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ARTICLE

Prevalence of Myopia Among Children and Adolescents Aged 5–17: A Cross-Sectional Study in Haishu District, Ningbo City, China

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Abstract

Aims/Background The rising incidence of myopia in children and adolescents represents a significant global public health concern in the domain of vision health and issues, especially in Asian countries like China. This study aims to investigate the prevalence and influencing factors of myopia among children and adolescents aged 5–17 in Haishu District, Ningbo City, China.

Methods A cross-sectional study was conducted using visual acuity data from 95,985 participants collected between July and December 2023. The participants included children and adolescents from senior kindergarten, primary and secondary schools.

Results The overall prevalence of myopia was 51.09%, with higher rates in urban (52.71%) than suburban areas (49.18%). Among males, the prevalence was 48.80%, while among females, it was higher at 53.68%. Prevalence rate increased significantly with age, particularly among individuals aged between 8 and 13 years, with girls surpassing boys from age 9. By ages 14–17, the prevalence among girls reached a plateau, while the boys' rates continued to rise. The median spherical equivalent was –2.00 D (right eye) and –1.88 D (left eye).

Conclusion The findings highlight the need for targeted, age- and region-specific vision protection measures to address the rising myopia burden among children and adolescents.

Key words: myopia; prevalence; children and adolescents; Chinese; cross-sectional study

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Introduction

Vision issues in children and adolescents represent a significant public health concern globally. In recent years, the incidence of myopia among children has been rising worldwide, particularly in Asian countries like China, with a trend inclining towards younger ages and higher severity, posing a serious threat to students' visual health (Jan et al, 2019; Wu et al, 2020). Myopia not only affects the quality of life and academic performance of children but also increases the risk of developing serious ocular complications in adulthood, such as glaucoma, macular degeneration, pathological myopia, and cataracts (Chang and Singh, 2013; Russo et al, 2022). By 2050, myopia is projected to affect approximately 50% of the global population, with 10% being highly myopic (Holden et al, 2016). Moreover, the

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progression of myopia is most rapid during childhood and adolescence. Coupled with the knowledge regarding the condition's age-specific progression behaviour, these statistics indicate an increasing challenge of youth myopia as a global public health issue (Huang et al, 2024). Therefore, there is a need to expand epidemiological studies and strengthen control measures for myopia in children and adolescents to minimise the incidence of myopia.

Over recent years, numerous scholars have reported on the prevalence of myopia among children or adolescents in various Chinese cities and analysed risk factors for myopia (Dong et al, 2020). In 2020, a study in Weifang City, Shandong Province, China, showed that the prevalence of myopia in children and adolescents aged 5–20 was 75.35%; this prevalence demonstrated a clear increase with age, rising from 26.05% in those $<$7 years to 93.98% in those $>$18 years, with the most rapid increase observed between ages 7 and 9; among high school students, the prevalence of severe myopia was 20.12% (Zhang et al, 2022). A 2024 cross-sectional study across Shandong Province revealed that the overall prevalence of myopia among adolescents aged 12–15 was 71.34%. The prevalence specifically increased from 68.97% in 12-year-olds to 70.46% in 13-year-olds, 72.10% in 14-year-olds, and 73.12% in 15-year-olds. Another study indicated that the prevalence of myopia in urban areas was significantly higher than in rural areas (Huang et al, 2024). These previous findings demonstrate that the prevalence of myopia in children and adolescents can vary significantly by region, age, and gender.

To our knowledge, this is the first report on the prevalence and influencing factors of myopia among children and adolescents in Haishu District, Ningbo City, based on a large-scale dataset of 95,985 participants. This innovative approach provides a comprehensive analysis of myopia patterns across gender, age, and region, offering crucial insights into the unique epidemiological characteristics of this population. Given the rapidly increasing prevalence of myopia worldwide and its severe long-term complications, such as glaucoma and retinal detachment, this study underscores the urgent need for targeted prevention and intervention strategies. Our findings aim to fill a critical gap in myopia research, guiding the formulation of evidence-based public health measures tailored to specific regional needs.

Methods

Study Participants

This cross-sectional study included a large-scale set of visual acuity data from children and adolescents aged 5–17 in Haishu District, Ningbo City, collected from July to December 2023. The dataset comprised visual acuity data from 95,985 children and adolescents, including those from senior kindergarten, primary and secondary schools. Students who had previously undergone cataract surgery, laser refractive surgery, or treatment with low-dose atropine were excluded from the study. From the 99,776 participants who met the screening criteria, defined as children and adolescents aged 5–17 years with no history of cataract surgery, laser refractive surgery, or treatment with low-dose atropine, 95,985 participants (96.20% participation rate) had completed all examinations. These examinations included uncorrected visual acuity (UCVA) testing, spherical equivalent (SE) measurement of refractive error using an automated refractometer (Topcon KR-800 Automated Refractometer, Topcon Corporation, Tokyo, Japan).

Sampling Strategy and Population Coverage

The study utilised a stratified cluster sampling method to ensure representativeness of the target population. Schools in Haishu District, including senior kindergartens, primary schools, and secondary schools, were selected to represent both urban and suburban areas proportionally. Specifically, the number of schools selected from urban and suburban areas was determined using official demographic data provided by the Haishu District Education Bureau, which outlines the proportion of students residing in urban versus suburban areas. This ensured that the sampling frame reflected the actual distribution of the target population.

Within each selected school, all students aged 5–17 were invited to participate, resulting in a total sample size of 95,985 participants. This sampling strategy ensured broad demographic coverage, including balanced representation across genders and geographic locations, which aligns with the demographic structure of Haishu District.

Quality Control Measures

To ensure data reliability, strict quality control measures were implemented throughout the study. Examiners were rigorously trained and certified by experienced ophthalmologists before data collection began. Standardised protocols were strictly followed, including regular calibration of visual acuity testing equipment (Topcon KR-800 Automated Refractometer, Topcon Corporation, Tokyo, Japan) to ensure measurement accuracy. Supervisors conducted random checks during the testing process to monitor adherence to protocols. Additionally, all data entries were double-checked by independent data managers to minimise transcription errors. These measures collectively ensured the reliability and consistency of the collected data.

Vision Testing and Refraction Screening

Visual acuity was tested using a standard logarithmic E-chart under controlled conditions. Testing was conducted in well-lit rooms with ambient light levels maintained above 300 Lux, following the Standard for Logarithmic VisuaI Acuity Chart (GB11533-2011) issued by the Ministry of Health of the People's Republic of China (2011). All participants were asked to remove their glasses for the refraction and uncorrected visual acuity (UCVA) tests. Each participant was seated at a fixed distance of 5 meters from the chart, and UCVA was tested using a standard logarithmic E-chart. During the test for the right eye (OD), a non-contact black spoon-shaped eye cover was used to cover the left eye (OS). After completing the OD test, the OS was tested. Each test took an interval of 5–10 seconds to complete.

Examiners were trained and certified by experienced ophthalmologists to ensure consistency and accuracy in the testing process. Vision data, including UCVA, corrected visual acuity, and refractive status, were collected with the assistance of local educational and medical institutions. UCVA and spherical equivalent (SE) were the primary indices measured. To minimise operational bias, examiners adhered strictly to standardised protocols throughout the data collection process.

Non-mydriatic optometry was performed to ensure feasibility given the large-scale nature of this study. Refractive data were obtained using an automated refractometer (Topcon KR-800 Automated Refractometer, Topcon Corporation, Tokyo, Japan), which is widely recognised for its accuracy and reliability in population-based research. Myopia was classified into three categories for analysis based on spherical equivalent (SE) thresholds. Mild myopia was defined as SE $\leq$–0.50 D and $>$–3.00 D, moderate myopia as SE $\leq$–3.00 D and $>$–6.00 D, and high myopia as SE $\leq$–6.00 D. These thresholds were chosen based on the Gab-Alla (2020) standard, which is widely accepted in international ophthalmology research. Importantly, this classification aligns with thresholds used in previous large-scale studies conducted in China, indicating its relevance to the Chinese population and ensuring consistency with local research practices.

Data Processing

Data processing and plotting were performed using GraphPad Prism software (version 9.5.0, GraphPad Software LLC, San Diego, CA, USA). All continuous variables were first tested for normality using the Kolmogorov-Smirnov test. Continuous variables with normal distribution were described using mean and standard deviation. Quantitative data with skewed distribution are represented by median (P25, P75). Comparisons between two groups for this kind of data were conducted using the Mann-Whitney U test. Categorical variables are expressed in counts and percentages. The Chi-square (χ^2) test was used for inter-group comparisons. Differences were considered statistically significant at $p < 0.05$.

Results

Basic Vision Data

This study included visual acuity data from 95,985 children and adolescents aged 5–17 (Table 1), with males accounting for 53.05% and females 46.95%, and the median age being 10.00 (8.00, 13.00). Among these children and adolescents, the prevalence of myopia was 51.09%. The median age of children and adolescents with myopia was 10.00 years (8.00, 14.00), while the median age of those without myopia was 11.00 years (9.00, 12.00), with a statistically significant difference between the two groups ($p < 0.001$). The prevalence of myopia was 53.68% in girls and 48.80% in boys, with the difference being statistically significant ($p < 0.001$). The median SE for the right eye was –2.00 (–3.38, –1.13) and for the left eye was –1.88 (–3.25, –1.00); the median UCVA for both eyes was 4.60 (4.30, 4.80). These values were significantly lower in the myopia group compared to the non-myopia group ($p < 0.001$). Geographically, among all children and adolescents, 54.19% resided in urban areas, while 45.81% resided in suburban areas. Among those with myopia, 55.90% lived in urban areas and 44.10% in suburban areas, with a statistically significant difference between the two groups ($p < 0.001$).

Table 1. Basic data of children and adolescents with and without myopia.

	Overall	Myopia status		χ^2/Z-value	*p*-value
		Myopia group	Non-myopia group		
Total, *n* (%)	95,985	49,042 (51.09)	46,943 (48.91)		
Age, median (P25, P75)	10.00 (8.00, 13.00)	10.00 (8.00, 14.00)	11.00 (9.00, 12.00)	–16.237	<0.001[a]
Gender				227.500	<0.001[b]
Male, *n* (%)	50,922 (53.05)	24,852 (48.80)	26,070 (51.20)		
Female, *n* (%)	45,063 (46.95)	24,190 (53.68)	20,873 (46.32)		
SE of right eye, median (P25, P75)	–0.63 (–2.13, 0.00)	–2.00 (–3.38, –1.13)	0.00 (–0.38, 0.38)	–238.238	<0.001[a]
SE of left eye, median (P25, P75)	–0.63 (–2.00, 0.13)	–1.88 (–3.25, –1.00)	0.00 (–0.25, 0.50)	–229.719	<0.001[a]
UCVA of right eye, median (P25, P75)	4.90 (4.50, 5.00)	4.60 (4.30, 4.80)	5.00 (4.90, 5.00)	–226.466	<0.001[a]
UCVA of left eye, median (P25, P75)	4.90 (4.60, 5.00)	4.60 (4.30, 4.80)	5.00 (4.90, 5.00)	–215.768	<0.001[a]
Regions				118.400	<0.001[b]
Rural (suburban), *n* (%)	43,970 (45.81)	21,626 (49.18)	22,344 (50.82)		
Urban, *n* (%)	52,015 (54.19)	27,416 (52.71)	24,599 (47.29)		

Note: [a] Compared using the Mann-Whitney *U* test; [b] Compared using the Chi-square test. SE, spherical equivalent; UCVA, uncorrected visual acuity.

Influence of Gender and Age on Myopia Severity

Myopia is defined as a SE ≤–0.50 D, with low myopia ranging from –0.5 to –3.0 D, moderate myopia from –3.0 to –6.0 D, and high myopia <–6.0 D (Gab-Alla, 2020; Holden et al, 2016). To understand whether gender influences the degree of myopia, we separately analyzed the proportions of normal vision, low, moderate, and high myopia among all males and females (Fig. 1A). Overall, there was a significant difference (χ^2-value = 231.200, $p < 0.001$) in the distribution of myopia severity between boys and girls. Among boys, the proportions for normal vision, mild myopia, moderate myopia, and high myopia were 51.20%, 37.07%, 10.46%, and 1.25%, respectively; among girls, these were 46.32%, 41.12%, 11.13%, and 1.42%, respectively.

To further understand and analyze changes in myopia across different age groups, we statistically assessed the overall prevalence of myopia and the numbers of children with low, moderate, and high myopia across subjected aged 5–17 (Fig. 1B). The analysis brought to the surface a clear trend that the prevalence of myopia increased with age (Fig. 1B and Fig. 2). The overall prevalence of myopia (including low, moderate, and high) was 8.00% at age 5, increasing to 13.70% by age 6; by age 16, it had risen to 83.89%, and by age 17, to 87.80%; in the age range of 5–17, the rate of myopia increased more than tenfold (Table 2). In terms of specific degrees of myopia, at age 6, the proportion with mild myopia was 13.29%, reaching 46.78% by age 16; severe myopia was 0.08% at age 6, increasing to 6.13% by age 16, and to 12.20% by age 17 (Table 2). By age 14, the rates of low and moderate myopia

Table 2. Statistics of myopia severity among children and adolescents by age.

Age (years)	Overall	No myopia (%)	Myopia (n = 49,042)			
			Mild (%)	Moderate (%)	High (%)	Total (%)
	n = 95,985	n = 46,943	n = 37,418	n = 10,343	n = 1281	n = 49,042
5	25	92.00	8.00	0.00	0.00	8.00
6	5976	86.30	13.29	0.33	0.08	13.70
7	10,463	86.62	12.92	0.36	0.10	13.38
8	11,373	77.49	21.77	0.63	0.11	22.51
9	9788	63.51	34.04	2.36	0.09	36.49
10	10,698	51.00	43.54	5.20	0.26	49.00
11	9771	38.27	51.42	9.61	0.71	61.73
12	10,426	30.60	53.65	14.57	1.18	69.40
13	8941	23.11	53.75	20.69	2.45	76.89
14	7945	18.96	52.61	25.02	3.41	81.04
15	7633	16.26	49.81	29.33	4.60	83.74
16	2905	16.11	46.78	30.98	6.13	83.89
17	41	12.20	46.34	29.27	12.20	87.80

began to show a steady or even slight decline, but the rate of high myopia continued to show a rapid increment. Thus, our data indicate that age is a significant factor for visual changes observed in children and adolescents.

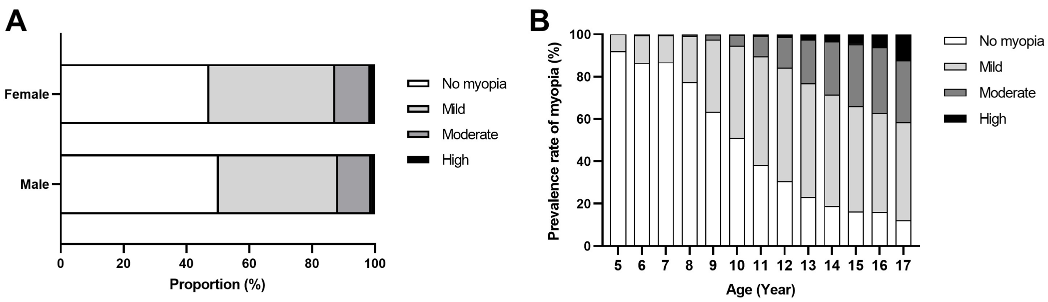

Fig. 1. Distribution of myopia severity among children and adolescents by gender and age. (A) Distribution of myopia severity by gender among children and adolescents. (B) Distribution of myopia severity by age among children and adolescents.

By comparing data for boys and girls, we detected no significant difference in how the degree of myopia changed with age; both showed increasing trends with age (Fig. 3). In numerical terms, from age 9, girls consistently had higher rates of myopia than boys (Fig. 2). Boys aged 15–17 experienced a surge in the myopia rate, which exceeded the rate among girls by age 17. For instance, at age 7, the proportion of moderate myopia was 0.30% for boys and 0.36% for girls; by age 11, these rates increased to 8.95% for boys and 10.15% for girls; and by age 16, to 29.97% for boys and 31.94% for girls (Table 3).

Table 3. Statistics of changes in myopia severity among children and adolescents by gender and age.

Age (years)	Male, n = 50,922				Female, n = 45,063			
	No myopia (%)	Mild (%)	Moderate (%)	High (%)	No myopia (%)	Mild (%)	Moderate (%)	High (%)
	n = 26,070	n = 18,889	n = 5325	n = 638	n = 20,873	n = 18,529	n = 5018	n = 643
5	92.31	7.69	0.00	0.00	91.67	8.33	0.00	0.00
6	86.73	12.91	0.27	0.09	86.69	12.96	0.28	0.07
7	85.37	14.23	0.30	0.09	88.17	11.39	0.36	0.08
8	77.59	21.73	0.56	0.12	77.31	21.92	0.66	0.11
9	65.82	32.16	1.89	0.13	61.58	35.60	2.77	0.04
10	54.62	40.05	5.11	0.22	48.91	45.82	4.98	0.29
11	42.12	48.36	8.95	0.57	35.01	54.00	10.15	0.85
12	34.38	50.81	13.82	0.98	27.34	56.08	15.20	1.39
13	27.58	51.21	18.91	2.30	19.69	55.45	22.29	2.57
14	22.61	50.49	23.67	3.22	16.17	54.12	26.15	3.57
15	24.22	33.19	37.39	5.20	13.24	52.02	29.52	5.22
16	17.93	45.94	29.97	6.15	14.58	47.42	31.94	6.06
17	4.00	56.00	28.00	12.00	20.00	33.33	33.33	13.33

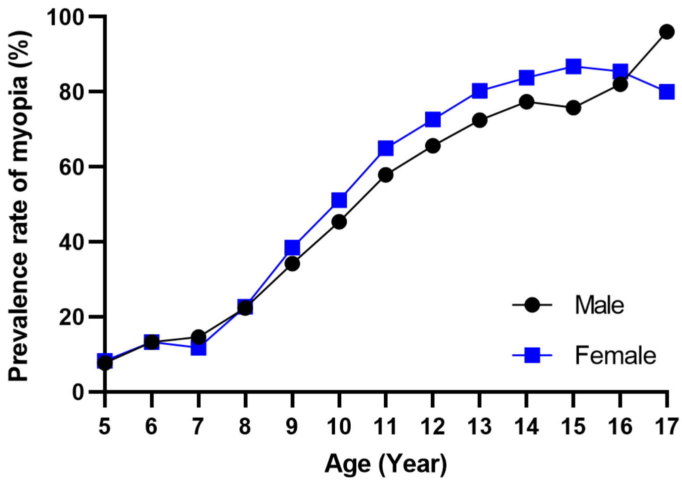

Fig. 2. Myopia prevalence in boys and girls by age.

Impact of Residential Location on the Prevalence of Myopia

We further analyzed the impact of residential location (urban or suburban) on the prevalence of myopia among children and adolescents aged 5–17 (Fig. 4). The results showed that the prevalence of myopia in suburban children and adolescents was 49.18%, while it was higher among their counterparts in urban areas at 52.71%. Between the ages of 5–7, suburban children experienced a higher rate of myopia than those in urban areas; however, from age 8 onwards, the prevalence of myopia in urban adolescents was slightly higher than that in suburban areas. Additionally, there was no significant difference in the increase in myopia prevalence (epidemic) between urban and suburban areas; at both locations, the prevalence of myopia

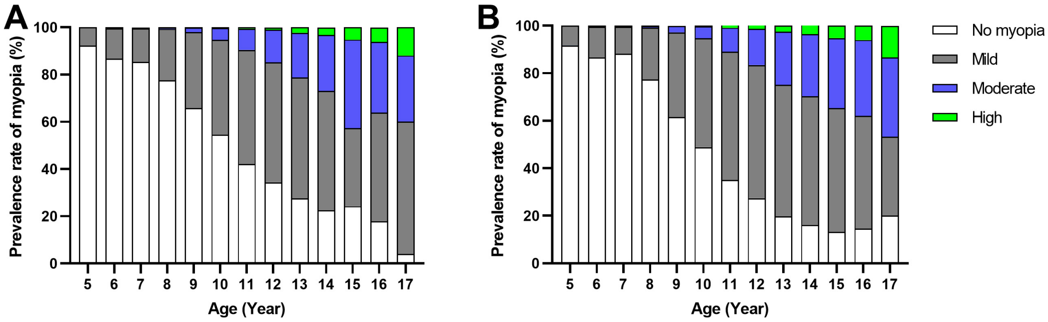

Fig. 3. Distribution of myopia severity among boys and girls by age. (A) Changes in the distribution of myopia severity among boys with age. (B) Changes in the distribution of myopia severity among girls with age.

gradually increased with age. By age 17, 89.47% of urban children and adolescents were myopic, compared to 90.48% in suburban areas.

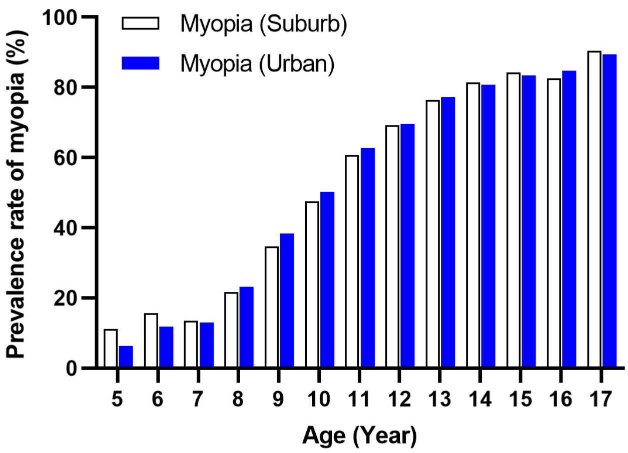

Fig. 4. Prevalence of myopia among children and adolescents in urban and suburban areas.

Discussion

Myopia is one of the leading causes of visual impairment and has garnered widespread international concern (Han et al, 2022). Over the past decade, an increased usage of electronic devices, along with rising academic pressures, has caused a steady increase in the prevalence rate of myopia. It has been reported that the overall prevalence of myopia in China has reached 80%, with a trend towards earlier onset becoming more apparent (Jong et al, 2021; Xiao et al, 2022). Our comprehensive statistical analysis of the visual conditions of children and adolescents aged 5–17 (median age 10.00 years) in Haishu District, Ningbo City, revealed valuable findings. According to our survey results, the overall rate of myopia among children and adolescents aged 5–17 in Haishu District was 51.09%, which is close to the rates reported previously. A study showed that the overall prevalence of myopia among children and adolescents in China was 52.7% in 2020 (Zhang et al, 2023). According to China's National Disease Control and Prevention Administration, the myopia rate among children and adolescents reached 51.9% in 2022 (Global Times, 2024). In a study conducted in 2021, children and adolescents with myopia in Tianjin were found to constitute 54.71% of the demographic group aged 6–16 (Li et al, 2024). The distribution of overall myopia prevalence does not vary significantly across different provinces or cities in China. However, the overall myopia rates in China and Asian populations are significantly higher than in some European countries. In Singapore, adolescents aged 11–19 had a myopia rate of 69.1% (Awodele, 2016), while from 2014 to 2017, a study revealed that the myopia rate among German children and adolescents aged 0–17 was only 11.4%, with no significant differences between different age groups or genders (Schuster et al, 2020). A study in Portugal among adolescents aged 10–18 showed a myopia rate of 21.5% (Nunes et al, 2024). These rates are substantially lower than the 51.09% observed in our study. Such disparities may be explained by differences in education systems and cultural practices. In China, students often face intense academic pressures, marked by longer school hours and frequent after-school tutoring, all of which lead to increased near-work activities and reduced outdoor exposure, which are significant risk factors for myopia (Martínez-Albert et al, 2023). In contrast, European countries such as Germany and Portugal generally emphasize balanced education systems with shorter school hours and more opportunities for outdoor activities, potentially reducing the risk of myopia (Grzybowski et al, 2020). Additionally, cultural priorities regarding academic achievement and leisure activities likely influence these trends, as Chinese students are often encouraged to prioritize academic success over physical activities. These findings underscore the need to consider education systems and cultural attitudes when developing strategies to address the myopia epidemic.

The prevalence of myopia increases significantly with age. Our study found that from ages 8 or 9, the prevalence of myopia began to increase significantly, reaching 69.40% by age 12 and 83.7% by age 15. This trend is likely related to increased academic pressures and reduced outdoor activities after starting school, which is consistent with previous studies. A 2021 study in Shenyang, China, on a sample with a median age of 11.9 years found an overall myopia rate of 60% (Zhang et al, 2023). In 2024, a study of adolescents aged 12–15 in Shandong Province found an overall myopia rate of 71.34%; at age 12, the prevalence was 68.97%, which rose to 73.12% at age 15 (Huang et al, 2024). Overall, the prevalence of myopia is highly correlated with the age of the surveyed children or adolescents; the younger the age, the lower the rate of myopia. A study targeting children and adolescents aged 3–14 in Chengdu found an overall myopia rate of 38.1% (Wang et al, 2021).

In terms of gender, although girls have a higher rate of myopia than boys (53.68% vs 48.80%), there is no significant difference in how myopia severity changes with age between the genders; both show increasing trends with age. Moreover, from age 9, the rate of myopia in girls is consistently higher than in boys, which is consistent with previous studies. In a survey of adolescent myopia rates in Shandong Province, the rate of high myopia among females was 73.12%, compared to 70.45% among males (Huang et al, 2024). A study in Tianjin found that the rate of myopia among females was 57.58%, slightly higher than males (52.05%) (Li et al, 2024). A cross-sectional study of school-aged children in Guangzhou found that girls had a higher risk of myopia than boys (Guo et al, 2016). The higher rate of myopia among females may be related to genetic, physiological, behavioral, psychological, and sociocultural factors, and possibly due to the predilection of girls towards "quieter activities" and avoidance of outdoor activities, since it has been found that increasing outdoor activity can reduce the rate of myopia (French et al, 2013). To better understand and address this phenomenon, further research is needed to explore the interactions between these factors and to develop targeted prevention and intervention measures.

This study also revealed that the severity of myopia also increases with age. We found that in children aged 5 to 8 years, the incidence of moderate myopia and high myopia does not exceed 0.63% and 0.11%, respectively. From age 9, there is a rapid increase in rates of low, moderate, and high myopia. By age 14, the rates of low and moderate myopia begin to stabilize or even slightly decline, but the rate of high myopia continues to rise significantly, contributing to the overall increase in myopia rates. Interestingly, Table 3 shows a notable drop in the percentage of males aged 15 with low myopia (33.19%). This reduction may reflect the natural progression of low myopia into moderate or high myopia during adolescence. This phenomenon may be exacerbated by increased academic pressures and near-work tasks, which are prevalent in this age group. Hormonal changes during puberty could also contribute to these visual alterations. Furthermore, sampling variability or differences in adherence to protective behaviors, such as outdoor activities or usage of corrective lenses, may also play a role. Further studies are needed to explore these factors in depth. This pattern is consistent with previous findings, such as a study conducted in Tianjin reporting the continued rise of moderate and high myopia rates in the age range of 9–16, with a slow increase by age 14 (Li et al, 2024). A cross-sectional study concluded that there is a sharp increase in myopia development around age 7 (23.7%), reaching 90% by age 12, after which the rate of increase begins to slow (Wang et al, 2020).

Our study also showed that the prevalence of myopia is higher among urban adolescents from age 8 compared to their suburban counterparts. This finding aligns with studies from Shandong and Guangdong provinces, showing higher rates of myopia among urban children and adolescents compared to those from rural or suburban areas (Pan and Lan, 2024). A study in Tianjin showed significantly higher rates of moderate and high myopia among children residing in the city's six central districts compared to other areas (Li et al, 2024). Similar patterns have been observed globally. A study in India among children and adolescents aged 5–15 reported an urban myopia prevalence of 8.5% compared to 6.1% in rural areas (Agarwal et al, 2020). The difference between urban and rural myopia rates may be attributed to higher levels of education and socioeconomic status typically found in urban environments(Martínez-Albert et al, 2023).

A limitation of this study is the lack of statistical analysis on the causes of myopia among these children and adolescents, such as eye usage habits, genetic predispositions, outdoor activity time, and homework duration. However, there are numerous studies that have reported the reasons for the increasing rates of myopia among children and adolescents. The impact of outdoor activity time on children's vision has been confirmed, with increased outdoor activity providing some protection against myopia (Eppenberger and Sturm, 2020; He et al, 2022). According to Chen et al (2016) study, longer outdoor activity delays the onset of myopia. A review analysis showed that the causes of myopia are related to genetic and environmental factors. If parents are myopic, their children are more likely to be myopic. Among environmental factors, duration and intensity of schooling represent a major risk factor for the development of myopia (Martínez-Albert et al, 2023). Additionally, late sleeping may also be a risk factor for myopia. A 2-year longitudinal study in Shanghai among children aged 6–9 found that late sleepers are more susceptible to the development and progression of myopia, highlighting the importance of circadian rhythms (Liu et al, 2020). In summary, myopia in children and adolescents is closely related to living environments, genetics, and lifestyle habits. Further quantification of the relationship between adolescent myopia and these factors will aid in the prevention and intervention of myopia. It is recommended that schools and parents encourage children to increase outdoor activity time, reduce near-work duration, and regularly conduct vision screenings to promptly detect and address vision problems.

Based on our findings and in combination with the "Myopia Prevention and Control Guidelines (2024 Edition)" promulgated by the National Health Commission (2024), several public health recommendations have been put forward to reduce the incidence of myopia. First, increasing outdoor activity time should be prioritized, as evidence suggests that greater exposure to natural light is protective against myopia progression (Eppenberger and Sturm, 2020). Second, strategies to reduce near-work duration, such as limiting screen time and encouraging regular breaks during study sessions, should be implemented both at home and in schools. Third, school-based education programs should be organized to raise awareness among parents, teachers, and students about the importance of myopia prevention and early detection. These strategies are practical, culturally relevant, and align with existing national health initiatives. Future research should further evaluate the effectiveness of these interventions in reducing myopia prevalence and severity.

This study has several limitations. First, due to its cross-sectional design, the study only reflects the myopia status of adolescents in Haishu District, Ningbo City, at a specific time point, unable to track long-term myopia progression or evaluate the sustained effects of various myopia prevention interventions. Second, the study participants were sourced from a single region. Although the sample selection aimed to cover students from different schools and age groups, the regional restriction means the findings may be influenced by local social and environmental factors, education systems, and lifestyle habits. Thus, the results obtained may not fully represent myopia conditions among adolescents in other parts of China, limiting the generalizability and broader applicability of the findings. Future studies could adopt a longitudinal cohort design, include participants from multiple regions with larger sample sizes, and integrate biometric measurements (e.g., axial length, corneal curvature) alongside more comprehensive data on potential influencing factors. This approach would allow for a deeper analysis of myopia development mechanisms and the generation of more holistic evidence for informing the formulation of targeted myopia prevention strategies. Third, this study has certain limitations in its statistical methodology. Specifically, logistic regression was not employed due to several reasons. Critical confounders, such as parental myopia status, near-work duration, and outdoor activity time, were not collected due to logistical constraints during the study design phase. The absence of these variables limits the interpretability of regression models. Since the primary objective of this study was to provide a descriptive epidemiological overview rather than to establish causality, we employed descriptive and comparative statistical methods instead to better align with the study's goals.

Conclusion

Our large-scale cross-sectional study of children and adolescents aged 5–17 in Haishu District, Ningbo City, demonstrates that the prevalence of myopia is correlated with gender, age, and residential location. The analysis revealed an overall prevalence rate of 51.09%, with girls showing a slightly higher rate of 53.68% compared to boys at 48.80%. The prevalence of myopia increased with age, with a notable acceleration starting at the age of 9. By age 14, rates of low and moderate myopia began to level off or even slightly decline, yet the rate of high myopia continued to rise rapidly. Compared to suburban areas, urban areas exhibited higher rates of myopia in children and adolescents. The findings from this study provide a scientific basis for the development of effective vision protection measures for children.

Key Points

- The study highlights the high prevalence of myopia among children and adolescents, its association with age, gender, and residential location, and the need for targeted vision protection measures.
- The overall prevalence of myopia among children and adolescents aged 5–17 in this study was 51.09%, with girls showing a higher prevalence (53.68%) compared to boys (48.80%).
- The prevalence of myopia increased significantly with age, rising from 8.00% at age 5 to 87.80% at age 17, the period between age 8 and 13 was identified as a critical stage that is associated with a rapid increase in myopia prevalence.
- While the rates of low and moderate myopia stabilized after age 14, the prevalence of high myopia continued to rise.
- In the age range of 5–7, suburban children exhibited a slightly higher prevalence of myopia, but from age 8 onwards, urban children surpassed their suburban peers, by age 17, the urban adolescents and their suburban counterparts demonstrated a myopia prevalence rate of 89.47% and 90.48%, respectively.

Availability of Data and Materials

All data included in this study are available from the corresponding author upon reasonable request.

Author Contributions

XJ: Conceptulization, Supervision, Data curation, Methodology, Writing — original draft. CL: Conceptulization, Supervision, Writing — review & editing. SW: Data curation, Methodology. JZ: Data curation, Methodology. DY: Data curation. YS: Data curation. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of the First Affiliated Hospital of Ningbo University (2024 Research No.095RS). The study included minors, and their informed consent forms were signed by their legal guardians. Written informed consent was obtained from all subjects participating in the trial, and their information was stored and used for research anonymously.

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Conflict of Interest

The authors declare no conflict of interest.

References

Agarwal D, Saxena R, Gupta V, Mani K, Dhiman R, Bhardawaj A, et al. Prevalence of myopia in Indian school children: Meta-analysis of last four decades. PLoS ONE. 2020; 15: e0240750. https://doi.org/10.1371/journal.pone.0240750

Awodele A. Prevalence, incidence and progression of myopia in Singaporean adolescents [Master's thesis]. Duke University. 2016.

Chang RT, Singh K. Myopia and glaucoma: diagnostic and therapeutic challenges. Current Opinion in Ophthalmology. 2013; 24: 96–101. https://doi.org/10.1097/ICU.0b013e3201331

Chen Y, Chang BHW, Ding X, He M. Patterns in longitudinal growth of refraction in Southern Chinese children: cluster and principal component analysis. Scientific Reports. 2016; 6: 37636. https://doi.org/10.1038/srep37636

Dong L, Kang YK, Li Y, Wei WB, Jonas JB. PREVALENCE AND TIME TRENDS OF MYOPIA IN CHILDREN AND ADOLESCENTS IN CHINA: A Systemic Review and Meta-Analysis. Retina. 2020; 40: 399–411. https://doi.org/10.1097/IAE.0000000000002590

Eppenberger LS, Sturm V. The Role of Time Exposed to Outdoor Light for Myopia Prevalence and Progression: A Literature Review. Clinical Ophthalmology. 2020; 14: 1875–1890. https://doi.org/10.2147/OPTH.S245192

French AN, Ashby RS, Morgan IG, Rose KA. Time outdoors and the prevention of myopia. Experimental Eye Research. 2013; 114: 58–68. https://doi.org/10.1016/j.exer.2013.04.018

Gab-Alla AA. Reference Values of the Central Corneal Thickness with Different Refractive Errors for the Adult Egyptian Population. Clinical Ophthalmology. 2020; 14: 3465–3474. https://doi.org/10.2147/OPTH.S277137

Global Times. Myopia rate among children and adolescents amounts to 51.9% in 2022: China's National Disease Control and Prevention Administration. 2024. Available at: https://www.globaltimes.cn/page/202403/1308787.shtml (Accessed: 13 March 2024)

Grzybowski A, Kanclerz P, Tsubota K, Lanca C, Saw SM. A review on the epidemiology of myopia in school children worldwide. BMC Ophthalmology. 2020; 20: 27. https://doi.org/10.1186/s12886-019-1220-0

Guo L, Yang J, Mai J, Du X, Guo Y, Li P, et al. Prevalence and associated factors of myopia among primary and middle school-aged students: a school-based study in Guangzhou. Eye. 2016; 30: 796–804. https://doi.org/10.1038/eye.2016.39

Han X, Liu C, Chen Y, He M. Myopia prediction: a systematic review. Eye. 2022; 36: 921–929. https://doi.org/10.1038/s41433-021-01805-6

He X, Sankaridurg P, Wang J, Chen J, Naduvilath T, He M, et al. Time Outdoors in Reducing Myopia: A School-Based Cluster Randomized Trial with Objective Monitoring of Outdoor Time and Light Intensity. Ophthalmology. 2022; 129: 1245–1254. https://doi.org/10.1016/j.ophtha.2022.06.024

Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, et al. Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology. 2016; 123: 1036–1042. https://doi.org/10.1016/j.ophtha.2016.01.006

Huang Z, Song D, Tian Z, Wang Y, Tian K. Prevalence and associated factors of myopia among adolescents aged 12-15 in Shandong Province, China: a cross-sectional study. Scientific Reports. 2024; 14: 17289. https://doi.org/10.1038/s41598-024-68076-5

Jan C, Xu R, Luo D, Xiong X, Song Y, Ma J, et al. Association of Visual Impairment With Economic Development Among Chinese Schoolchildren. JAMA Pediatrics. 2019; 173: e190914. https://doi.org/10.1001/jamapediatrics.2019.0914

Jong M, Jonas JB, Wolffsohn JS, Berntsen DA, Cho P, Clarkson-Townsend D, et al. IMI 2021 Yearly Digest. Investigative Ophthalmology & Visual Science. 2021; 62: 7. https://doi.org/10.1167/iovs.62.5.7

Li T, Wei R, Du B, Wu Q, Yan J, Meng X, et al. Prevalence of myopia among children and adolescents aged 6-16 during COVID-19 pandemic: a large-scale cross-sectional study in Tianjin, China. The British Journal of Ophthalmology. 2024; 108: 879–883. https://doi.org/10.1136/bjo-2023-323688

Liu XN, Naduvilath TJ, Wang J, Xiong S, He X, Xu X, et al. Sleeping late is a risk factor for myopia development amongst school-aged children in China. Scientific Reports. 2020; 10: 17194. https://doi.org/10.1038/s41598-020-74348-7

Martínez-Albert N, Bueno-Gimeno I, Gené-Sampedro A. Risk Factors for Myopia: A Review. Journal of Clinical Medicine. 2023; 12: 6062. https://doi.org/10.3390/jcm12186062

Ministry of Health of the People's Republic of China. Standard for Logarithmic VisuaI Acuity Chart (GB11533-2011). 2011; 1–12.

National Health Commission. Myopia Prevention and Control Guidelines (2024 Edition). 2024. Available at: https://www.nhc.gov.cn/yzygj/c100068/202405/8536cb2bb0f5480ab345be7ebf7502ea.shtml (Accessed: 31 May 2024).

Nunes AF, Cunha M, Sousa MCB, Godinho CA. Prevalence, sociodemographic risk factors, and coverage of myopia correction among adolescent students in the central region of Portugal. BMC Public Health. 2024; 24: 2490. https://doi.org/10.1186/s12889-024-19914-8

Pan W, Lan W. The Current and Future Landscape of the Childhood Myopia Epidemic in China-A Review. Ophthalmology and Therapy. 2024; 13: 883–894. https://doi.org/10.1007/s40123-024-00887-1

Russo A, Boldini A, Romano D, Mazza G, Bignotti S, Morescalchi F, et al. Myopia: Mechanisms and Strategies to Slow Down Its Progression. Journal of Ophthalmology. 2022; 2022: 1004977. https://doi.org/10.1155/2022/1004977

Schuster AK, Krause L, Kuchenbäcker C, Prütz F, Elflein HM, Pfeiffer N, et al. Prevalence and Time Trends in Myopia Among Children and Adolescents. Deutsches Arzteblatt International. 2020; 117: 855–860. https://doi.org/10.3238/arztebl.2020.0855

Wang J, Li Y, Zhao Z, Wei N, Qi X, Ding G, et al. School-based epidemiology study of myopia in Tianjin, China. International Ophthalmology. 2020; 40: 2213–2222. https://doi.org/10.1007/s10792-020-01400-w

Wang J, Liu J, Ma W, Zhang Q, Li R, He X, et al. Prevalence of myopia in 3-14-year-old Chinese children: a school-based cross-sectional study in Chengdu. BMC Ophthalmology. 2021; 21: 318. https://doi.org/10.1186/s12886-021-02071-6

Wu PC, Chen CT, Chang LC, Niu YZ, Chen ML, Liao LL, et al. Increased Time Outdoors Is Followed by Reversal of the Long-Term Trend to Reduced Visual Acuity in Taiwan Primary School Students. Ophthalmology. 2020; 127: 1462–1469. https://doi.org/10.1016/j.ophtha.2020.01.054

Xiao J, Liu M, Huang Q, Sun Z, Ning L, Duan J, et al. Analysis and modeling of myopia-related factors based on questionnaire survey. Computers in Biology and Medicine. 2022; 150: 106162. https://doi.org/10.1016/j.compbiomed.2022.106162

Zhang D, Sun B, Wu M, Liu H, Zhou L, Guo L. Prevalence and associated factors of myopia among school students in Shenyang, China: a cross-sectional study. Frontiers in Public Health. 2023; 11: 1239158. https://doi.org/10.3389/fpubh.2023.1239158

Zhang J, Li Z, Ren J, Wang W, Dai J, Li C, et al. Prevalence of myopia: A large-scale population-based study among children and adolescents in Weifang, China. Frontiers in Public Health. 2022; 10: 924566. https://doi.org/10.3389/fpubh.2022.924566