

Preplanned Studies

A Multi-Center Cross-Sectional Study on Visual Impairment and Depression Among Students — Jiangsu Province, China, 2017–2022

Xiyan Zhang^{1,2}; Wei Du³; Yan Wang¹; Wenyi Yang¹; Xin Wang¹; Jie Yang^{1,2,#}

Summary

What is already known about this topic?

China exhibits a significantly high prevalence of myopia compared to other countries globally. Children with vision impairment have been found to engage less in physical activities, achieve lower academic performance, and have increased vulnerability to depression.

What is added by this report?

During a six-year observational study, a population-level correlation was identified between varying degrees of visual impairment and the presence of depressive symptoms among students. Specifically, individuals with a visual acuity below 4.0 had a significantly higher odds ratio of 1.90 (95% confidence interval: 1.53–2.37) compared to individuals with normal vision (visual acuity ≥ 5.0).

What are the implications for public health practice?

This study highlights the importance of holistic health interventions that address both visual and psychological aspects. Understanding common mechanisms and influential factors can guide the development of more impactful public health strategies.

Vision impairment is a significant global issue, affecting 2.2 billion individuals worldwide, including an estimated 19 million children aged 0–14 years. Of this group, approximately 1.4 million children suffer from irreversible blindness (1). In China, over half of children aged 6–18 years are affected by myopia, which can be attributed to the high-pressure educational environment they face (2). This vision impairment can have detrimental effects on their education and may contribute to the development of depressive symptoms (2). As vision is crucial for perceiving and comprehending the environment, impairments in this modality can negatively impact mental health, leading to anxiety, depression, or self-esteem issues.

Particularly in the eastern China, where myopia prevalence is highest among children and adolescents, the link between visual health and psychological well-being is a significant public health concern that requires further investigation and ongoing attention.

The study was conducted from 2017 to 2022, with participation from 11 project sites. Random sampling of districts or counties was used to select these sites in Jiangsu Province, which consists of 98 districts or counties. During the research period, a total of 8,997 middle and high school students across 6 grade levels participated in the survey. For more detailed information on the survey process (Figure 1).

The survey comprised several components. First, ophthalmic examinations were conducted by trained program members, nurses, and doctors. The myopia screening institution needed to have a valid medical institution license. Visual impairment, referred to as low vision, was assessed using the “Standard Logarithmic Visual Acuity Chart” (GB 11533–2011) (3). Visual acuity of 5.0 or more indicated health vision in children and adolescents aged 6 and above. Visual acuity ranging from 4.6 to 4.9 was considered as mild to moderate visual impairment, while visual acuity equal to or less than 4.5 was classified as severe visual impairment. The severe visual impairment group was further categorized into severe vision impairment group 1 (visual acuity ≤ 4.0) and severe vision impairment group 2 (visual acuity ranging from 4.1 to 4.5). Second, height and weight measurements were taken. Students removed their shoes and clothes before their weight and height were measured. The measurements were taken according to the standardized equipment and procedures outlined in the health check list for primary and junior school students (GB 16134–2011) (4). Overweight, obesity, and body mass index (BMI) screening followed the unified classification criteria based on the screening for overweight and obesity among school-age children and adolescents (WST 586–2018) issued by the National

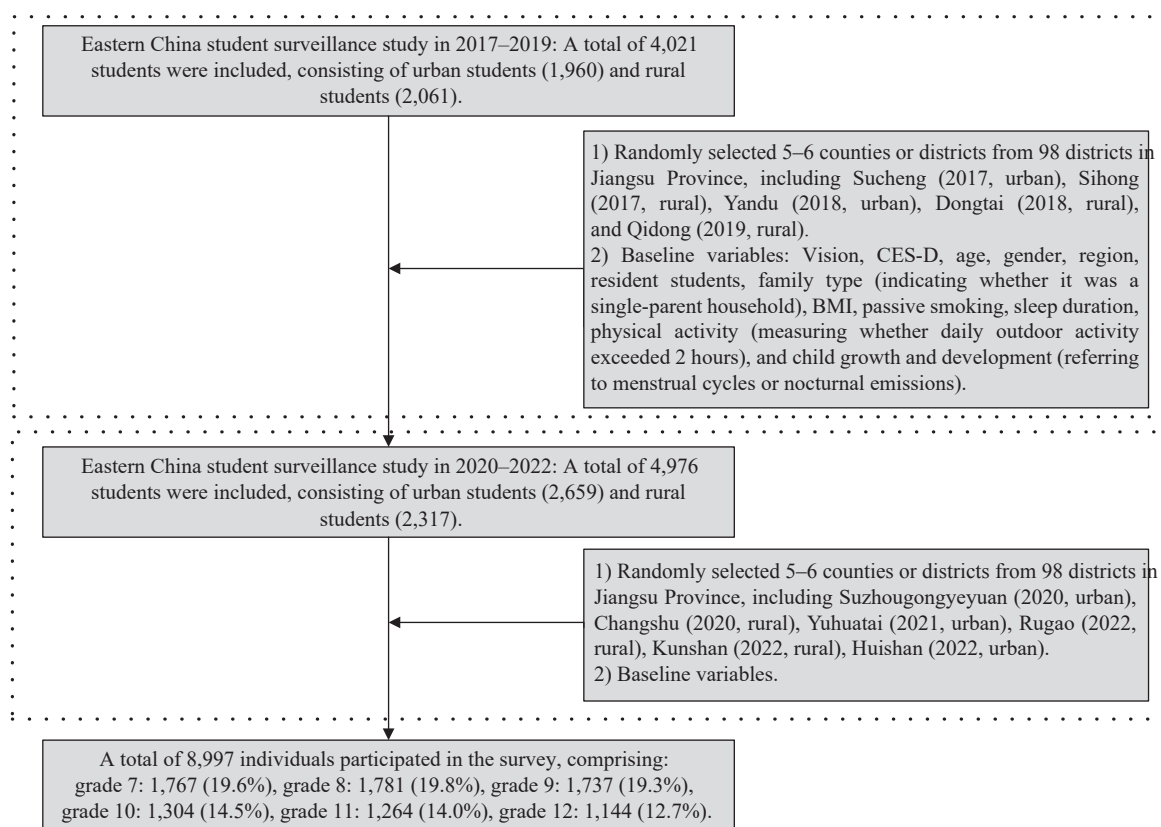


FIGURE 1. The flowchart illustrates the research procedure involving middle and high school students from 2017 to 2022. Abbreviation: CES-D=Center for Epidemiologic Studies Depression Scale; BMI=body mass index.

Health Commission of the People's Republic of China. BMI was calculated as weight in kilograms divided by height in meters squared. Third, the prevalence of depressive symptoms was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D) (5). The CES-D scale, which has been widely used and validated for reliability in Chinese cohorts, was utilized. The Chinese version of the CES-D scale employs a four-point Likert scale, with higher scores indicating more severe depressive symptoms. A CES-D score of 20 or higher was used as the threshold to identify the presence of depressive symptoms (6). Finally, a comprehensive questionnaire was administered to collect baseline data, including information on date of birth, family structure, outdoor activity levels, exposure to passive smoking, and other relevant factors.

The characteristics of the participating students were described as follows: 1) Continuous variables such as age, BMI, and sleep duration, which followed a normal distribution, were presented as mean±standard deviation. 2) Categorical variables, including resident students, single-parent household, and passive

smoking, were analyzed using chi-square tests and presented as percentages. 3) Multilevel logistic models were used to investigate the association between visual impairment and symptoms of depression. The analysis included the following covariates: age, gender, region, resident students, family type (single-parent household), BMI, passive smoking, sleep duration, physical activity (more than 2 hours of daily outdoor activity), child growth development, and year. Odds ratios (ORs) along with their corresponding 95% confidence intervals (CIs) were calculated. Data analysis was performed using IBM SPSS (version 20.0; IBM Corp., Armonk, NY, US). Statistically significant results were defined as P -value < 0.05.

This study included 8,997 participants between 2017 and 2022. The average age of the participants was 14.4 ± 1.7 years. Of the total participants, 4,745 (52.7%) were male students and 4,619 (51.3%) were urban children and adolescents. Comparing the group with low depression scores (CES-D < 20) to the high depression score group (CES-D \geq 20), several significant distinguishing characteristics were found. Table 1 provides a detailed overview of these differences.

TABLE 1. Basic demographic characteristics of children sorted by CES-D scores.

Variable	CES-D (≥ 20), n=1,571	CES-D (< 20), n=7,426	χ^2/It	P
Age*, years, mean \pm SD	14.8 \pm 1.6	14.3 \pm 1.7	9.67	<0.001
Male students*, n (%)	774 (49.3)	3,971 (53.5)	9.20	0.002
Urban, n (%)	803 (51.1)	3,816 (51.4)	0.04	0.844
Year*				
2017–2019	746 (18.6)	3,275 (81.4)	6.01	0.014
2020–2022	825 (16.6)	4,151 (79.1)		
Middle and high school grade*				
Grade 7	193 (10.9)	1,574 (89.1)	103.18	<0.001
Grade 8	267 (15.0)	1,514 (85.0)		
Grade 9	328 (18.9)	1,409 (81.1)		
Grade 10	249 (19.1)	1,055 (80.9)		
Grade 11	270 (21.4)	994 (78.6)		
Grade 12	264 (23.1)	880 (76.9)		
Resident students*, n (%)	393 (25.0)	1,573 (21.1)	11.16	<0.001
Single-parent household*, n (%)	133 (8.5)	499 (6.7)	6.05	0.014
BMI*, kg/m ² , mean \pm SD	22.2 \pm 4.2	21.7 \pm 4.1	4.23	<0.001
Passive smoking*, n (%)	169 (10.8)	354 (4.8)	84.99	<0.001
Sleep duration*, h	6.7 \pm 1.6	7.3 \pm 1.4	14.76	<0.001
Physical activity (≥ 2 h)*, n (%)	371 (23.6)	2,205 (29.7)	23.44	<0.001
Child growth development*, n (%)	1,266 (80.6)	5,334 (71.8)	50.88	<0.001
Vision*, mean \pm SD	4.3 \pm 0.4	4.4 \pm 0.4	8.00	<0.001
Healthy vision (≥ 5.0), n (%)	128 (8.1)	971 (13.1)		
Mild and moderate visual impairment (4.6–4.9), n (%)	263 (16.7)	1,397 (18.8)	61.98	<0.001
Severe vision impairment group 2 (4.0–4.5), n (%)	651 (41.4)	3,169 (42.7)		
Severe vision impairment group 1 (≤ 4.0), n (%)	529 (33.7)	1,889 (25.4)		

Abbreviation: CES-D=Center for Epidemiologic Studies Depression Scale; SD=standard deviation; BMI=body mass index.

* $P < 0.05$.

We conducted a pooled analysis to examine the association between visual impairment and depressive symptoms. Three models were used: Model 1 with no covariates, Model 2 with covariates such as age, gender, region, and year, and Model 3 with a comprehensive set of covariates including age, gender, region, resident students, family type, BMI, passive smoking, sleep duration, physical activity, and child growth development, along with year. In Model 3, compared to the healthy vision group (visual acuity ≥ 5.0), the ORs for the severe vision impairment group 1 (≤ 4.0), severe vision impairment group 2 (visual acuity between 4.1 and 4.5), and mild and moderate visual impairment group (visual acuity between 4.6 and 4.9) were 1.90 (95% CI: 1.53–2.37), 1.53 (95% CI: 1.24–1.88), and 1.46 (95% CI: 1.16–1.84), respectively. These findings indicate a significant population-level association between vision

impairment and depressive symptoms among Chinese students (Figure 2).

DISCUSSION

From 2017 to 2022, this study was conducted at 11 project sites involving a total of 8,997 middle and high school students. A pooled analysis was performed, adjusting for various covariates such as age, gender, region, residential status, family type (indicating single-parent household status), BMI, passive smoking, sleep duration, physical activity (evaluating if daily outdoor activity exceeded 2 hours), child growth development (referring to menstrual cycles or nocturnal emissions), and year. The analysis revealed a statistically significant association between the group with severe vision impairment and depressive symptoms compared to the group with healthy vision.

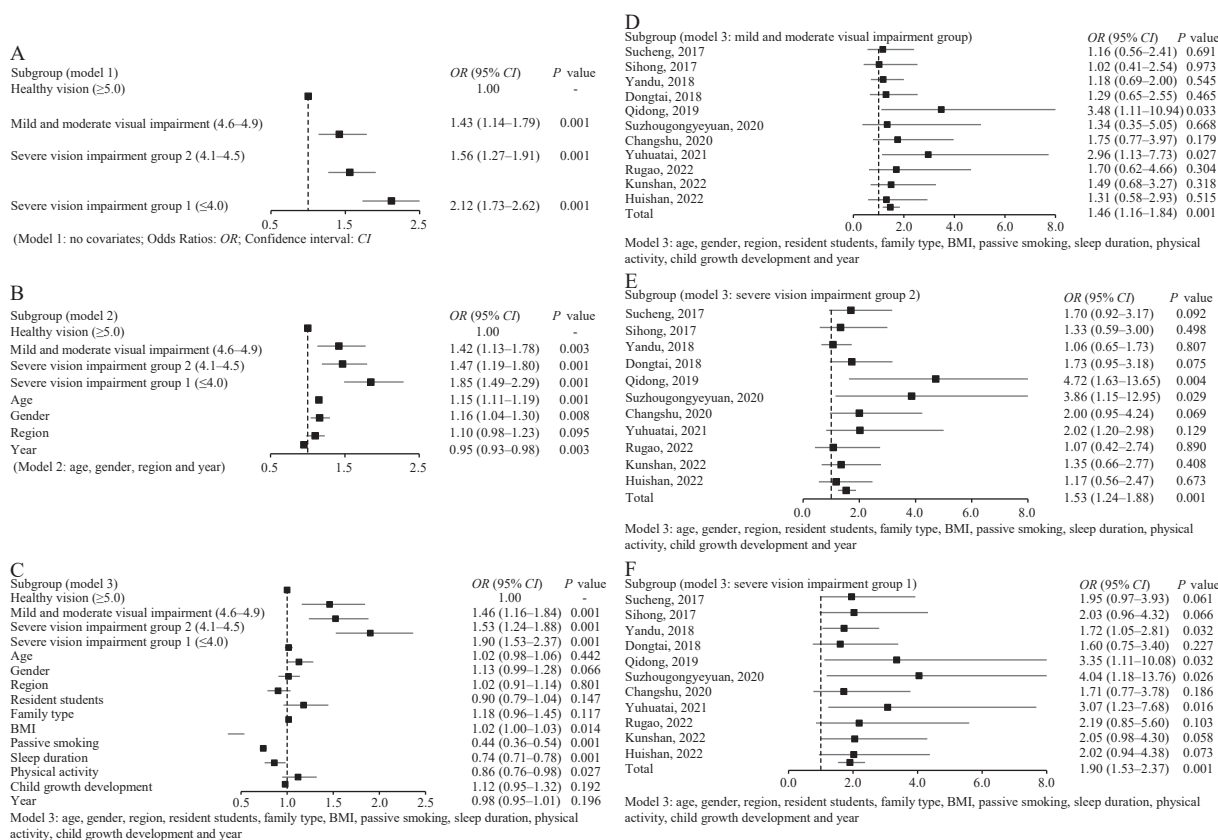


FIGURE 2. Forest plot depicting the association between visual impairment and depressive symptoms. (A) Relationship between visual impairment and depressive symptoms with Model 1; (B) relationship between visual impairment and depressive symptoms with Model 2; (C) relationship between visual impairment and depressive symptoms with Model 3; (D) relationship between visual impairment (4.6–4.9) and depressive symptoms with Model 3 sorted by regions; (E) relationship between visual impairment (4.1–4.5) and depressive symptoms with Model 3 sorted by regions; (F) relationship between visual impairment (≤ 4.0) and depressive symptoms with Model 3 sorted by regions. Abbreviation: OR=odds ratio; CI=confidence interval; BMI=body mass index.

The intricate neural mechanisms connecting vision and depression require a comprehensive investigation of various biological, psychological, and sociocultural factors. While previous studies have observed a statistical correlation between visual impairment and depression symptoms or other mental health concerns (7–8), caution is necessary when interpreting this association as it does not establish a cause-and-effect relationship. To gain a better understanding of this connection, further research, including long-term observational studies and examinations of potential mechanisms, is needed. The processing of visual information involves multiple brain regions, such as the visual cortex, secondary visual cortex, and emotionally-related areas like the amygdala (9). Abnormal processing of visual information or visual impairments may consequently impact the functioning of these brain regions and influence emotional states (10). Moreover, visual impairments can lead to social

isolation, self-awareness issues, and daily life challenges, which may contribute to the onset of depressive symptoms (11).

This study is subject to some limitations. First, it would benefit from continued longitudinal follow-up with the population to explore causal relationships further. Long-term observation is essential for definitive establishment of causality. Second, reliance on self-reported data without clinical or objective measurements, particularly when assessing depression, introduces potential bias or inaccuracies due to personal perception and interpretation.

In conclusion, this six-year observational study found a significant association at the population level between visual impairment and symptoms of depression among school-age children. These findings highlight the importance of addressing both the visual and psychological well-being of students with compromised vision. The study provides valuable

insights for interventions targeting the co-occurrence of visual and mental health conditions in students. Given the shared nature of common diseases in this population and their underlying mechanisms, a comprehensive approach to public health policies can offer invaluable guidance.

Acknowledgements: The epidemiological field workers involved in this study, including staff from Sucheng District, Sihong County, Yancheng District, Qidong City, Suzhou Industrial Park, Changshu City, Yuhuatai District, Rugao City, Kunshan City, and Huishan District.

Conflict of interest: All authors had no conflicts of interest.

Funding: Supported by the Jiangsu Provincial Science and Technology Resource Coordination Service Platform for their open research project (TC2022B023).

doi: 10.46234/ccdcw2023.215

Corresponding author: Jie Yang, 51478536@qq.com.

¹ Jiangsu Provincial Center for Disease Control and Prevention, Nanjing City, Jiangsu Province, China; ² School of Public Health, Nanjing Medical University, Nanjing City, Jiangsu Province, China; ³ School of Public Health, Southeast University, Nanjing City, Jiangsu Province, China.

Submitted: October 07, 2023; Accepted: December 04, 2023

REFERENCES

1. Solebo AL, Rahi J. Epidemiology, aetiology and management of visual impairment in children. *Arch Dis Child* 2014;99(4):375 – 9. <http://dx.doi.org/10.1136/archdischild-2012-303002>.
2. Ma X, Zhou Z, Yi H, Pang X, Shi Y, Chen Q, et al. Effect of providing free glasses on children's educational outcomes in China: cluster randomized controlled trial. *BMJ* 2014;349:g5740. <http://dx.doi.org/10.1136/bmj.g5740>.
3. Zhang XY, Zhou YL, Wang Y, Du W, Yang J. Trend of myopia through different interventions from 2010 to 2050: findings from Eastern Chinese student surveillance study. *Front Med* 2023;9:1069649. <http://dx.doi.org/10.3389/fmed.2022.1069649>.
4. General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Standardization Administration of the People's Republic of China. GB/T 16134-2011 Standard for physical examination records for elementary and middle school students. Beijing: Standards Press of China, 2012. <http://www.csres.com/detail/221666.html>. (In Chinese).
5. Lewinsohn PM, Seeley JR, Roberts RE, Allen NB. Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychol Aging* 1997;12(2):277 – 87. <http://dx.doi.org/10.1037/0882-7974.12.2.277>.
6. Wang X, Wang Y, Zhang XY, Yang WY, Yang J. A large-scale cross-sectional study on mental health status among children and adolescents — Jiangsu Province, China, 2022. *China CDC Wkly*, 2023;5(32): 710 – 4. <http://dx.doi.org/10.46234/ccdcw2023.136>.
7. Li QL, Yang JZ, He Y, Wang T, Zhong L, Zhu ZQ, et al. Investigation of the psychological health of first-year high school students with myopia in Guangzhou. *Brain Behav* 2020;10(4):e01594. <http://dx.doi.org/10.1002/brb3.1594>.
8. Li DF, Chan VF, Virgili G, Piyasena P, Negash H, Whitestone N, et al. Impact of vision impairment and ocular morbidity and their treatment on depression and anxiety in children: a systematic review. *Ophthalmology* 2022;129(10):1152 – 70. <http://dx.doi.org/10.1016/j.ophtha.2022.05.020>.
9. Blot A, Roth MM, Gasler I, Javadzadeh M, Imhof F, Hofer SB. Visual intracortical and transthalamic pathways carry distinct information to cortical areas. *Neuron* 2021;109(12):1996 – 2008.e6. <http://dx.doi.org/10.1016/j.neuron.2021.04.017>.
10. Jaworska N, Yang XR, Knott V, MacQueen G. A review of fMRI studies during visual emotive processing in major depressive disorder. *World J Biol Psychiatry* 2015;16(7):448 – 71. <http://dx.doi.org/10.3109/15622975.2014.885659>.
11. Huang JR, Dang HJ, Cai Y, Liu J, Chen QH. Myopia and depression among middle school students in China-is there a mediating role for wearing eyeglasses? *Int J Environ Res Public Health* 2022;19(20):13031. <http://dx.doi.org/10.3390/ijerph192013031>.