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Prevalence of Refractive Errors Among Secondary School Students in Vietnam: A Cross-Sectional Study

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Abstract*— Objective:** *This study conducted to describe the current situation and identify several factors associated with refractive errors among students at two secondary schools in Hai Duong city, Vietnam.* ***Materials and Methods: *A cross-sectional study was conducted on 775 students aged 11 to 15 years at two secondary schools in Hai Duong city, Vietnam from Sept 2023 to August 2024. Visual acuity was measured using a Snellen chart, and students with vision worse than 6/12 underwent retinoscopy to confirm and classify refractive errors. Data was analysed by SPSS 20.0.* ***Results:*** *The results showed that 59.6% of children had refractive errors, with myopia being the most common at 52.0%. The rate of refractive errors was significantly higher in students at urban school (72.1%) compared to rural school (52.5%) (p<0.001). Most children had mild myopia (-0.5D to -3.00D), accounting for 61.6%, while only 7.1% had severe myopia. Out of 1,550 eyes examined, 52.9% had uncorrected visual acuity below 20/30, and 40.4% of these eyes had refractive errors but were not wearing glasses. Among those who wore glasses, only 44.8% achieved good vision (>20/30). Factors associated with refractive errors included family history (OR=2.8; p<0.001), lack of outdoor activity (OR=2.0; p<0.001), attending extra classes (OR=1.8; p<0.001), and frequent reading of storybooks (OR=1.4; p<0.05).* ***Conclusion:*** *The prevalence of refractive errors among secondary school students is high. It is essential to develop and implement appropriate intervention models to enhance the effectiveness of prevention and management strategies for school-related refractive errors.*

***Keywords*—** *Astigmatism, Hyperopia, Myopia, Refractive errors, Students*.

I. INTRODUCTION

Good vision plays a key role in children's learning and overall development. However, refractive errors - including myopia, hyperopia and astigmatism - are emerging as a worrying public health problem globally, especially among school-age children.[1] Myopia is the most common form and tends to increase rapidly with age.[2] Research by Holden et al. (2016) predicts that the number of people with myopia will increase from 1.4 billion in 2000 to 4.8 billion in 2050.[3]

Refractive errors in students not only directly affect their vision and academic performance, but also negatively impact their mental health and social development. Poor vision makes it difficult for them to concentrate in class, easily tired, and less confident when participating in extracurricular activities, thereby reducing their quality of life. In addition, the cost of treatment, glasses and eye care services also creates a significant economic burden for families and society.[4] In addition, refractive errors, especially severe myopia, not only cause vision loss but also increase the risk of complications such as macular degeneration, retinal detachment or amblyopia, which have long-term effects on children's quality of life and learning ability.[3,4]

Recent studies in China, Korea and Singapore have shown that the rate of myopia in junior high school students has exceeded 60–80%, with a tendency to start at an increasingly earlier age and progress faster than before.[5,6] Meanwhile, Vietnam is recognized as the region with the highest rate of refractive errors in the worl. Many surveys in Hanoi, Ho Chi Minh City and Da Nang in the past 5 years have also recorded the rate of myopia in urban students ranging from 40–55%, significantly higher than in rural areas.[7,8] In Hai Duong, although some previous studies have mentioned the status of refractive errors in primary and junior high school students, these studies mainly stopped at determining the general rate, not going into specific analysis of the rate of each type of refractive error such as myopia, hyperopia and astigmatism.[9,10] This gap limits the development of appropriate intervention strategies for each target group, so more detailed research is needed.

In recent years, especially after the COVID-19 pandemic, children's living and learning habits have changed dramatically. Most of them increased time for online learning and use of electronic devices, reduced outdoor activities, along with high academic pressure. These factors have been shown to increase the risk of refractive errors.[11,12] This poses an urgent need for updated research, comprehensive assessment of the situation and related factors to develop appropriate prevention and intervention measures. Based on the above reality, we conducted the study with the aims to describe the current situation and identify several factors associated with refractive errors among students at two secondary schools in Hai Duong city, Vietnam. The research results will provide the latest scientific evidence, serving as the basis for effective strategies for caring for and protecting school vision.

II. METHODS

Study design

A cross-sectional study was conducted on 775 students of two secondary schools in Hai Duong city, Vietnam from Sept

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2023 to August 2024. In addition, the study complies with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for cross-sectional studies.

Study participants

Inclusion criteria: Students aged 11 to 15 years and being studying at Thach Khoi (located in urban area), and Chu Van An (located at rural area) in Hai Duong city, Vietnam.

Exclusion criteria: Students with ocular diseases such as conjunctivitis, those currently using orthokeratology (Ortho-K) lenses, and those who refuse to participate in the study.

Sample size

Students were selected for this study by convenience sampling technique. However, the sample size was counted by the formula for estimating a ratio:

$$n0=Z2 \cdot p(1-p)/d2$$

In which:

n = required sample size

Z = 1.96, taking a 95% confidence interval

p = 0.349. This rate followed a study of Nguyen et al (2015).[13]

d = absolute precision, 0.05

Then, apply design factor DE = 2 for cluster survey: $nDE=n0\times DE=698$

Expected non-response compensation of 10%. Therefore, the final sample consisted of 775 students.

Participants selection

We applied a two-stage cluster sampling method. In stage 1, two secondary schools in Hai Duong province were randomly selected, including one in an urban area and one in a rural area. In stage 2, eligible students were conveniently selected from the two selected schools, between September 2023 and June 2024, until the sample size of 775 students was reached. Finally, the study collected data from 495 students at Thach Khoi secondary school, and 280 students at Chu Van An secondary school.

Study measurements

Refractive errors among students were assessed using a standardized ophthalmic examination protocol. Visual acuity was measured with a Snellen chart placed at the standard testing distance, followed by objective refraction assessment using a lensometer and an HUVITZ 7000 autorefractor. The results were verified and refined with a trial lens set. Fundus examination was performed using a direct ophthalmoscope to detect retinal and optic nerve abnormalities Cycloplegia with 1% Cyclogyl was given when necessary to get precise refractive measurements. In addition, demographic information (age, gender, grade level, etc.) was collected through a short, self-administered questionnaire completed by the participants.

Ethical considerations

On December 18, 2024, the ethics committee of Hai Duong Medical Technical University gave its approval to the study under No. 974/QD-DHKTYTHD. The research process ensures that it does not affect the health and rights of patients. Patient data is encrypted, entered into the computer, and kept private.

Data analyze

Data were analyzed using SPSS 20.0. Quantitative variables were summarized as mean ± standard deviation (SD), and categorical variables as frequency and percentage. Group comparisons used the Chi-square test, with statistical significance set at $p < 0.05$. The prevalence and severity of refractive errors were calculated and stratified by grade level and school type. Severity of myopia was classified as mild (-0.50D to -3.00D), moderate (-3.00D to -6.00D), or severe (> -6.00D). Potential risk factors were examined using multivariate logistic regression, reporting odds ratios (ORs) with 95% confidence intervals (CIs).

III. RESULT

General characteristics of secondary students

Among 755 students, the average age was 13.14 ± 1.046. Most students were studying in Grade 6 (34.8%), while grade 9 had the lowest proportion (12.8%). The rate of male students was 56.0%.

Current status of refractive errors among secondary students

Table 1 shows that 59.6% of children have refractive errors, of which the highest rate is myopia at 52.0%, hyperopia at 3.7% and mixed astigmatism at 3.9%. Comparing the refractive error status of students between the two schools, the results showed that the rate of students at Chu Van An primary school was 72.1%, while at Thach Khoi school, the rate was 52.5%. This difference was statistically significant with $p<0.001$ (Table 1). Table 2 shows the rate of refractive errors in secondary school students by grade level. Of which, grade 6 students had the highest rate of refractive errors at 63.7%, and the lowest was grade 8 students at 53.7%. There was no difference in the rate of refractive errors among students when comparing the 4 grades ($p>0.05$) (Table 2).

TABLE 1. Current status of refractive errors among secondary students

Schools	Emmetropia		Refractive errors						p
			Myopia		Hyperopia		Mixed Astigmatism		
	n	%	n	%	n	%	n	%	
Thach Khoi	235	47.5	211	42.6	23	4.6	26	5.3	**<0.001**
Chu Van An	78	27.9	192	68.6	6	2.1	4	1.4	
Total	**313**	**40.4**	**403**	**52.0**	**29**	**3.7**	**30**	**3.9**	

TABLE 2. Refractive error status of students distributed by block grade level

Block grade	Emmetropia		Refractive errors						p
			Myopia		Hyperopia		Mixed Astigmatism		
	n	%	n	%	n	%	n	%	
6	98	36.3	146	54.1	12	4.4	16	5.2	**<0.001**
7	89	41.2	113	52.3	8	3.7	6	2.8	
8	88	46.3	89	46.8	7	3.7	4	3.2	
9	38	38.4	55	55.6	2	2.0	4	4.0	
Total	**313**	**40.4**	**403**	**52.0**	**29**	**3.7**	**30**	**3.9**	

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Assessing the level of myopia, the results in Table 4 show that most children's eyes have mild myopia from -0.5D to -3.00D with 61.6%, and only 7.1% of children have severe myopia (Table 3).

TABLE 3. Distribution of myopia severity among students by grade level (number of eyes)

Level / Block grade	Mild		Moderate		Severe		Total	
	n	%	n	%	n	%	n	%
6	174	64.0	74	27.2	24	8.8	272	35.9
7	146	68.2	58	27.1	10	4.7	214	28.2
8	99	59.6	59	35.5	8	4.8	166	21.9
9	48	45.3	46	43.4	12	11.3	106	14.0
Total	**467**	**61.6**	**237**	**31.3**	**54**	**7.1**	**758**	**100**

Vision status of secondary students

Table 4 shows that out of a total of 1,550 eyes examined, 820 eyes had uncorrected visual acuity below 20/30, accounting for 52.9%. Of these, only 489 eyes wore glasses, accounting for 59.6%. Thus, 40.4% of eyes had refractive errors but had not been corrected with glasses. Of the eyes that wore glasses, only 219 eyes (44.8%) had good vision with glasses (visual acuity > 20/30), while the remaining 270 eyes, despite wearing glasses, had visual acuity below 20/30 (55.2%). Visual acuity decreased mainly between 20/200 and 20/30.

TABLE 4. Distribution of eyes examined by visual acuity groups without glasses and with glasses

Visual acuity / Group	VA without glasses		VA with glasses	
	n	%	n	%
VA > 20/30	730	47.1	219	44.8
(2) 20/200 < VA ≤ 20/30	509	32.8	270	55.2
(3) VA ≤ 20/200	311	20.1	0	0
Sum (1+2)	0	0	489	59.6
Sum (2+3)	820	52.9	270	55.2
Sum (1+2+3)	1550	100	489	100

Some factors related to refractive errors in secondary students

Students with a family history of refractive error had nearly three times higher odds of having the condition (OR = 2.8; 95%CI: 1.9–4.1; p<0.001). The risk was also elevated among those without outdoor activities (OR = 2.0; 95%CI: 1.5–2.7; p<0.001), those attending extra classes outside school (OR = 1.8; 95%CI: 1.4–2.4; p<0.001), and those frequently reading storybooks (OR = 1.4; 95%CI: 1.2–2.0; p<0.05). Moreover, glare at the seating position was associated with a 60% increase in odds (OR = 1.6; 95%CI: 1.1–2.3; p<0.05) (Table 5).

IV. DISCUSION

Refractive errors constitute a major factor influencing health, work capacity, and daily activities. In an examination of 775 students from two secondary schools, 462 students were diagnosed with refractive errors, accounting for 59.6% of the total sample. Myopia was the most prevalent condition, affecting 52.0% of all examined students. This findings was consistent with the study of Hung et al. (2020), who reported that school myopia has become a major public ophthalmic issue in Vietnam and neighboring countries, with prevalence rates in urban Vietnamese students ranging from 40–50%.[7] Similarly, Tuan et al. (2023) found a myopia prevalence of 55.5% among students in Hanoi city,[13] and Nguyen et al. (2025) reported 54.7% in four secondary schools in Hai Phong city.[8] When compared with previous studies conducted in Hai Duong, the prevalence found in our research was markedly higher than that reported by Ngoc et al. (2014) with 9.74%,[9] and Do et al. (2024) with 35.0%,[10] suggesting a rapid increase in refractive error rates among Hai Duong students. Internationally, our prevalence was higher than that reported by Williams et al. among European children,[15] and comparable to Zhao's findings in Hong Kong.[16]

TABLE 5 The relationship between some factors and the rate of myopia in secondary students

Factors	Myopia (n=403)	Non-myopia (n=372)	OR	95% CI	p
Family history			2.8	1.9-4.1	<0.001
Yes	117 (71.3)	47 (28.7)			
No	286 (46.8)	315 (53.2)			
Outdoor activities			2.0	1.5-2.7	<0.001
Yes	223 (45.0)	272 (55.0)			
No	180 (64.3)	100 (35.7)			
Frequently reading books			1.4	1.2-2.0	<0.05
Yes	177 (59.6)	120 (40.4)			
No	226 (47.2)	252 (52.8)			
Attending extra classes outside school			1.8	1.4-2.4	<0.001
Yes	276 (57.6)	203(42.4)			
No	127 (42.9)	169 (57.1)			
Glare at the seating position			1.6	1.1-2.3	<0.05
Yes	76 (61.3)	48 (38.7)			
No	327 (50.2)	324(49.8)			

Comparison between two research sites, the prevalence was significantly higher in urban site (72.1%) compared to rural (52.5%) (p < 0.001). This aligns with Tuan et al. (2023) findings, which indicated urban prevalence at 58.7% versus rural at 16.7%,[14] and Zhao et al. (2000) in China (urban 78.4%, rural 43.0% in 15-year-old students).[16] These results reinforce that environmental, lifestyle, and behavioral factors play an important role in refractive error development among students. Across grade levels (and thus age groups), the prevalence remained uniformly high, with no statistically significant differences, contrasting with Quyen et al. (2021) findings, where grade 9 and grade 8 students had the highest prevalence (42.1% and 38.6%) compared with grade 6 (27.0%).[13] A plausible explanation may be the COVID-19 pandemic, during which prolonged social distancing and indoor confinement may have elevated refractive error rates in younger cohorts (grades 6–7) beyond those in prior studies.

Regarding myopia severity, Quyen et al. (2021) reported similar patterns in students aged 11–14, with mild myopia comprising the majority (63.0%), followed by moderate (28.9%) and severe (8.1%).[13] Our results were comparable with mild myopia (−0.50D to −3.00D) accounted for 61.6%, moderate myopia (−3.00D to −6.00D) for 31.3%, and severe myopia (>−6.00D) for only 7.1%. Since mild myopia, often termed "school myopia", is largely preventable, educational

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and public health interventions are essential to reduce its incidence, decrease dependency on corrective lenses, and mitigate the long-term societal burden.

Visual acuity assessment revealed an alarming finding. Specifically, 40.4% of students with refractive errors were not using corrective lenses. This proportion was similar to that reported by Tuan et al. (2023),[14] but higher than that observed by Le et al. (2009).[17] Among students wearing glasses, only 44.8% of eyes achieved good visual acuity (VA $\geq$ 20/30), while 55.2% had suboptimal vision despite correction. Substandard corrected vision may lead to symptoms such as eye strain, headache, and blurred vision, which, if persistent, can impair health, academic performance, and potentially accelerate myopia progression.

Children with a family history of refractive errors such as parents with refractive errors have a rate of myopia 2.8 times higher than students without parents with refractive errors. The results show that children with one parent with refractive errors have a rate of 70.2%, while children with both parents with refractive errors have a rate of 78.3%. In Vietnam, congenital and genetic factors related to refractive errors in the study of many authors also give similar results, according to Tuan et al. (2023), students with parents with refractive errors have a risk of refractive errors 2.1 times higher than other students.[14]

We found that high study intensity and time spent on close-up activities play an important role in the increase in myopia in students. The group of students who regularly take extra classes outside of school and/or regularly read stories are 1.5 times more likely to have refractive errors than the group of students who do not. The results are also consistent with the study of the Singapore Research Group on Myopia Risk Factors (SCORM) which shows that children who read more than 2 books per week are more likely to have myopia than children who read less than 2 books/week.[11] The results show that students who do not regularly participate in outdoor sports are 2.0 times more likely to have refractive errors than students who regularly participate in outdoor sports. According to a study by Dirani (2009) in Singapore, the average time spent on outdoor activities is 3.24 hours/day, which has two important changes for the eyes: the equivalent refractive index increases by 0.17D and the axial length of the eyeball decreases by an average of 0.06mm, which are two important factors in the onset and progression of myopia in children.[12]

Inadequate classroom lighting is an important risk factor that can affect school refractive errors. Currently, classroom lighting conditions are not only a lack of light but can also be due to glare because most classrooms are equipped with televisions and projectors. In our study, students sitting at desks with glare when looking at the board were 1.6 times more likely to have refractive errors than students sitting at desks without glare, which is also due to poor classroom hygiene conditions. This result is also consistent with the study of Le et al. (2009).[17]

The findings provide important epidemiological evidence on the prevalence and severity of refractive errors among lower secondary school students in both urban and peri-urban settings. These data can inform health authorities, schools, and local governments in developing and implementing regular vision screening programs, eye health education, and early intervention strategies to reduce new cases and limit the progression of school myopia. Furthermore, the study highlights significant disparities between schools, suggesting that resource allocation and intervention design should be tailored to environmental and demographic characteristics of each area.

Limitations

This study was conducted in only two lower secondary schools; therefore, the findings may not fully represent the refractive error situation among all lower secondary school students in the city or in other provinces. The cross-sectional design allows only for describing the status and associations at a single point in time and cannot establish causal relationships between risk factors and refractive errors. In addition, refractive measurements were performed without cycloplegia, which may have led to an overestimation of myopia severity in some students, particularly younger ones. Therefore, future studies should be expanded to a larger scale, including multiple schools from both urban and rural areas, to enhance generalizability. Longitudinal designs are recommended to identify risk factors and monitor the progression of refractive errors over time. The use of cycloplegic refraction would improve the accuracy of refractive error classification. In addition, surveys on study habits, screen time, and outdoor activity should be integrated to develop predictive models and design more effective prevention strategies.

V. Conclusion

The prevalence of refractive errors among students was 59.6%, with myopia accounting for 52.0%. Rates were higher in urban areas (72.1%) than rural areas (52.5%). Mild myopia was most common (61.6%), and 40.4% of cases were uncorrected. Associated factors included frequent reading of storybooks, attending extra classes, limited outdoor sports activities, and glare from classroom seating. Future studies should be larger in scale, cover both urban and rural schools, use longitudinal designs with cycloplegic refraction, and incorporate surveys on study habits, screen time, and outdoor activities to improve classification, identify risk factors, and guide prevention strategies.

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