3.04, 3.53)		68,167	1,553	2.28 (2.17, 2.39)		72,627	2,196	3.02 (2.90, 3.15)		161,889	4,442	2.74 (2.66, 2.82)	
Softness of mattress				0.125				<0.001				0.002				<0.001
Soft	4,683	125	2.67 (2.21, 3.13)		17,250	305	1.77 (1.57, 1.96)		20,322	525	2.58 (2.37, 2.80)		42,255	955	2.26 (2.12, 2.40)	
Medium	26,767	864	3.23 (3.02, 3.44)		82,861	1,927	2.33 (2.22, 2.43)		94,097	2,839	3.02 (2.91, 3.13)		203,725	5,630	2.76 (2.69, 2.84)	
Hard	2,697	86	3.19 (2.53, 3.85)		7,274	168	2.31 (1.96, 2.65)		10,944	345	3.15 (2.83, 3.48)		20,915	599	2.86 (2.64, 3.09)	
Sole wear patterns (left/right)				0.057				0.676				0.699				0.615
No difference	32,187	1,031	3.20 (3.01, 3.40)		100,740	2,256	2.24 (2.15, 2.33)		116,961	3,457	2.96 (2.86, 3.05)		249,888	6,744	2.70 (2.64, 2.76)	
Left	867	18	2.08 (1.13, 3.03)		2,964	69	2.33 (1.79, 2.87)		3,677	104	2.83 (2.29, 3.36)		7,508	191	2.54 (2.19, 2.90)	
Right	1,093	26	2.38 (1.48, 3.28)		3,681	75	2.04 (1.58, 2.49)		4,725	148	3.13 (2.64, 3.63)		9,499	249	2.62 (2.30, 2.94)	
Sole wear patterns (inside/outside)				0.922				0.839				0.1				0.266
No difference	30,596	962	3.14 (2.95, 3.34)		94,874	2,112	2.23 (2.13, 2.32)		111,363	3,276	2.94 (2.84, 3.04)		236,833	6,350	2.68 (2.62, 2.75)	
Inside	1,259	42	3.34 (2.34, 4.33)		4,384	99	2.26 (1.82, 2.70)		5,256	181	3.44 (2.95, 3.94)		10,899	322	2.95 (2.64, 3.27)	
Outside	2,292	71	3.10 (2.39, 3.81)		8,127	189	2.33 (2.00, 2.65)		8,744	252	2.88 (2.53, 3.23)		19,163	512	2.67 (2.44, 2.90)	
Sitting and standing posture				<0.001				<0.001				<0.001				<0.001
Just be comfortable	6,697	229	3.42 (2.98, 3.85)		24,439	566	2.32 (2.13, 2.50)		34,354	1,077	3.14 (2.95, 3.32)		65,490	1,872	2.86 (2.73, 2.99)	
Sometimes monitor myself	12,857	459	3.59 (3.25, 3.89)		40,268	1,068	2.65 (2.50, 2.81)		48,056	1,581	3.29 (3.13, 3.45)		101,181	3,108	3.07 (2.97, 3.18)	
Keep reminding myself	6,825	204	2.99 (2.59, 3.39)		20,539	405	1.97 (1.78, 2.16)		21,472	608	2.83 (2.61, 3.05)		48,836	1,217	2.49 (2.35, 2.63)	
Maintain good posture at all time	7,768	183	2.36 (2.02, 2.69)		22,139	361	1.63 (1.46, 1.80)		21,481	443	2.06 (1.87, 2.25)		51,388	987	1.92 (1.80, 2.04)	

Abbreviation: *CI*=confidence interval; BMI=body mass index; MVPA=Moderate to vigorous physical activity.

* BMI categorization was based on the "Screening standard for malnutrition of school-age children and adolescents" and the "Screening for overweight and obesity among school-age children and adolescents," using age-specific values.

† MVPA was categorized as sufficient or insufficient based on whether an individual achieved more than 60 minutes of MVPA per day.

§ According to the 'Notice on Further Strengthening the Management of Sleep for Primary and Secondary School Students' issued by the Ministry of Education of China, insufficient sleep was defined as self-reported sleep of less than 10 hours per day for primary school students, less than 9 hours for junior high school students, and less than 8 hours for senior high school students.

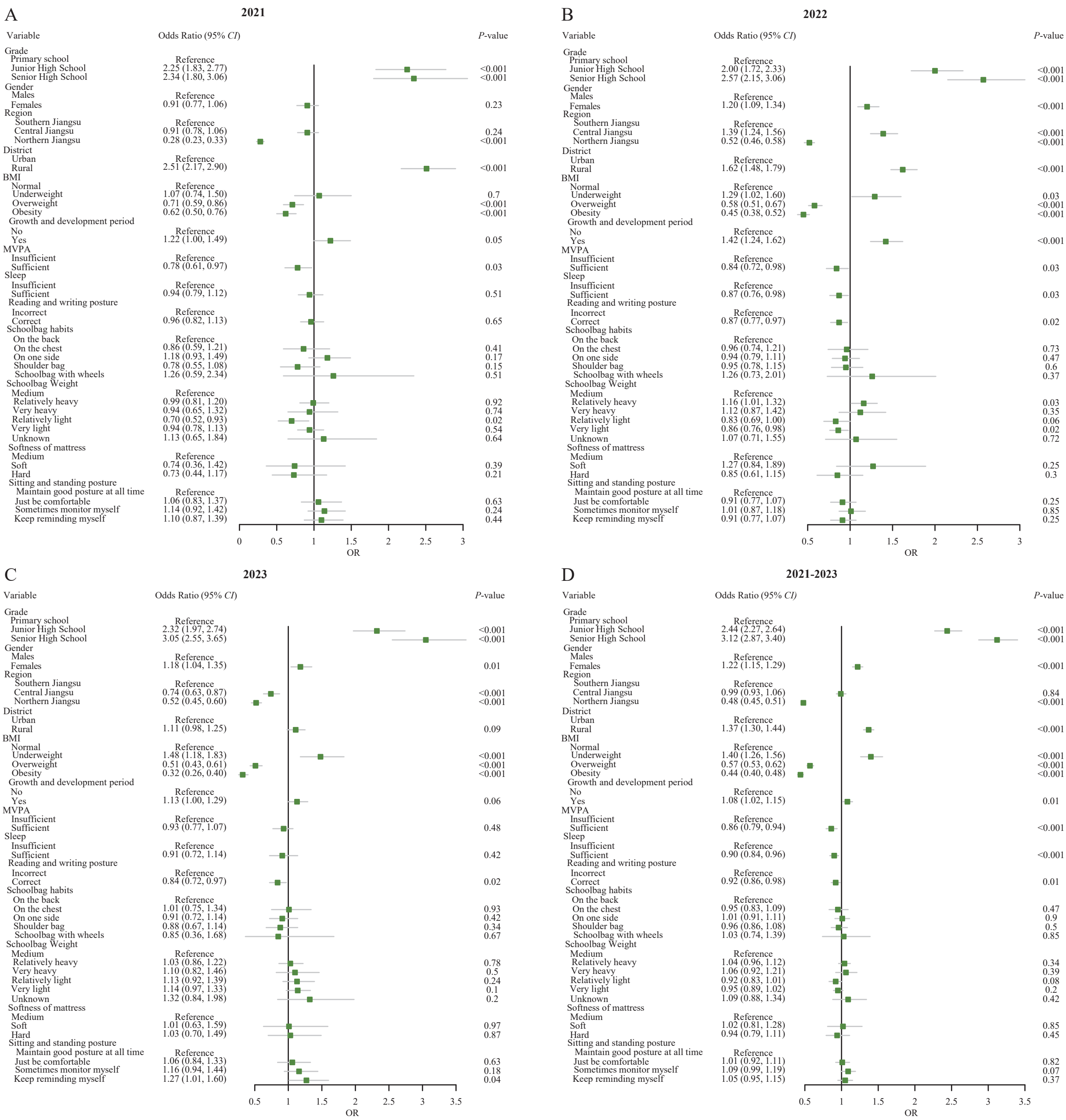

FIGURE 2. Factors associated with abnormal spinal curvature in children and adolescents in Jiangsu Province. (A) Period: 2021; (B) Period: 2022; (C) Period: 2023; (D) Period: 2021–2023.
Abbreviation: *CI*=confidence interval; BMI=body mass index; MVPA=Moderate to vigorous physical activity.

including sex-based variations in genetic heredity and the interaction between leptin production and the nervous system in females, which may trigger scoliosis development (*8*). Additionally, the differential progression of spinal curves between genders could be explained by imbalanced paraspinal muscle strength along the concave and convex sides of the spine, particularly if females engage in less moderate to vigorous physical activity than males.

Similar to previous findings demonstrating a positive correlation between low BMI and scoliosis occurrence (*9*), this study revealed that children and adolescents with low BMI exhibited a higher risk for abnormal spinal curvature. This association likely stems from biomechanical factors, where predisposed individuals lack sufficient paravertebral muscle force necessary to counteract the establishment and progression of scoliotic curves (*10*).

In alignment with existing literature (*11*–*13*), this study's identification of multiple risk factors —

including underweight status, improper reading and writing postures, insufficient sleep, and inadequate moderate to vigorous physical activity — underscores the necessity for targeted interventions. The well-documented relationship between sufficient physical activity and bone health in children and adolescents (*14*) suggests that future strategies should address the combined effects of multiple risk factors on spinal curvature abnormalities. Moreover, individuals with abnormal screening results require prompt medical evaluation and, where indicated, surgical intervention. Enhanced collaboration among families, schools, public health institutions, and hospitals is essential to protect the spinal health of children and adolescents.

Several limitations warrant consideration in this study. First, these findings from Jiangsu Province may not be generalizable to the broader Chinese population. Second, variations in detection rates between years may reflect differences in study population coverage due to the coronavirus disease 2019 (COVID-19) pandemic. Third, the cross-sectional design precludes causal inference. Finally, the reliance on self-reported questionnaires introduces potential recall bias, necessitating cautious interpretation of results. Future longitudinal studies are needed to evaluate the incidence rates of abnormal spinal curvature in this population.

In conclusion, abnormal spinal curvature emerged as a prevalent condition among children and adolescents aged 6–17 years in Jiangsu Province during 2021–2023, highlighting the urgent need for multisectoral investment in prevention and control. The Scoliosis Study Group's recommendation for annual scoliosis examinations in children aged 10–14 years (*15*) reinforces the importance of maintaining surveillance programs to facilitate service planning and ensure timely referral to public health specialists and orthopedic surgeons.

Conflicts of interest: No conflicts of interest

Ethical statement: Received ethics approval from the Institutional Ethics Committee for Clinical Research of Zhongda Hospital Affiliated with Southeast University (No. 2023ZDSYLL456-P01).

Funding: Supported by Ministry of Science and Technology (Grant No. G2023141005L), Ministry of Education (Grant No. 1125000172), Jiangsu Provincial Social Science Foundation (Grant No.24SHB005), SEU Innovation Capability Enhancement Plan for Doctoral Students (Grant No. CXJH_SEU 25220), and Jiangsu Provincial Department of Science and Technology.

doi: 10.46234/ccdcw2025.033

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Submitted: December 06, 2024
Accepted: January 24, 2025
Issued: February 07, 2025

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SUPPLEMENTARY TABLE S1. Detection rate of abnormal spinal curvature in a randomized sample of adolescents in Jiangsu Province, 2021–2023.

Variables	2021				2022				2023				Total			
	N	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*	*N*	*n*	Rate (95% *CI*)	*P*
Region				<0.001				<0.001				<0.001				<0.001
Southern Jiangsu	12,934	571	4.41 (4.06–4.77)		17,491	347	1.98 (1.78–2.19)		12,810	541	4.22 (3.87–4.57)		43,235	1,459	3.37 (3.2–3.54)	
Central Jiangsu	7,940	328	4.13 (3.69–4.57)		11,218	136	1.21 (1.01–1.41)		7,554	232	3.07 (2.68–3.46)		26,712	696	2.61 (2.41–2.8)	
Northern Jiangsu	13,273	176	1.33 (1.13–1.52)		18,161	253	1.39 (1.22–1.56)		13,074	339	2.59 (2.32–2.87)		44,508	768	1.73 (1.60–1.85)	
District				<0.001				<0.001				<0.001				<0.001
Urban	19,091	383	2.01 (1.81–2.21)		25,367	528	2.08 (1.91–2.26)		18,137	758	4.18 (3.89–4.47)		62,595	1,669	2.67 (2.54–2.79)	
Rural	15,056	692	4.60 (4.26–4.93)		21,503	208	0.97 (0.84–1.10)		15,301	354	2.31 (2.08–2.55)		51,860	1,254	2.42 (2.29–2.55)	
Gender				0.153				<0.001				0.019				<0.001
Males	17,742	535	3.02 (2.76–3.27)		24,476	280	1.14 (1.01–1.28)		17,292	536	3.10 (2.84–3.36)		59,510	1,351	2.27 (2.15–2.39)	
Females	16,405	540	3.29 (3.02–3.56)		22,394	456	2.04 (1.85–2.22)		16,146	576	3.57 (3.28–3.85)		54,945	1,572	2.86 (2.72–3.00)	
Grade				<0.001				<0.001				<0.001				<0.001
Primary school	13,161	218	1.66 (1.44–1.87)		26,849	158	0.59 (0.50–0.68)		12,646	214	1.69 (1.47–1.92)		52,656	590	1.12 (1.03–1.21)	
Junior high school	12,651	534	4.22 (3.87–4.57)		12,481	278	2.23 (1.97–2.49)		12,568	517	4.11 (3.77–4.46)		37,700	1,329	3.53 (3.34–3.71)	
Senior high school	8,335	323	3.88 (3.46–4.29)		7,540	300	3.98 (3.54–4.42)		8,224	381	4.63 (4.18–5.09)		24,099	1,004	4.17 (3.91–4.42)	
BMI				<0.001				<0.001				<0.001				<0.001
Normal	19,946	715	3.58 (3.33–3.84)		27,460	543	1.98 (1.81–2.14)		19,287	797	4.13 (3.85–4.41)		66,693	2,055	3.08 (2.95–3.21)	
Underweight	1,220	48	3.93 (2.84–5.03)		1,593	41	2.57 (1.80–3.35)		1,548	81	5.23 (4.12–6.34)		4,361	170	3.90 (3.32–4.47)	
Overweight	6,521	172	2.64 (2.25–3.03)		8,673	94	1.08 (0.87–1.30)		6,153	121	1.97 (1.62–2.31)		21,347	387	1.81 (1.63–1.99)	
Obesity	6,460	140	2.17 (1.81–2.52)		9,144	58	0.63 (0.47–0.80)		6,450	113	1.75 (1.43–2.07)		22,054	311	1.41 (1.25–1.57)	
Growth and development period				<0.001				<0.001				0.056				<0.001
No	17,777	415	2.33 (2.11–2.56)		31,273	225	0.72 (0.63–0.81)		27,441	888	3.24 (3.03–3.45)		76,491	1,528	2.00 (1.90–2.10)	
Yes	16,370	660	4.03 (3.73–4.33)		15,597	511	3.28 (3.00–3.56)		5,997	224	3.74 (3.26–4.22)		37,964	1,395	3.67 (3.49–3.86)	
Total	47,310	1,224	2.59 (2.44–2.73)		46,870	736	1.57 (1.46–1.68)		33,438	1,112	3.33 (3.13–3.52)		127,618	3,072	2.41 (2.32–2.49)	

Abbreviation: *CI*=confidence interval; BMI=body mass index.

Preplanned Studies

Variation in and Factors Associated with Youth Self-Harm in College Students — Jiangsu Province, China, 2019–2023

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Summary

What is already known about this topic?

Self-harm represents a significant public health challenge that disproportionately affects young adults. Understanding individual- and institutional-level risk factors is crucial for developing and implementing effective mental wellness intervention programs for college students.

What is added by this report?

The prevalence of youth self-harm fluctuated between 2.21% and 3.83% from 2019 to 2023. Risk factors associated with self-harm included unhealthy lifestyle behaviors, particularly internet addiction, while the implementation of regular family psychological forums was associated with reduced self-harm risk.

What are the implications for public health practice?

Effective campus-based psychosocial support systems must incorporate person-centered approaches and context-specific needs, optimize resource allocation through targeted interventions, and prioritize high-risk groups exhibiting unhealthy lifestyle behaviors.

ABSTRACT

Introduction: Self-harm represents a significant public health challenge, particularly affecting young adults. This study evaluated prevalence rates and identified individual- and college-level risk factors for self-harm among college students in Jiangsu Province.

Methods: Using data from the 'Surveillance for common disease and health risk factors among students in Jiangsu Province' program during 2019-2023, we employed multilevel logistic regression models to account for potential clustering within sampled colleges and to estimate odds ratios (*OR*) and 95% confidence intervals (*CI*) for person- and college-level factors. Dynamic analyses were conducted with repeated modeling by year.

Results: Youth self-harm rates fluctuated between 2.21% and 3.83% during the study period. Self-harm was strongly associated with unhealthy lifestyles, particularly internet addiction (*OR*: 2.50, 95% *CI*: 1.91, 3.24), while regular family psychological forums were associated with decreased risk (*OR*: 0.72, 95% *CI*: 0.55, 0.95).

Conclusion: Our findings emphasize the necessity of on-campus psychosocial support and highlight the importance of leveraging family-college collective resources with targeted interventions, especially for high-risk groups exhibiting unhealthy lifestyles, particularly internet addiction.

Self-harm, defined as any act of self-injury or self-poisoning regardless of suicidal intent (*1*), represents a significant public health concern, particularly among young adults and adolescents. As the third leading cause of disability-adjusted life-years in youth globally (*2*), self-harm demands comprehensive clinical and community care. Educational settings have been identified as crucial intervention points, with targeted support recommended during mental health crises to prevent youth self-harm (*3*). Regular surveillance is essential for establishing prevention and control priorities (*4*). Analysis of data from the "Surveillance for common disease and health risk factors among students in Jiangsu Province" program during 2019–2023 revealed self-harm rates fluctuating between 2.21% and 3.83% among 15,641 college students. Among identified risk factors, internet addiction demonstrated the strongest association, with 2.5-fold increased odds of youth self-harm. Notably, institutions implementing regular family psychological forums showed approximately 30% lower risk. These findings underscore the global imperative for prompt and effective responses to address youth mental health challenges and stress management.

Comprehensive public health surveillance of self-harm behaviors among young people, coupled with the identification of associated individual and contextual factors, is fundamental for developing targeted mental health interventions (*4*). Before implementing mental health service improvements, policymakers require evidence-based insights to identify core challenges and optimize resource allocation between individual- and environment-oriented programs. This study therefore aimed to evaluate self-harm prevalence rates and identify both individual- and college-level risk factors among college students in Jiangsu Province, China.

Data for this study were obtained from the 'Surveillance for Common Disease and Health Risk Factors Among Students in Jiangsu Province' Project spanning 2019–2023. The surveillance program employed a stratified multi-stage cluster sampling design encompassing 13 prefecture-level administrative regions in Jiangsu Province. Within each administrative region, 1 college was randomly selected, followed by random selection of 6 classes from each of the first 3 college years. All students in selected classes were invited to voluntarily complete an anonymous self-reported questionnaire after providing informed consent. Rigorous quality control measures were implemented throughout data collection, including follow-up calls to clarify ambiguous responses. Detailed methodology of the surveillance program has been previously described (*5*).

The primary outcome measure was self-harm experience, assessed through the question *"Have you ever deliberately hurt yourself in some way in the past year, such as cut or hit yourself?"* with binary (yes/no) responses (*6*). Independent variables included: college grade (freshman, sophomore, or junior); sex (male or female); ethnicity (Han or non-Han); family size (0–2 or >2 people including the student); boarding status at college (yes/no); unhealthy diet (yes/no); ever-smoking status (yes/no); ever-alcohol consumption (yes/no); internet addiction (yes/no) (*7*); daily outdoor physical exercise of at least 1 hour in the past week (yes/no); college type (key universities, regular universities, or vocational colleges); and study major category (comprehensive university, polytechnic college, or medical college). On-campus crisis intervention services were categorized as binary variables based on the presence or absence of: regular psychological counselor training; regular psychological training for in-service teachers; established psychological intervention research centers; and family psychological education forums (*8*).

Categorical variables were summarized using frequencies and proportions. To account for college-level clustering, multilevel logistic regression models were employed to quantify outcome variation and estimate odds ratios (*OR*s) and 95% confidence intervals (*CI*s) for factors of interest. Dynamic analysis was conducted by repeating the modeling procedure annually. All statistical analyses were performed using R software (version 4.4.0; R Core Team, Vienna, Austria), with statistical significance set at $P<0.05$.

Among the 15,641 college students included in this study, 7,601 (48.6%) were male and 8,040 (51.4%) were female, with a relatively even distribution across academic years: 33.7% freshmen, 33.5% sophomores, and 32.8% juniors (Table 1). The prevalence of self-harm fluctuated between 2.21% and 3.83% during the study period (2019–2023) (Table 1), with significant variations observed across individual and institutional factors, including unhealthy diet, smoking status, alcohol consumption, internet addiction, presence of family psychological education forums, and college type (Table 2).

While year-by-year multilevel analyses revealed no consistently significant risk factors across all time points (Table 3), the comprehensive 5-year model identified several notable associations. Internet addiction emerged as the strongest risk factor (*OR*=2.50, *95% CI*: 1.91, 3.24). Students at institutions with established psychological intervention research centers reported higher rates of self-harm (*OR*=1.62, *95% CI*: 1.12, 2.21) compared to those without such facilities. Conversely, both sophomores (*OR*=0.64, *95% CI*: 0.51, 0.80) and juniors (*OR*=0.52, *95% CI*: 0.41, 0.66) demonstrated significantly lower risk compared to freshmen. Additionally, the implementation of regular family psychological forums was associated with reduced odds of self-harm (*OR*=0.72, *95% CI*: 0.55, 0.95) (Table 3).

DISCUSSION

Enhancing youth mental wellness in educational settings is crucial to address the growing demand for mental health services. Aligned with global initiatives advocating for investment in youth mental health (*9*), our findings emphasize the necessity of implementing person-centered interventions and optimizing environmental contexts to improve mental health service delivery for youth self-harm prevention. The observation of higher self-harm reporting rates in institutions with established psychological intervention research centers underscores the importance of

TABLE 1. Sociodemographic characteristics and prevalence of self-harm among college students in Jiangsu Province, China, 2019–2023.

Variables	2019			2020			2021			2022			2023			Total		
	N (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)
Grade																		
Freshman	1,093 (34.1)	51 (41.5)	4.67 (3.49, 6.09)†	1,046 (33.3)	41 (43.2)	3.92 (2.89, 5.32)†	1,085 (33.3)	33 (45.2)	3.77 (2.40, 5.95)	961 (33.9)	31 (43.7)	3.23 (2.27, 4.59)	1,091 (34.1)	41 (48.2)	3.76 (2.77, 5.10)*	5,276 (33.7)	197 (44.1)	3.73 (3.25, 4.29)*
Sophomore	1,069 (33.3)	41 (33.3)	3.84 (2.77, 5.17)	1,054 (33.5)	29 (30.5)	3.57 (2.10, 6.09)	1,086 (33.4)	15 (20.5)	2.20 (1.06, 4.56)	950 (33.5)	21 (29.6)	2.21 (1.44, 3.39)	1,080 (33.8)	28 (32.9)	2.59 (1.79, 3.75)	5,239 (33.5)	134 (30.0)	2.56 (2.16, 3.03)
Junior	1,047 (32.6)	31 (25.2)	2.96 (2.02, 4.18)	1,045 (33.2)	25 (26.3)	2.42 (1.47, 4.00)	1,085 (33.3)	25 (34.2)	2.99 (1.67, 5.35)	924 (32.6)	19 (26.8)	2.06 (1.31, 3.22)	1,025 (32.1)	16 (18.8)	1.56 (0.96, 2.55)	5,126 (32.8)	116 (26.0)	2.26 (1.89, 2.71)
Sex																		
Male	1,570 (48.9)	60 (48.8)	4.01 (3.10, 5.11)	1,590 (50.6)	45 (47.4)	3.21 (2.29, 4.49)	1,393 (42.8)	38 (52.1)	2.73 (1.98, 3.75)	1,146 (40.4)	31 (43.7)	2.71 (1.90, 3.85)	1,902 (59.5)	45 (52.9)	2.37 (1.77, 3.17)	7,601 (48.6)	227 (50.8)	2.74 (2.40, 3.12)*
Female	1,639 (51.1)	63 (51.2)	3.66 (2.80, 4.69)	1,555 (49.4)	50 (52.6)	3.30 (2.19, 4.97)	1,863 (57.2)	35 (47.9)	2.91 (1.75, 4.84)	1,689 (59.6)	40 (56.3)	2.37 (1.74, 3.23)	1,294 (40.5)	40 (47.1)	3.09 (2.27, 4.21)	8,040 (51.4)	220 (49.2)	2.99 (2.62, 3.40)
Ethnic group																		
Non, Han	99 (3.1)	8 (6.5)	8.08 (3.55, 15.3)†	70 (2.2)	–	2.86 (0.71, 11.42)	135 (4.1)	–	2.24 (0.72, 6.94)	112 (4.0)	–	1.79 (0.45, 7.14)	132 (4.1)	–	3.79 (1.58, 9.10)	548 (3.5)	20 (4.5)	3.65 (2.35, 5.66)
Han	3,110 (96.9)	115 (93.5)	3.70 (3.06, 4.42)	3,075 (97.8)	–	3.02 (2.47, 3.71)	3,121 (95.9)	–	2.21 (1.75, 2.80)	2,723 (96.0)	–	2.53 (2.00, 3.21)	3,064 (95.9)	–	2.61 (2.10, 3.25)	15,334 (98.0)	427 (95.5)	2.83 (2.57, 3.11)
Family size																		
>2	2,817 (87.8)	98 (79.7)	3.48 (2.83, 4.22)*	2,868 (91.2)	83 (87.4)	2.89 (2.33, 3.59)	2,989 (91.8)	65 (89.0)	2.14 (1.68, 2.74)	2,449 (86.4)	55 (77.5)	2.25 (1.72, 2.93)†	2,897 (90.6)	68 (80.0)	2.35 (1.85, 2.98)*	15,334 (98.0)	296 (66.2)	2.56 (2.28, 2.86)*
0–2	392 (12.2)	25 (20.3)	6.38 (4.17, 9.27)	277 (8.8)	12 (12.6)	4.33 (2.46, 7.63)	267 (8.2)	8 (11.0)	3.00 (1.50, 5.99)*	386 (13.6)	16 (22.5)	4.15 (2.54, 6.77)	299 (9.4)	17 (20.0)	5.69 (3.53, 9.15)	548 (3.5)	151 (33.8)	3.73 (3.18, 4.38)
Boarding at college																		
Yes	3,087 (96.2)	114 (92.7)	3.69 (3.06, 4.42)†	3,110 (98.9)	–	2.96 (2.41, 3.63)	3,206 (98.5)	–	2.18 (1.73, 2.76)	2,787 (98.3)	–	2.44 (1.92, 3.09)	3,144 (98.4)	–	2.67 (2.16, 3.31)	15,334 (98.0)	429 (96.0)	2.80 (2.55, 3.08)*
No	122 (3.8)	9 (7.3)	7.38 (3.43, 13.54)	35 (1.1)	–	8.57 (2.76, 26.58)	48 (1.5)	–	4.17 (1.04, 16.6)	48 (1.7)	–	6.25 (2.02, 19.38)	52 (1.6)	–	1.92 (0.27, 13.65)	305 (2.0)	18 (4.0)	5.90 (3.72, 9.37)
Total	3,209 (100.0)	123 (100.0)	3.83 (3.21, 4.57)	3,145 (100.0)	95 (100.0)	2.99 (2.44, 3.66)	3,256 (100.0)	73 (100.0)	2.21 (1.76, 2.79)	2,835 (100.0)	71 (100.0)	2.50 (1.98, 3.16)	3,196 (100.0)	85 (100.0)	3.30 (2.60, 4.19)	15,641 (100.0)	477 (100.0)	2.86 (2.60, 3.14)

Note: "–" indicates calculations were not performed for cells with small numbers (<5). *P* were calculated using the Cochran-Armitage test.

Abbreviation: *CI*=confidence interval.

* *P*<0.01.

† *P*<0.05.

TABLE 2. Individual and college-level characteristics associated with self-harm prevalence among college students in Jiangsu Province, China, 2019–2023.

Variables	2019			2020			2021			2022			2023			Total		
	N (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)
Individual-level factors																		
Unhealthy diet																		
Yes	2,458 (76.6)	108 (87.8)	4.39 (3.62, 5.28)*	720 (22.9)	41 (43.2)	5.69 (4.19, 7.73)*	822 (25.2)	32 (43.8)	3.90 (2.76, 5.52)*	711 (25.1)	34 (47.9)	4.78 (3.42, 6.69)*	878 (27.5)	32 (37.6)	3.64 (2.58, 5.15)†	5,589 (35.7)	247 (55.3)	4.42 (3.90, 5.00)*
No	751 (23.4)	15 (12.2)	2.00 (1.12, 3.27)	2,425 (77.1)	54 (56.8)	2.23 (1.71, 2.91)	2,434 (74.8)	41 (56.2)	1.64 (1.21, 2.24)	2,124 (74.9)	37 (52.1)	1.74 (1.26, 2.40)	2,318 (72.5)	53 (62.4)	2.29 (1.75, 2.99)	10,052 (64.3)	200 (44.7)	1.99 (1.73, 2.29)
Ever-smoking status																		
Yes	453 (14.1)	27 (22.0)	5.96 (3.96, 8.55)†	342 (10.9)	17 (17.9)	4.97 (3.09, 8.00)†	311 (9.6)	15 (20.5)	4.82 (2.91, 8.00)*	250 (8.8)	16 (22.5)	6.40 (3.92, 10.45)*	356 (11.1)	18 (21.2)	5.06 (3.19, 8.03)*	1,712 (10.9)	93 (20.8)	5.43 (4.43, 6.66)*
No	2,756 (85.9)	96 (78.0)	3.48 (2.83, 4.24)	2,803 (89.1)	78 (82.1)	2.78 (2.23, 3.47)	2,943 (90.4)	57 (78.1)	1.94 (1.49, 2.51)	2,585 (91.2)	55 (77.5)	2.13 (1.63, 2.77)	2,840 (88.9)	67 (78.8)	2.36 (1.86, 3.00)	13,927 (89.1)	353 (79.0)	2.53 (2.28, 2.81)
Ever-alcohol consumption status																		
Yes	2,756 (85.9)	67 (54.5)	4.55 (3.54, 5.74)	1,265 (40.2)	40 (42.1)	3.16 (2.32, 4.31)	1,117 (34.3)	33 (45.2)	2.96 (2.10, 4.16)†	1,016 (35.8)	32 (45.1)	3.15 (2.23, 4.45)	1,342 (42.0)	39 (45.9)	2.91 (2.12, 3.98)*	6,212 (39.7)	211 (47.2)	2.50 (2.20, 2.84)*
No	1,737 (54.1)	56 (45.5)	3.22 (2.44, 4.17)	1,880 (59.8)	55 (57.9)	2.93 (2.25, 3.81)	2,139 (65.7)	40 (54.8)	1.83 (1.33, 2.50)	1,819 (64.2)	39 (54.9)	2.14 (1.57, 2.93)	1,854 (58.0)	46 (54.1)	2.48 (1.86, 3.31)	9,429 (60.3)	236 (52.8)	3.40 (2.97, 3.89)
Internet addiction																		
Yes	228 (7.1)	21 (17.1)	9.21 (5.79, 13.73)*	182 (5.8)	11 (11.6)	6.04 (3.35, 10.91)†	197 (6.1)	13 (17.8)	6.63 (3.85, 11.42)*	234 (8.3)	16 (22.5)	6.84 (4.19, 11.16)*	234 (7.3)	14 (16.5)	5.98 (3.54, 10.10)*	1,075 (6.9)	75 (16.8)	6.98 (5.56, 8.75)*
No	2,981 (92.9)	102 (82.9)	3.42 (2.80, 4.14)	2,961 (94.2)	83 (87.4)	2.96 (2.27, 3.86)	3,059 (93.9)	60 (82.2)	1.93 (1.50, 2.49)	2,601 (91.7)	55 (77.5)	2.11 (1.62, 2.75)	2,962 (92.7)	71 (83.5)	2.40 (1.90, 3.02)	14,564 (93.1)	371 (83.0)	2.55 (2.30, 2.82)
Physical exercise, weekly																		
Yes	2,048 (63.8)	39 (31.7)	4.10 (3.28, 5.05)	2,205 (70.1)	33 (34.7)	2.83 (2.11, 3.78)	2,163 (66.4)	56 (76.7)	2.55 (1.96, 3.32)	1,972 (69.6)	47 (66.2)	2.38 (1.79, 3.17)	2,421 (75.8)	66 (77.6)	2.73 (2.14, 3.47)	9,922 (63.4)	270 (60.4)	2.72 (2.42, 3.07)
No	1,161 (36.2)	95 (77.2)	3.36 (2.40, 4.56)	940 (29.9)	62 (65.3)	4.26 (2.66, 6.81)	1,093 (33.6)	17 (23.3)	1.56 (0.97, 2.50)	863 (30.4)	24 (33.8)	2.78 (1.86, 4.15)	775 (24.2)	19 (22.4)	2.45 (1.56, 3.84)	5,719 (36.6)	177 (39.6)	3.09 (2.67, 3.59)
College-level factors																		
Regular training with psychological counselors																		
Yes	2,965 (92.4)	–	3.98 (3.32, 4.77)	2,905 (92.4)	81 (85.3)	2.76 (2.21, 3.43)*	2,993 (91.9)	–	2.45 (1.88, 3.19)	2,569 (90.6)	63 (88.7)	2.45 (1.92, 3.14)	2,941 (92.0)	77 (90.6)	2.62 (2.09, 3.27)	14,373 (91.9)	410 (91.7)	2.85 (2.59, 3.14)
No	244 (7.6)	–	2.05 (0.85, 4.92)	240 (7.6)	14 (14.7)	6.07 (3.35, 11.0)	263 (8.1)	–	1.21 (0.19, 7.75)	266 (9.4)	8 (11.3)	3.01 (1.50, 6.01)	255 (8.0)	8 (9.4)	3.14 (1.57, 6.27)	1,268 (8.1)	37 (8.3)	2.92 (2.11, 4.03)
Regular psychological training with in-service teachers																		
Yes	2,725 (84.9)	110 (89.4)	4.04 (3.35, 4.87)	2,668 (84.8)	71 (74.7)	2.66 (2.11, 3.36)*	2,756 (84.6)	–	2.54 (1.94, 3.33)	2,569 (90.6)	63 (88.7)	2.45 (1.92, 3.14)	2,785 (87.1)	71 (83.5)	2.55 (2.02, 3.22)	13,503 (86.3)	383 (85.7)	2.84 (2.57, 3.14)
No	484 (15.1)	13 (10.6)	2.69 (1.56, 4.63)	477 (15.2)	24 (25.3)	5.30 (3.24, 8.69)	500 (15.4)	–	1.27 (0.42, 3.86)	266 (9.4)	8 (11.3)	3.01 (1.50, 6.01)	411 (12.9)	14 (16.5)	3.41 (2.02, 5.75)	2,138 (13.7)	64 (14.3)	2.99 (2.34, 3.82)

Continued

Variables	2019			2020			2021			2022			2023			Total		
	N (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)	*N* (%)	*n* (%)	Rate % (95% *CI*)
Established psychological intervention research centers																		
Yes	463 (14.4)	16 (13.0)	3.46 (2.12, 5.64)	475 (15.1)	18 (18.9)	3.79 (2.39, 6.01)	493 (15.1)	15 (20.5)	3.04 (1.83, 5.05)	506 (17.8)	12 (16.9)	2.37 (1.35, 4.18)	514 (16.1)	13 (15.3)	2.53 (1.47, 4.36)	2,451 (15.7)	74 (16.6)	3.02 (2.40, 3.79)
No	2,746 (85.6)	107 (87.0)	3.90 (3.22, 4.71	2,670 (84.9)	77 (81.1)	2.95 (2.30, 3.78)	2,763 (84.9)	58 (79.5)	2.22 (1.64, 2.99)	2,329 (82.2)	59 (83.1)	2.53 (1.96, 3.27)	2,682 (83.9)	72 (84.7)	2.68 (2.13, 3.38)	13,190 (84.3)	373 (83.4)	2.83 (2.55, 3.13)
Regular family psychological education forums																		
Yes	1,496 (46.6)	49 (39.8)	3.28 (2.48, 4.33)	1,476 (46.9)	40 (42.1)	2.78 (1.93, 3.99)	493 (15.1)	35 (47.9)	2.75 (1.82, 4.15)	1,566 (55.2)	34 (47.9)	2.17 (1.55, 3.04)	1,517 (47.5)	37 (43.5)	2.44 (1.77, 3.37)†	7,586 (48.5)	195 (43.6)	2.57 (2.23, 2.96)†
No	1,713 (53.4)	74 (60.2)	4.32 (3.44, 5.43)	1,669 (53.1)	55 (57.9)	3.27 (2.48, 4.32)	2,763 (84.9)	38 (52.1)	2.15 (1.56, 2.97)	1,269 (44.8)	37 (52.1)	2.92 (2.11, 4.02)	1,679 (52.5)	48 (56.5)	2.86 (2.15, 3.79)	8,055 (51.5)	252 (56.4)	3.13 (2.77, 3.54)
Types of study majors																		
Comprehensive university	1,970 (61.4)	81 (65.9)	4.11 (3.31, 5.11)	1,905 (60.6)	57 (60.0)	2.94 (2.26, 3.82)	1,722 (52.9)	34 (46.6)	2.12 (1.44, 3.13)	1,516 (53.5)	–	2.77 (2.05, 3.75)	1,662 (52.0)	40 (47.1)	2.41 (1.77, 3.28)	8,775 (56.1)	254 (56.8)	2.61 (2.35, 2.90)
Polytechnic college	992 (30.9)	35 (28.5)	3.53 (2.53, 4.91)	999 (31.8)	31 (32.6)	3.49 (2.26, 5.38)	1,289 (39.6)	31 (42.5)	2.33 (1.63, 3.33)	1,061 (37.4)	–	2.26 (1.52, 3.37)	1,267 (39.6)	37 (43.5)	2.92 (2.12, 4.03)	5,608 (35.9)	158 (35.3)	4.23 (2.79, 6.43)
Medical college	247 (7.7)	7 (5.7)	2.83 (1.35, 5.94)	241 (7.7)	7 (7.4)	2.90 (1.38, 6.09)	245 (7.5)	8 (11.0)	3.27 (1.63, 6.53)	258 (9.1)	–	1.94 (0.81, 4.66)	267 (8.4)	8 (9.4)	3.00 (1.50, 5.99)	1,258 (8.0)	35 (7.8)	4.12 (3.32, 5.11)
Types of colleges																		
Regular universities	2,696 (84.0)	95 (77.2)	3.52 (2.88, 4.31)†	2,655 (84.4)	80 (84.2)	3.10 (2.42, 3.98)	2,724 (83.7)	55 (75.3)	1.99 (1.52, 2.59)	2,318 (81.8)	50 (70.4)	2.16 (1.63, 2.85)	2,713 (84.9)	62 (72.9)	2.29 (1.78, 2.93)	13,106 (83.8)	342 (76.5)	2.89 (2.56, 3.27)*
Key universities	269 (8.4)	13 (10.6)	4.83 (2.81, 8.32)	251 (8.0)	9 (9.5)	3.59 (1.87, 6.89)	–	–	–	–	–	–	–	–	–	520 (3.3)	22 (4.9)	2.82 (2.41, 3.29)
Vocational colleges	244 (7.6)	15 (12.2)	6.15 (3.71, 10.2)	239 (7.6)	6 (6.3)	2.51 (1.13, 5.59)	532 (16.3)	18 (24.7)	3.38 (2.13, 5.37)	517 (18.2)	21 (29.6)	4.06 (2.65, 6.23)	483 (15.1)	23 (27.1)	4.76 (3.16, 7.17)	2,015 (12.9)	83 (18.6)	2.78 (2.00, 3.87)

Note: "–" indicates calculations were not performed for cells with small numbers (<5). *P*-values were calculated using the Cochran-Armitage test.

Abbreviation: *CI*=confidence interval.

* *P*<0.01.

† *P*<0.05.

TABLE 3. Adjusted odds ratios and 95% confidence intervals for individual and college characteristics associated with self-harm among college students in Jiangsu Province, China, 2019–2023.

Variables	2019	2020	2021	2022	2023	Total
Social demographic characteristics						
Grade						
Freshman (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Sophomore	0.79 (0.51, 1.21)	0.69 (0.41, 1.14)	0.44 (0.23, 0.82)	0.60 (0.34, 1.07)	0.60 (0.36, 0.99)	0.64 (0.51, 0.80)
Junior	0.51 (0.32, 0.83)	0.53 (0.31, 0.91)	0.70 (0.40, 1.21)	0.53 (0.29, 0.97)	0.37 (0.20, 0.67)	0.52 (0.41, 0.66)
Sex						
Male (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Female	1.20 (0.79, 1.83)	0.93 (0.58, 1.50)	0.91 (0.54, 1.53)	1.22 (0.73, 2.05)	1.68 (1.04, 2.71)	0.85 (0.70, 1.05)
Ethnic group						
Non-Han (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Han	0.55 (0.25, 1.19)	1.05 (0.24, 4.54)	1.10 (0.33, 3.63)	1.88 (0.43, 8.17)	0.63 (0.24, 1.62)	0.79 (0.51, 1.30)
Family size						
>2 (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
0–2	1.93 (1.20, 3.11)	1.30 (0.67, 2.55)	1.37 (0.63, 2.97)	1.74 (0.97, 3.12)	2.61 (1.48, 4.60)	1.08 (0.86, 1.34)
Boarding at college						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.46 (0.21, 1.01)	0.31 (0.08, 1.23)	0.41 (0.09, 1.83)	0.34 (0.10, 1.19)	1.41 (0.18, 10.95)	0.48 (0.30, 0.83)
Individual-level factors						
Unhealthy diet						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.08 (1.19, 3.65)	2.43 (1.57, 3.78)	2.13 (1.29, 3.49)	2.40 (1.46, 3.95)	1.55 (0.97, 2.48)	2.03 (1.65, 2.50)
Ever-smoking status						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.35 (0.81, 2.33)	2.12 (1.12, 4.01)	1.76 (0.92, 3.40)	2.63 (1.34, 5.16)	2.09 (1.14, 3.84)	1.85 (1.42, 2.41)
Ever-alcohol consumption status						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.19 (0.79, 1.79)	0.93 (0.57, 1.51)	1.29 (0.77, 2.16)	1.04 (0.61, 1.78)	1.12 (0.68, 1.83)	1.09 (0.89, 1.35)
Internet addiction						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.89 (1.72, 4.86)	1.90 (0.93, 3.88)	3.53 (1.85, 6.74)	2.73 (1.48, 5.05)	2.39 (1.29, 4.42)	2.50 (1.91, 3.24)
Physical exercise, weekly						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.74 (0.50, 1.11)	0.84 (0.53, 1.33)	1.88 (1.06, 3.35)	0.87 (0.51, 1.48)	1.11 (0.65, 1.89)	0.99 (0.81, 1.21)
College-level factors						
Regular training for psychological counselors						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	2.44 (0.89, 6.71)	0.67 (0.15, 2.93)	2.71 (0.58, 12.77)	0.55 (0.15, 1.97)	1.05 (0.30, 3.65)	1.10 (0.61, 1.93)
Regular psychological training for in-service teachers						
No (ref.)	1.00	1.00	1.00	–	1.00	1.00
Yes	0.98 (0.40, 2.42)	0.24 (0.06, 0.97)	1.45 (0.41, 5.08)	–	0.59 (0.23, 1.55)	0.87 (0.57, 1.38)

Continued

Variables	2019	2020	2021	2022	2023	Total
Established psychological intervention research centers						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.39 (0.70, 2.78)	2.15 (0.85, 5.44)	2.20 (1.04, 4.66)	1.49 (0.70, 3.16)	1.50 (0.71, 3.18)	1.62 (1.18, 2.21)
Regular family psychological forums						
No (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.62 (0.34, 1.12)	1.76 (0.54, 5.74)	0.70 (0.36, 1.36)	0.92 (0.44, 1.95)	0.75 (0.40, 4.39)	0.72 (0.55, 0.95)
Types of colleges						
Regular universities (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Key universities	1.91 (0.89, 4.10)	2.01 (0.65, 6.25)	−	−	−	1.95 (1.16, 3.17)
Vocational colleges	1.54 (0.78, 3.06)	2.40 (0.56, 10.26)	0.70 (0.36, 1.36)	2.30 (1.17, 4.51)	2.44 (1.36, 4.39)	1.72 (1.30, 2.25)
Types of study majors						
Comprehensive University (ref.)	1.00	1.00	1.00	1.00	1.00	1.00
Polytechnic College	1.38 (0.83, 2.30)	0.96 (0.41, 2.25)	1.18 (0.66, 2.13)	0.71 (0.33, 1.53)	1.17 (0.66, 2.08)	1.08 (0.84, 1.38)
Medical College	0.83 (0.35, 1.98)	3.08 (0.74, 12.79)	1.74 (0.72, 4.17)	0.88 (0.31, 2.53)	1.62 (0.69, 3.82)	1.11 (0.74, 1.63)

Note: “−” indicates calculations were not performed due to collinearity or cells with small numbers (<5); “ref.” means the reference.

strengthening public health surveillance and intervention programs for college students’ mental wellness. Effective prevention of youth self-harm requires enhancement of existing on-campus crisis intervention services, including regular psychological counselor training, systematic psychological training for in-service teachers, establishment of psychological intervention research centers, and regular family psychological education forums. These components collectively facilitate early identification of at-risk youths and enable development of comprehensive countermeasures for self-harm prevention and control.

Future campus crisis intervention services require evidence-based prioritization, particularly focusing on different institutional types (key universities, vocational colleges) and students with unhealthy lifestyles. Global best practices in campus mental health services emphasize integrated multidisciplinary care aimed at providing stigma-free, meaningful consultations and interventions. Current evidence supports a comprehensive approach combining clinical-, community-, web- and school-based interventions for managing youth self-harm (*8*), complementing the established paradigm of gatekeeper access to campus mental health services (*10*). Future investments should strengthen collaborative workforce coordination among stakeholders (students, families, college administrators, clinicians, and authorities), adapt services to person-centered and context-specific needs, optimize resource allocation through targeted interventions, and specifically address high-risk groups exhibiting unhealthy lifestyles, particularly internet addiction.

This study has several important limitations. First, the cross-sectional design precluded investigation of causal relationships between individual and institutional characteristics and self-harm behaviors among college students. Nevertheless, the observed variations in youth self-harm underscore the importance of delivering integrated physical, behavioral, and psychosocial support services on campus. Second, the reliance on self-reported data may have led to underestimation of self-harm prevalence. While clinical confirmation using DSM-V diagnostic criteria would provide greater diagnostic accuracy, such extensive clinical evaluation was not feasible in this large-scale surveillance study. The survey instruments used are, however, widely validated screening tools in the literature. Future clinical investigations targeting high-risk groups identified through initial screening would enhance prevalence estimate reliability and provide additional validation. Third, although this study employed a stratified multi-stage cluster sampling scheme to ensure representative sampling across Jiangsu Province, the framework did not achieve comprehensive coverage of all college types and academic majors. Without census data for the entire college student population across different academic backgrounds, our results should be interpreted with appropriate caution. Future research should focus on identifying modifiable service components and evaluating their contribution to reducing self-harm in youth, advancing evidence-based resource allocation for campus mental health services.

This investigation demonstrates that individual-level variation in youth self-harm can be effectively addressed through strategic implementation of campus mental health services during this critical period of psychological development. The findings emphasize the urgent need for sustained commitment and systematic efforts to identify, assess, modify, and monitor both personal behaviors and contextual factors associated with youth self-harm reduction in collegiate settings, particularly as demand for youth mental health services continues to grow.

Conflicts of interest: No conflicts of interest.

Ethical statement: Received ethics approval from the Institutional Ethics Committee for Clinical Research of Zhongda Hospital Affiliated with Southeast University (No.2023ZDSYLL456-P01).

Funding: Supported by National Social Science Foundation of China (Grant No. 23CGL072), Ministry of Science and Technology (Grant No. G2023141005L), Ministry of Education (Grant No. 1125000172), SEU Innovation Capability Enhancement Plan for Doctoral Students (Grant No. CXJH_SEU 25220), and Jiangsu Provincial Department of Science and Technology, Jiangsu Provincial Social Science Foundation (Grant No. 24SHB005).

doi: 10.46234/ccdcw2025.034

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Submitted: November 21, 2024
Accepted: January 20, 2025
Issued: February 07, 2025

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Review

Advances in HPV-Associated Cervical Cancer Dynamic Modelling for Prevention and Control Evaluation

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ABSTRACT

Cervical cancer is a common malignancy in women, with persistent human papillomavirus (HPV) infection as its primary cause. Understanding the progression from HPV infection to cervical cancer is crucial. Mathematical models play a key role in converting clinical trial data into long-term health forecasts, helping decision-makers tackle challenges posed by limited data and uncertain outcomes. This paper reviews transmission dynamics models and advancements in simulating HPV transmission leading to cervical cancer. It evaluates preventive and control measures, focusing on the impact of HPV vaccination across different vaccine types, doses, age groups, and both genders. These model-based assessments aim to provide insights for developing effective strategies to prevent and control HPV-related cervical cancer.

Cervical cancer ranks as the fourth most common malignancy and leading cause of cancer-related mortality among women globally, following breast, colorectal, and lung cancers (*1–2*). High-risk human papillomavirus (hrHPV) infection represents the primary risk factor for cervical cancer development (*3*). While 90% of HPV-infected individuals spontaneously clear the virus within 2 years, persistent infection occurs in specific populations, including those engaging in high-risk sexual behaviors, immunocompromised individuals, and those experiencing long-term recurrent HPV infections.

The pathogenesis of cervical cancer, initiated by hrHPV infection, is characterized by its low probability of occurrence and extended natural history, which poses significant challenges for clinical studies attempting to establish direct causal relationships between HPV vaccination, infection, and cervical cancer outcomes. Mathematical models serve as valuable tools for decision-makers when relevant data are limited and outcomes remain uncertain. Current mathematical approaches in HPV vaccination and cervical cancer research encompass both static progression models (Markov models) and dynamic progression models (transmission dynamics models). Transmission dynamics models demonstrate superior reliability in simulating viral transmission within dynamic populations and temporal changes in health status compared to their static counterparts (*4*). Details of the model studies reviewed in this paper are provided in Table 1.

The infectious disease transmission dynamics model, also termed the “compartmental model,” stratifies populations into distinct compartments based on disease occurrence and transmission patterns. Through differential equations, these models simulate and illustrate disease progression and epidemiological patterns, enabling analysis of epidemic causation, trend prediction, intervention assessment, and optimization of prevention and control strategies (*5*).

HPV transmission primarily occurs through heterosexual or homosexual intercourse, oral sex, or finger-vaginal contact (*6*). The virus demonstrates high infectivity, with over 50% of young women acquiring HPV infection within 4 years of sexual debut, and prevalence rates reaching 80% among sexually active female populations (*7*). Researchers have developed compartmental models to simulate, estimate, and refine critical parameters in the natural progression of HPV infection, providing evidence-based recommendations to policy-makers for HPV-associated cervical cancer prevention and control strategies.

Korostil and colleagues developed eight distinct compartmental models for HPV-16 by incorporating varying assumptions regarding the relationship between seropositivity and immunity (*8*). To account for the asymptomatic period characteristic of HPV infection, Wang et al. constructed a Susceptible-Exposed-Infected-Removed (SEIR) model and determined optimal vaccination strategies using a constrained time-varying approach (*9*). This SEIR model, offering greater biological accuracy than its SIR

TABLE 1. Summary table of references.

Author	Year	District	Model	HPV Types	Precautions		Natural history of disease			Sources
					Vaccine	Screening	CC	CIN	Diseases for men	
Korostil	2013	Australia	SIS/SIR/SIRS	HPV-16	NA	NA	NA	NA	NA	[8]
Wang	2019	China	SEIR	NA	NA	NA	NA	NA	NA	[9]
Johnson	2012	Sweden	SICR	HPV-6/11/ 16/18/31/33/45/52/58	NA	Yes	Yes	CIN1, CIN2, CIN3	NA	[10]
Zechmeister	2009	Austria	SICR	No	Yes	Yes	Yes	CIN1, CIN2, CIN3	NA	[12]
Owusu	2022	England	SIRS	HPV-6/11/ 16/18/31/33/45/52/58	4v, 9vHPV	NA	Yes	CIN1, CIN2&3	Anal/head and neck/penile cancer	[14]
Elbasha	2007	United States	SVIR	HPV-6/11/16/18	4vHPV	Yes	Yes	CIN1, CIN2&3	NA	[15]
Van De Velde	2012	Canada	HPV-ADVISE	HPV-6/11/ 16/18/31/33/45/52/58	2v, 4v, 9vHPV	Yes	Yes	CIN1, CIN2, CIN3	Anal/head and neck cancer	[16]
De La Fuente	2019	Spanish	SIRS	HPV-6/11/16/18/31/33/45/52/58	4v, 9vHPV	NA	Yes	CIN1, CIN2&3	Anal/mouth/ head and neck/penile cancer	[17]
Chou	2022	Taiwan, China	SIRS	HPV-6/11/ 16/18/31/33/45/52/58	2v, 9vHPV	NA	Yes	NA	NA	[18]
Malik	2016	No	SVIR-SIR	HPV-6/11/ 16/18/31/33/45/52/58	2v, 4v, 9vHPV	NA	NA	NA	NA	[19]
Sharomi	2017	United States	SVEIR	NA	2v, 4v, 9vHPV	NA	Yes	CIN	NA	[20]
Laprise	2014	Canada	HPV-ADVISE	HPV-6/11/ 16/18/31/33/45/52/58	4vHPV	Yes	Yes	CIN1, CIN2, CIN3	Cancer of the anus, penis and oropharynx	[21]
Prem	2023	Worldwide	HSA/HPV-ADVISE/ Harvard	HPV-6/11/ 16/18/31/33/45/52/58	9vHPV	Yes	Yes	CIN1, CIN2, CIN3	Cancer of the anus, penis and oropharynx	[22]
Jit	2015	United Kingdom	HPV-ADVISE	HPV-6/11/ 16/18/31/33/45/52/58	2v, 4vHPV	Yes	Yes	CIN1, CIN2, CIN3	Cancer of the anus, penis and oropharynx	[23]
Burger	2018	Ugandan	Harvard-HPV	HPV-16/18/31/33/45/52/58	No	Yes	Yes	NA	NA	[24]
Cheung	2023	Hong Kong SAR, China	SVIR	HPV-6/11/ 16/18/31/33/45/52/58	9vHPV	Yes	Yes	CIN1, CIN2&3	Anal/mouth/ head and neck/penile cancer	[26]
Simoens	2021	Belgium	SVIR	HPV-6/11/ 16/18/31/33/45/52/58	2v, 9vHPV	NA	Yes	CIN	Anal/head and neck cancer	[27]
Drolet	2021	India\ Vietnam\ Uganda\ Nigeria	SVI	HPV-6/11/ 16/18/31/33/45/52/58	2v, 4v, 9vHPV	NA	Yes	CIN1, CIN2, CIN3	NA	[28]
Saldana	2022	Mexico	SVAIC	HPV-6/11/ 16/18/31/33/45/52/58	9vHPV	NA	Yes	NA	Anal/mouth/ head and neck/penile cancer	[29]

Note: “NA” signifies that the corresponding section of the article has not been examined, whereas “No” denotes the absence of explanation within the article.

Abbreviation: HPV=human papillomavirus; NA=not applicable; SIS=susceptible-infected-susceptible; SIR=susceptible-infected-recovered; SIRS=susceptible-infected-recovered-susceptible; SEIR=susceptible-exposed-infected-recovered; SICR=susceptible-infected-cancer-recovered; SVR=susceptible-vaccinated-infected-recovered; HPV-ADVISE=human papillomavirus-ADvanced vaccination impact simulation model; SVIR-SIR=susceptible-vaccinated-infected-recovered-SIR; SVEIR=susceptilble-vaccinated-exposed-infected-recovered; HSA=health simulation model for HPV vaccination; CIN=cervical intraepithelial neoplasia; CC=cervical cancer.

predecessor, has emerged as the predominant framework for simulating HPV transmission dynamics.

While these models effectively capture HPV infection dynamics, their predictive capacity is limited by the exclusion of disease progression states such as precancerous lesions and cancer. Johnson et al. addressed this limitation by developing a comprehensive transmission dynamics model encompassing the complete natural history from HPV infection through cervical cancer progression (*10*). The model structure is illustrated in Figure 1, where cervical intraepithelial neoplasia (CIN) stages are represented as CIN1 to 3. Following similar principles, Campos et al. and Zechmeister et al. constructed transmission dynamics models incorporating discrete compartments for CIN1–3, aligned with the disease's natural progression (*11–12*).

Vaccination represents the primary preventive measure against HPV infection and cervical cancer (*13*). Currently, three HPV vaccines are widely utilized: the bivalent (2vHPV), quadrivalent (4vHPV), and nine-valent (9vHPV) vaccines.

The introduction of the 9vHPV vaccine has enabled comprehensive comparative evaluations across vaccine types, considering factors such as immunological efficacy, coverage rates, and long-term benefits. Following the United Kingdom Department of Public Health's 2021 decision to transition from quadrivalent to nine-valent vaccination, Kwame et al. (2022) (*14*) conducted a comparative analysis of 4vHPV and 9vHPV vaccines. They expanded upon Elbasha et al.'s original model (*15*) by incorporating additional compartments and differential equations to account for infections and diseases associated with HPV-31, -33, -45, -52, and -58. Their findings demonstrated that transitioning from 4vHPV to 9vHPV vaccination in national programs yields substantial health and economic benefits. Similar comparative analyses of 2vHPV/4vHPV versus 9vHPV vaccines in developed countries were conducted through transmission dynamics modeling by Nicolas et al. (*16*), Jesús et al. (*17*), Chou et al. (*18*), and Malik et al. (*19*). These studies, conducted in Canada, Spain, Taiwan, China, and the USA, corroborated Kwame's findings (*14*), demonstrating superior reduction in HPV infection prevalence and cervical cancer cases with 9vHPV vaccination, along with enhanced cost-effectiveness.

The effectiveness and persistence of HPV vaccine protection correlate with dosing schedules. Sharomi et al. (2017) developed a deterministic model stratifying the female cohort by age (≤26 years and >26 years) and vaccination doses. Their analysis revealed that high vaccination adherence reduced HPV infections, with three-dose regimens demonstrating superior efficacy compared to two-dose or single-dose schedules (*20*).

In contrast to Sharomi's findings regarding cost-effectiveness and immune protection duration, Laprise et al. (*21*) evaluated different dosing scenarios by comparing cumulative reduction percentages and ICERs of HPV-related cancers. Their analysis suggested that as two-dose vaccine protection duration increases, its cancer prevention efficacy approaches that of three-dose regimens, while demonstrating progressive cost-effectiveness advantages. Prem et al. integrated three established transmission dynamics models to evaluate HPV vaccine impact across varying doses, efficacy levels, protection duration, and coverage rates (*22*). All three models consistently predicted that a single-dose HPV vaccination program achieving 80% global coverage could provide robust population protection cost-effectively. Additional transmission dynamics analyses by Jit et al. (*23*) and Burger et al. (*24*) in the UK and US, respectively, demonstrated that single-dose HPV vaccination prevents nearly as many cervical cancer cases as multi-dose regimens, provided protection persists for 20 years or maintains at least 80% efficacy.

The World Health Organization's updated HPV vaccination guidelines designate females aged 9–14 years as the primary target population. However, since the U.S. Food and Drug Administration's initial approval of the HPV vaccine in 2006, the majority of the population has exceeded this recommended age range (*25*). Consequently, vaccination strategies have

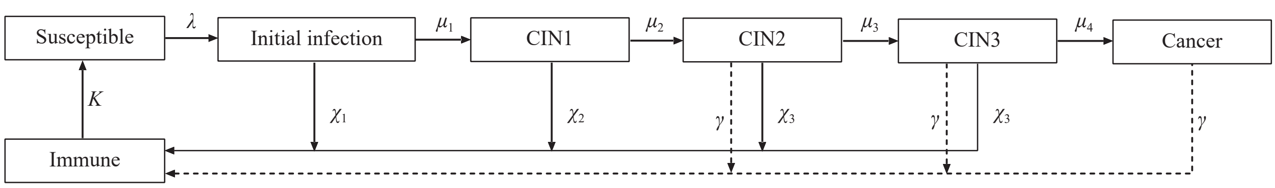

FIGURE 1. Flowchart of the dynamics model.
Note: CIN1–3: cervical intraepithelial neoplasia stages are represented as CIN1 to CIN3.

expanded beyond routine programs to address women outside the target age group through various age-specific approaches, including both routine and catch-up vaccination protocols. The guidelines also indicate that when resources permit, countries may extend vaccination to secondary populations, including males and older females.

Elbasha and colleagues developed a comprehensive compartmental model tracking disease progression from HPV infection to cervical cancer (*15*). Their analysis demonstrated that implementing 4vHPV vaccination for individuals ≤12 years of age, combined with catch-up vaccination for those aged 12–24 years across both sexes, yielded the most substantial reductions in condyloma acuminatum, CIN, and cervical cancer cases while maintaining cost-effectiveness. Chesson et al. adapted this model to Hong Kong's context by incorporating local demographic data, sexual behavior patterns, and adjusting for cervical cancer detection parameters and screening rates (*26*). Their findings revealed that supplementing an intersex vaccination strategy with a catch-up program would enhance the reduction of HPV-associated diseases while remaining cost-effective. Similarly, Simoens et al. applied Elbasha's model framework to evaluate the feasibility of implementing a two-sex 9vHPV vaccination strategy in Belgium (*27*). Their results corroborated previous literature, confirming the superior effectiveness of gender-neutral vaccination approaches compared to female-only strategies.

However, these models primarily reflect the contexts of developed nations, where vaccination strategy implementation is predominantly influenced by economic capacity, geographic accessibility, and healthcare insurance systems. Studies examining the expansion of HPV vaccination initiatives in resource-limited settings within developing and least developed nations have yielded markedly different conclusions.

Drolet et al. evaluated individualized vaccination strategies across four low- and middle-income countries (India, Vietnam, Uganda, and Nigeria) (*28*). Through comparative analysis of seven distinct HPV vaccination strategies, they determined that routine vaccination of 9–year-old girls, supplemented by vaccination of girls aged 9–14 years during the initial implementation year, represented the most efficient and cost-effective approach compared to no vaccination scenarios. Notably, male vaccination strategies emerged as the least efficient and cost-effective option, rendering them unsuitable for implementation in low- and middle-income regions. Similarly, Saldaña et al. developed a two-sex deterministic mathematical model in Mexico to evaluate four different HPV vaccination strategies (*29*). Their findings support a hierarchical vaccination approach in resource-constrained settings, prioritizing young girls first, followed by adult females, young boys, and adult males, respectively.

The prevention of cervical cancer fundamentally relies on understanding HPV transmission dynamics and implementing effective vaccination strategies. Dynamic transmission models have emerged as invaluable tools for analyzing viral spread patterns and evaluating vaccine impact. Evidence consistently demonstrates that the 9-valent HPV vaccine offers superior effectiveness and cost-efficiency compared to its bivalent and quadrivalent predecessors, particularly in developed nations. However, resource-limited settings benefit most from targeted strategies focusing on young girls and adult women. While extending vaccination coverage to male populations and older age groups can provide additional population-level benefits, such approaches may not always be economically or logistically feasible. These findings underscore the importance of developing context-specific vaccination strategies that prioritize coverage and accessibility within local resource constraints. Future research should address implementation challenges in low-resource regions and evaluate long-term strategies to achieve sustainable reductions in global cervical cancer burden.

Conflicts of interest: No conflicts of interest.

Funding: Supported by grants from The Department of Science and Technology of Hunan Province (No: 2020SK1010) and the National Health Commission of the Hunan Province (No: 202212054651).

doi: 10.46234/ccdcw2025.035

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Submitted: October 18, 2024
Accepted: January 20, 2025
Issued: February 07, 2025

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Notifiable Infectious Diseases Reports

Reported Cases and Deaths of National Notifiable Infectious Diseases — China, December 2024*

Diseases	Cases	Deaths
Plague	0	0
Cholera	0	0
SARS-CoV	0	0
Acquired immune deficiency syndrome†	4,909	1,878
Hepatitis	161,938	632
Hepatitis A	1,247	0
Hepatitis B	141,532	42
Hepatitis C	15,881	589
Hepatitis D	27	0
Hepatitis E	2,680	1
Other hepatitis	571	0
Poliomyelitis	0	0
Human infection with H5N1 virus	0	0
Measles	176	0
Epidemic hemorrhagic fever	613	0
Rabies	21	22
Japanese encephalitis	3	0
Dengue	442	0
Anthrax	24	1
Dysentery	1,915	0
Tuberculosis	48,656	318
Typhoid fever and paratyphoid fever	308	0
Meningococcal meningitis	16	1
Pertussis	6,662	3
Diphtheria	0	0
Neonatal tetanus	3	0
Scarlet fever	8,296	0
Brucellosis	3,690	0
Gonorrhea	9,649	0
Syphilis	47,978	2
Leptospirosis	18	0
Schistosomiasis	0	0
Malaria	248	0
Human infection with H7N9 virus	0	0
Monkey pox§	27	0
Influenza	1,509,750	7
Mumps	6,706	0

Continued

Diseases	Cases	Deaths
Rubella	63	0
Acute hemorrhagic conjunctivitis	1,863	0
Leprosy	19	0
Typhus	119	0
Kala azar	21	0
Echinococcosis	421	1
Filariasis	0	0
Infectious diarrhea[¶]	132,687	2
Hand, foot and mouth disease	46,782	0
Total	1,994,023	2,867

* According to the National Bureau of Disease Control and Prevention, not included coronavirus disease 2019 (COVID-19).

† The number of deaths of acquired immune deficiency syndrome (AIDS) is the number of all-cause deaths reported in the month by cumulative reported AIDS patients.

§ Since September 20, 2023, Monkey pox was included in the management of Class B infectious diseases.

¶ Infectious diarrhea excludes cholera, dysentery, typhoid fever and paratyphoid fever.

The number of cases and cause-specific deaths refer to data recorded in National Notifiable Disease Reporting System in China, which includes both clinically-diagnosed cases and laboratory-confirmed cases. Only reported cases of the 31 provincial-level administrative divisions in the Chinese mainland are included in the table, whereas data of Hong Kong Special Administrative Region, Macau Special Administrative Region, and Taiwan, China are not included. Monthly statistics are calculated without annual verification, which were usually conducted in February of the next year for de-duplication and verification of reported cases in annual statistics. Therefore, 12-month cases could not be added together directly to calculate the cumulative cases because the individual information might be verified via National Notifiable Disease Reporting System according to information verification or field investigations by local CDCs.

doi: 10.46234/ccdcw2025.036

Submitted: January 17, 2025
Accepted: January 21, 2025
Issued: February 07, 2025

Indexed by Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), PubMed Central (PMC), Scopus, Chinese Scientific and Technical Papers and Citations, and Chinese Science Citation Database (CSCD)

The inauguration of *China CDC Weekly* is in part supported by Project for Enhancing International Impact of China STM Journals Category D (PIIJ2-D-04-(2018)) of China Association for Science and Technology (CAST).

CCDC weekly

Vol. 7 No. 6 Feb. 7, 2025

Responsible Authority
National Disease Control and Prevention Administration

Sponsor
Chinese Center for Disease Control and Prevention

Editing and Publishing
China CDC Weekly Editorial Office
No.155 Changbai Road, Changping District, Beijing, China
Tel: 86-10-63150501, 63150701
Email: weekly@chinacdc.cn

CSSN
ISSN 2096-7071 (Print)
ISSN 2096-3101 (Online)
CN 10-1629/R1