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Risk Factors for Myopia in 2 Hong Kong School Systems: A Pilot Study

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Purpose: Myopia has reached "epidemic" proportions, especially in several East Asian countries. Most myopia emerges during childhood, particularly during the school years. The aim of this study was to investigate myopia prevalence and compare risk factors of myopia among Hong Kong Chinese primary school children under 2 different educational systems.

Design: Cross-sectional study

Methods: Visual assessments were conducted in 1 government-funded primary school (n = 159) and 1 international school (n = 223) in Hong Kong in September and October 2018, respectively. Measurements were performed on children aged 8 to 10 years old. Noncycloplegic refraction and axial length were measured, respectively. A validated questionnaire focusing on demographic information, nonscreen time (eg, reading and writing on paper materials), screen time (ie, smartphones and tablets usage), time spent on outdoor activities, and other myopia risk factors was completed by parents of participants.

Results: The prevalence of myopia [37.5% vs 12.8%, $P < 0.001$; spherical equivalent refraction (SER) ≤ -1.00 diopter (D)] and refractive astigmatism [25.0% vs 7.2%, $P < 0.001$; cylinder (Cyl) ≥ 1.00 diopter cylinder (DC)] were significantly higher in the local school than in the international school. Students in the local school were slightly older than those attending the international school (9.17 ± 0.82 years vs 8.95 ± 0.85 years, $P = 0.046$), and there was no significant difference in gender distribution between the 2 schools ($P = 0.51$). There were significant differences in the demographic information including parental myopia ($P < 0.001$), family income ($P < 0.001$), and parents' educational level ($P < 0.001$) between the 2 schools. Multiple regression analysis showed that parental myopia history and continuous near work was associated with myopia in the local school, while the father's educational level was related to myopia in the international school.

Conclusions: In this pilot study, despite the much higher prevalence of parental myopia and high myopia in the international school, the myopia prevalence among the students is lower in this school than in the local school, suggesting that environmental factors other than genetics might have a stronger protective effect in this school population.

Key Words: astigmatism, myopia, school system

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Myopia is the most common refractive error and is associated with excessive axial elongation of the eye.[1] Myopia prevalence varies across the world, with prevalence in young adults of more than 80% in some East and Southeast Asian countries.[2–4] Myopia with early-onset and fast progression has a high risk of developing into high myopia.[4,5] It is well known that myopia is a multifactorial disorder. Both genetic and environmental factors play a role in myopia development.[6]

Hong Kong is one of the most developed and vibrant cities in Asia. Its important role in global commercial and financial hub has attracted millions to come to Hong Kong for work. In order to meet the educational demand for nonlocal families in Hong Kong and provide a multicultural educational environment, there are currently 44 international primary schools.[7] Thus 2 school educational systems exist in Hong Kong. Such systems also exist in China (eg, Beijing and Shanghai), Japan, and India.[8] Of the educational systems in Hong Kong, one is local, government-supported schooling, in which the curriculum is followed closely across the schools. Based on the primary education results, students are later allocated to secondary schools of different academic ranks.[9] Therefore, the educational environment among primary local school students is quite intensive and competitive to enter secondary schools with a good academic reputation.[10] The other type, the international schools, has a different curriculum from local schooling. International school students participate in the International Baccalaureate (IB) program or the curriculum of their home countries, rather than taking the local examinations in Hong Kong. Although the initial intention of establishing international school was to provide education for expatriate communities, there are increasing numbers of local Chinese children attending international schools in Hong Kong. However, due to the high tuition fees in the international schools, the local schooling is still the most common form of education for local Chinese children in Hong Kong.[10] Although it is difficult to directly compare the study intensity between the 2 school systems due to the different curricula and assessment criteria, it is generally believed that the international school system has a less stressful learning environment than the local school system.

The Organization of Economic Cooperation and Development (OECD) Program for International Student Assessment (PISA) is one of the surveys that measure educational outcomes of children aged 15 years, to test their abilities in reading, mathematics, and science using standardized tests (www.oecd.org/pisa). According to PISA outcomes, locations in Asia such as Shanghai, Hong Kong, and Singapore have higher scores, but they also had the highest myopia prevalence. In contrast, other

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countries such as Finland and Australia also achieved higher academic performance, but have much lower myopia prevalence.[11] This suggests that the educational system could be a potential environmental risk factor for myopia development.[12] Although the association between education and myopia has been well established,[13] only a few studies have compared the risk factors for myopia in different educational systems, within the same country or city.[14,15] In this respect, although 2 studies have shown that Chinese children in the more intensive educational system had higher myopia prevalence, these children were from 2 different countries (China vs Singapore, and Singapore vs Australia), with potential confounding factors, such as living environment and population density.

Therefore, the primary aim of the current study was to investigate whether primary school children in the 2 different Hong Kong educational systems were exposed to the same set of myopia risk factors known to date. The secondary aim was to assess parents' awareness of myopia risk factors in the 2 different school systems. However, this was a pilot study with only 1 school chosen from each school system, the results may not be representative of the entire school system and need to be interpreted with caution.

METHODS

Population

Headmasters of 1 international school and 1 local school were contacted through personal communication and consented to participate in visual assessments in September and October 2018. Informed letters of consent were obtained from parents. The study followed the tenets of the Declaration of Helsinki and was approved by the Human Subjects Ethics Committee of The Hong Kong Polytechnic University (HSEARS20180726001). All children were invited to participate in the screening, however, only students who fulfilled the inclusion criteria were analyzed. Inclusion criteria were (1) Chinese school children aged 8 to 10 years old; and (2) currently not undergoing any myopia control treatment. This age range was selected because it is known to exhibit a high incidence of myopia.[5]

Examination Procedures

The same set of ophthalmic instruments and school settings were adopted in both schools. The visual assessments were conducted between 9 am and 12 pm during normal school days. The school's administrator decided the order for each class and students were guided by teachers to the screening site. Time spent on the whole screening process was less than 20 minutes. All measurements were completed under the natural room lighting (400 lux). Each child underwent monocular distance habitual visual acuity (VA) measurements (unaided and aided where applicable) using Early Treatment Diabetic Retinopathy Study (ETDRS) acuity charts (Precision Vision, La Salle, IL, US). An open-field autorefractometer (Shin-Nippon, NVision-K 5000, Japan) was used to measure refraction while students were instructed to look at the Maltese cross at 6 meters. Five consecutive readings of each eye were obtained and averaged. Ocular axial length was measured using an IOL Master (Carl Zeiss Meditec, Jena, Germany). Five consecutive measurements with signal-to-noise ratios >2.0 were collected and averaged for analysis. Both devices were calibrated using a model eye on a daily basis. Since we conducted visual assessments on normal school days and the teaching schedules in both schools were very tight, in order not to interfere with classroom learning activities and to increase the participation rate, cycloplegic drugs to relax accommodation were not applied, which is likely to result in somewhat more myopic results. Studies on Chinese school children reported the difference between cycloplegic and noncycloplegic refraction of 0.63 diopter (D) ± 0.65 D in myopes and hyperopes aged between 4 and 18 years old.[16,17]

Questionnaire

Based on a review of current literature and existing validated questionnaires, including the SMS Study,[18] SCORM study,[19] and ACES,[20] the questionnaire (Supplementary Digital Content 1, http://links.lww.com/APJO/A124) covered basic demographic information, ocular health history, family income, and parental myopia. In addition, it included questions related to children's visual habits, that is, viewing distance, the average time per day children engaged in nonscreen near work (reading and writing on paper materials), handheld digital screen work (smartphones and tablets), and outdoor activities during the non−school hours on weekdays and at weekends. A face-to-face interview was conducted at the Optometry Research Clinic in The Hong Kong Polytechnic University to test the comprehensibility of the questionnaire (ie, whether questions were precise and easy to understand by parents). Eight parents were invited to fill the questionnaire and encouraged by the same interviewer to raise questions related to the content. The repeatability of the questionnaire was then tested by asking another 20 parents to complete the same survey with a 2-week interval and was found to have a high intraclass correlation (ICC = 0.96, $P < 0.001$).

Statistical Analysis

The refractive errors were decomposed into spherical equivalent refraction (SER) and J0 and J45 astigmatic components, according to Fourier analysis.[21] The J0 and J45 values are derived by using the formulae: $J0 = -0.5^* Cyl^* Cos\ (2\alpha)$ and $J45 = -0.5^* Cyl^* Sin(2\alpha)$, where Cyl is the negative cylinder and α is the axis meridian. J0 is the Jackson cross-cylinder power at 90 degrees (negative value, indicating against-the-rule astigmatism) and 180 degrees (positive value, indicating with-the-rule astigmatism), and J45 (indicating oblique astigmatism) is the Jackson cross-cylinder power at axis 45 degrees (positive value) and 135 degrees (negative value). Only the data from the right eye were used because the refractive and biometric data of the right and left eyes were highly correlated (Pearson correlation, $r = +0.87$, $P < 0.001$). Myopia is usually defined as SER ≤ -0.50 D,[22] but because refraction data were obtained without cycloplegia, more conservative criteria were also applied to define myopia, ie, SER ≤ -1.00 D. Refractive astigmatism was defined as cylindrical error $\geq$0.50 diopter cylinder (DC).

Statistical analyses were performed using SPSS (version 22, IBM Corp, Amonk, NY, US) with the significance level set at $\alpha < 0.05$. First, a descriptive analysis was performed to compare ocular and nonocular parameters between the 2 schools, and myopes and nonmyopes in the same school. To be specific, continuous variables collected in 2018 were compared with either unpaired *t* test or Mann-Whitney *U* test (*U*), depending on the normality tested using the Shapiro-Wilk test. Data were presented

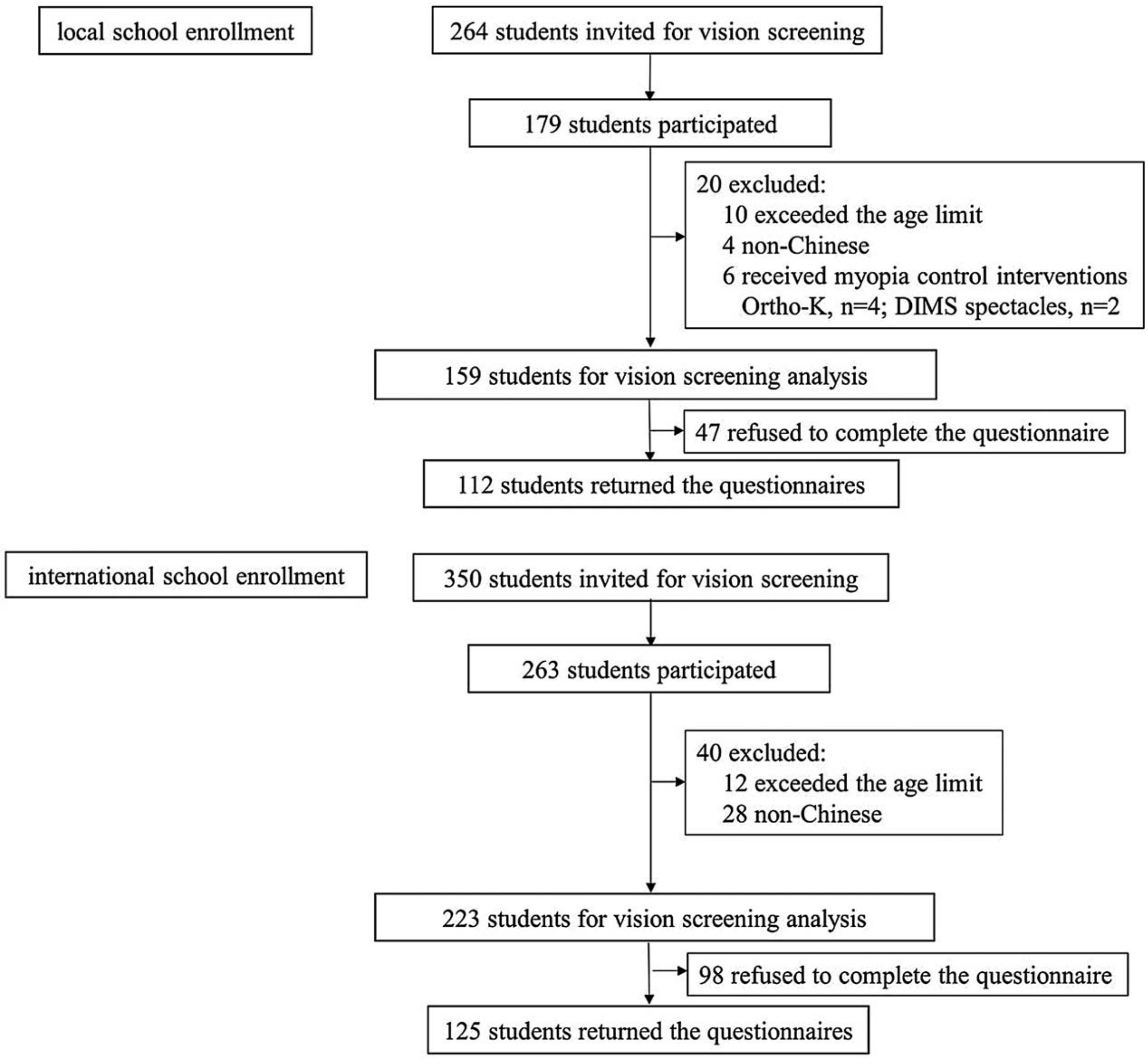

Figure 1. Flowcharts showing the participation of local and international school students.

as mean [± standard deviation (SD)] or median (interquartile range, IQR). Chi-square test (χ^2) was used to compare categorical variables between groups and reported in percentages. Second, univariate regression models were used to examine the risk factors of myopia on the presence of myopia and axial length under the 2 different educational systems. Then a multivariate analysis was conducted with the presence of myopia and axial length as dependent variables, and all other parameters significant in the univariate analysis as independent parameters. The backward stepwise method was further used to cater for the small sample size in the regression models, which was to eliminate insignificant variables starting from the one with the highest *P* value, until the *P* values of all remaining variables were below 0.05.

RESULTS

Subject Recruitment

Figure 1 shows that in the local school, 264 students were invited to join the study; 159 students were included in the current visual assessment and 112 school children returned the questionnaire. In the international school, 350 students were invited to join the study; 223 students were included in the current study for visual assessment and 125 school children returned the questionnaire. The following analyses were only conducted on students who participated in the visual assessment and returned their questionnaire (ie, local school: 112; international school: 125).

Ocular Parameters Results Between 2 Schools

Comparison of the participating students in the local and international schools (Table 2) revealed that the prevalence of myopia (SER ≤ -0.50 D) in the local school was more than twice as high as that in the international school (46.4% vs 22.4%, $\chi^2 = 15.25$, $P < 0.001$), even if a more conservative definition (SER ≤ -1.00 D) was used (37.5% vs 12.8%, $\chi^2 = 19.50$, $P < 0.001$). Similarly, school students attending the local school had a worse habitual VA than those attending the international school ($U = 6709.0$, $P = 0.040$). If children who did not return questionnaires were included, the myopia prevalence was still higher in the local school than in the international school (italicized data shown in brackets in Table 1, 40.0% vs 23.1%, $\chi^2 = 13.09$, $P < 0.001$). Similarly, the median SER value was more myopic in

Table 1. Proportions of Ocular Parameters Between 2 Schools

	Local School	International School	*P* Value
Habitual VA (logMAR)	0.06 (0, 0.14)	0.04 (−0.02, 0.10)	0.040
Myopia proportion (SER ≤ −0.50 D)	46.4%	22.4%	<0.001
Myopia proportion (SER ≤ −1.00 D)	37.5% (*40.0%*)	12.8% (*23.1%*)	<0.001
Median SER (IQR)	−0.31 (−1.49, +0.19) D	+0.13 (−0.41, +0.44) D	<0.001
Astigmatism proportion (Cyl ≥ −0.50 D)	57.1%	48.0%	0.16
Astigmatism proportion (Cyl ≥ −1.00 D)	25.0%	7.2%	<0.001
J0 (IQR)	+0.18 (0,+0.43) D	+0.12 (−0.03, +0.27) D	0.004
J45 (IQR)	−0.06 (−0.14, +0.02) D	0 (−0.10, +0.09) D	0.005
AXL (SD)	23.39 (0.89) mm	23.35 (0.95) mm	0.77
	23.56 (0.99) mm	*23.50 (0.97) mm*	0.55

AXL indicates axial length; Cyl, cylinder; D, diopter; IQR, interquartile range; SD, standard deviation; SER, spherical equivalent refraction.

Italicized data represent the results by including children who did not return questionnaires.

the local school than in the international school (−0.31D vs +0.13D, $U = 4724.0$, $P < 0.001$). There was also a significant difference in the prevalence of students with astigmatism (Cyl ≥ 1.00 DC) between 2 schools ($\chi^2 = 14.21$, $P < 0.001$). The J0 ($U = 5492.50$, $P = 0.004$) and J45 ($U = 5521.0$, $P = 0.005$) astigmatic components were both higher in the local school than in the international school. However, the axial length did not differ between the 2 schools (unpaired *t* test, $P = 0.77$) even including children who did not return questionnaires (unpaired *t* test, $P = 0.55$).

Questionnaire Results Between 2 Schools

Overall, students in the local school were slightly older than those attending the international school (unpaired *t* test, $t = 2.006$, $P = 0.046$) (Table 2), but there were no significant differences in gender distribution between the 2 schools. However, the proportions of parental myopia (76.8% vs 54.5%, $\chi^2 = 13.18$, $P < 0.001$) and high myopia (19.2% vs 6.3%, $\chi^2 = 8.71$, $P = 0.003$) were both higher in the international school than those in the local school. Furthermore, parents of children in the international school were more likely to have attained a higher educational level (father: 90.4% vs 15.2%, $\chi^2 = 134.97$, $P < 0.001$; mother: 78.4% vs 8.9%, $\chi^2 = 114.94$, $P < 0.001$) and had considerably higher family income compared with parents in the local school (2 × C Fisher exact test, $P < 0.001$). Students attending the local school spent about 4 hours more per week on both nonscreen near work (reading, writing, etc) ($U = 5337.0$, $P = 0.002$) and handheld digital devices ($U = 3683.0$, $P < 0.001$) than students attending

Table 2. Comparison of Questionnaire Results Between 2 Schools

	Local School	International School	*P* Value
Age (SD)	9.17 (0.82)	8.95 (0.85)	0.046
Female (%)	56.3	52.0	0.51
Parental myopia (%)*	54.5	76.8	<0.001
Parental high myopia (%)†	6.3	19.2	0.003
Father's educational level (%)			<0.001
Upper secondary or below	84.8	9.6	
Mother's educational level (%)			<0.001
Upper secondary or below	91.1	21.6	
Monthly family income (%)			<0.001
≤HK$ 9,999	7.4	0	
HK$ 10,000–HK$ 19,999	51.9	0	
HK$ 20,000–HK$ 29,999	21.3	0	
HK$ 30,000–HK$ 39,999	12.0	3.2	
HK$ 40,000–HK$ 49,999	4.6	4.8	
≥HK$ 50,000	2.8	92.0	
Near work time (h/wk)			
Nonscreen time (IQR)	10.8 (5.3, 16.4)	7.0 (4.5, 12.0)	0.002
Total handheld digital screen time (IQR)	9.5 (4.2, 14.4)	5.2 (2.0, 9.0)	<0.001
Smartphone use time	4.5 (1.6, 10.4)	0 (0, 3.9)	<0.001
Tablet use time	0 (0, 7.0)	2.0 (0, 6.5)	0.16
Viewing distance (cm) (SD)			
Reading/writing distance	25.34 (10.82)	26.65 (9.56)	0.38
Smartphone viewing distance	23.42 (10.94)	24.96 (8.96)	0.36
Tablet viewing distance	31.67 (15.41)	27.90 (9.79)	0.49
Outdoor time (h/wk) (IQR)	5.0 (3.0, 7.5)	7.5 (5.0, 10.5)	<0.001
Proportion of head tilt (%)	56.3	50.0	0.34
Proportion of continuous near work (%)	46.4	44.4	0.75

IQR indicates interquartile range; SD, standard deviation.

*,†Parental myopia and parental high myopia (SER ≤ −6.00 D) scored positive if at least 1 parent has myopia/high myopia.

Table 3. Regression Analysis of Risk Factors Related to Myopia in 2 Schools Students

	Univariate Analysis		Multivariate Analysis	
Local School	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Parental myopia*	4.52 (1.93, 10.63)	0.001	3.67 (1.50, 9.02)	0.005
Parental high myopia†	11.50 (1.33, 99.22)	0.026		
Proportion of continuous near work	2.75 (1.25, 6.06)	0.012	2.92 (1.23, 6.92)	0.015
	Univariate Analysis		**Multivariate Analysis**	
International School	**OR (95% CI)**	***P* Value**	**OR (95% CI)**	***P* Value**
Father's educational level				
Upper-secondary or below	4.21 (1.10, 16.09)	0.036	6.55 (1.39, 30.92)	0.018
Smartphone use time	1.18 (1.01, 1.39)	0.037		

CI indicates confidence interval; OR, odds ratio.

*,† Parental myopia and parental high myopia (SER ≤ –6.00 D) refer to the proportion with at least 1 parent with myopia/ high myopia.

the international school. Specifically, students attending the local school spent longer hours on their smartphone than those attending the international school ($U = 2530.0$, $P < 0.001$). In contrast, students attending the international school had more outdoor time than those in the local school ($U = 4975.0$, $P < 0.001$). However, no differences between 2 schools were found on viewing distances under the 3 conditions (reading/writing, smartphone use, and tablet use) (unpaired *t* test, $P > 0.05$), visual habits, such as head tilt when doing near work, and continuous near work for more than 30 minutes (χ^2 test, $P > 0.05$).

Factors Associated With Myopia in the 2 Schools

In univariate analysis (Table 3), myopia in students attending the local school was associated with parental myopia [odds ratio (OR): 4.52; 95% CI, 1.93–10.63; $P = 0.001$], parental high myopia (OR: 11.50; 95% CI, 1.33–99.22; $P = 0.026$), and continuous near-work time (OR: 2.75; 95% CI, 1.25–6.06; $P = 0.012$). Other factors were not associated with myopia in the local school. In the international school, myopia in students were associated with a father who had upper-secondary or below education background (OR: 4.21; 95% CI, 1.10–16.90; $P = 0.036$) and smartphone use time (OR: 1.18; 95% CI, 1.01–1.39; $P = 0.037$). Other factors were not associated with myopia in the international school. The multivariate regression analysis included myopia as the dependent parameter and all significant variables ($P < 0.05$) in the univariate analysis as independent parameters. In the local school, parental myopia (OR: 3.67; 95% CI, 1.50–9.02; $P = 0.005$) and continuous near-work time (OR: 2.92; 95% CI, 1.23–6.92; $P = 0.015$), but not parental high myopia (OR: 7.89; 95% CI, 0.85–73.41; $P = 0.069$), were significantly associated with myopia. In the international school, only father's educational level (OR: 6.55; 95% CI, 1.39–30.92; $P = 0.018$) was associated with myopia. A similar analysis on risk factors of myopia on axial length was also conducted and similar results were shown in the local school, while no risk factors were found in the international school (Table 4).

Parents' Awareness of Myopia Risk Factors in the 2 Schools

Descriptive analysis was used to compare parents' awareness of myopia complications and its risk factors between 2 schools. Nearly 75% of parents from both schools agreed that myopia was a health risk, which might lead to eye diseases or vision loss, and more than 90% agreed it would be necessary to take children for eye examinations regularly (χ^2 test, $P > 0.05$). Furthermore, more than 80% of parents in both schools agreed that near work–related parameters, such as long working hours on near work without breaks, improper posture, and dim lighting conditions, were related to myopia. Compared to parents from the local school, more parents in the international school thought that genetic factors (75.4% vs 56.9%, $\chi^2 = 8.89$, $P = 0.003$) and little outdoor time (41.8% vs 25.7%, $\chi^2 = 6.64$, $p = 0.010$) were associated with myopia (Table 5).

Table 4. Regression Analysis of Risk Factors Related to Axial Length in 2 Schools Students

	Univariate Analysis		Multivariate Analysis	
Local School	Coefficient (95% CI)	*P* Value	Coefficient (95% CI)	*P* Value
Parental myopia*	0.33 (0.16, 0.50)	<0.001	0.35 (0.021, 0.68)	0.037
Parental high myopia†	0.51 (0.15, 0.88)	0.006		
Proportion of continuous near work	0.23 (0.06, 0.41)	0.011		
	Univariate Analysis		**Multivariate Analysis**	
International School	**Coefficient (95% CI)**	***P* Value**	**Coefficient (95% CI)**	***P* Value**
Father's educational level				
Upper-secondary or below	0.23 (0.03, 0.43)	0.025		
Smartphone use time	0.023 (0.003, 0.043)	0.022		

CI indicates confidence interval; OR, odds ratio.

*,† Parental myopia and parental high myopia (SER ≤ –6.00 D) refer to the proportion with at least 1 parent with myopia/ high myopia.

Table 5. Parents' Awareness of Myopia Risk Factor in 2 Schools

	Local School	International School	*P* Value
Do you consider myopia as a health risk?			0.99
Yes	74.8%	74.8%	
No	25.2%	25.2%	
Is it necessary to bring your child to do eye examination regularly?			0.085
Yes	92.8%	97.6%	
No	7.2%	2.4%	
Myopia risk factors			
Long period of near work without a break	90.8%	94.3%	0.32
Improper postures for reading and writing	83.5%	89.3%	0.19
Dim lighting condition	82.6%	87.7%	0.27
Hereditary factor	56.9%	75.4%	0.003
Little outdoor time	25.7%	41.8%	0.010
Unbalanced diet	12.8%	20.5%	0.12

DISCUSSION

In the current study, the myopia prevalence among 8- to 10-year-old school children in the local school was more than twice as high as that in the international school (46.4% vs 22.4%, SER ≤ -0.50 D), even if a more conservative definition was used (37.5% vs 12.8%, SER ≤ -1.00 D). In addition, the astigmatism prevalence in the local school was much higher than that in the international school (25.0% vs 7.2%, Cyl $\geq$ 1.00 DC). Astigmatism frequently coexists with spherical ametropias (ie, myopia and hyperopia), and the magnitude of astigmatic error often correlates with that of myopia and hyperopia in both children and adults.[23,24] Thus, it has been hypothesized that astigmatism may be a by-product of myopia.[25,26] In this study, the higher prevalence of myopia and astigmatism in children attending the local school supports this notion. The lack of associated increase in axial length (compared with international school children) suggests that the origin of the increase in myopia prevalence might be refractive rather than axial in nature. However, because the refraction was determined without cycloplegia and no attempt was made to measure anterior segment changes (eg, corneal and crystalline lens shape), future studies are needed to investigate the etiology of the higher myopia prevalence in local school children. Nevertheless, the myopia prevalence found in the local school was consistent with those in previous studies of Hong Kong children.[5,27,28] In an earlier study, which recruited older Hong Kong Chinese students than the current study (13 to 15 years vs 8 to 10 years), no difference in myopia prevalence was found among students attending the international school and the local school.[29] These results suggest different incident or progression rates in the 2 school systems, or that the students in the 2 school systems were exposed to different risk factors.

From the validated questionnaire, it was found that the students from the 2 schools were exposed to different risk factors. First, significantly more parents in the international school (90.4% and 78.4%) received education at post-secondary level or above compared with parents in the local school (15.2% and 8.9%) (Table 2). Second, there were significantly higher proportions of parental myopia (76.8% vs 54.5%) and high myopia (19.2% vs 6.3%) in the international school, compared with those in the local school (Table 2). This result is not surprising given the higher parental educational level in the international school and the recent findings on the association between educational level and myopia prevalence in European Caucasians[30] and Hong Kong Chinese.[31] Third, students attending the local school spent nearly 4 hours per week or more on both nonscreen near work activities (reading, writing, drawing, etc) and handheld digital devices than those in the international school. Fourth, students attending the international school spent more time outdoors than those in the local school (7.5 h/wk vs 5 h/wk). Further multiple regression analysis showed that the myopic students in the local school were exposed to the combination of parental myopia history and continuous near-work time without breaks, whereas in the international school, myopia in students was associated with their father's educational level (Table 2).

Why would a risk factor have more impact on the prevalence of myopia in one school system than the other? It should be noted that the multiple regression analyses were performed on myopic students of the 2 schools separately, but no common risk factors were found. Under the local school system, parental myopia proportion was associated with the presence of myopia and axial length. The impact of parental myopia on children's myopia development has been consistently reported.[32–34] Parental myopia is usually regarded as a hereditary factor transmitted from parents to children and affects axial length and corneal curvature.[35] However, parental myopia as a risk factor may also be considered as myopic parents passing on their own academic standards or reading habits to their children rather than passing on myopia itself.[20,36] In this study, despite the much higher prevalence of parental myopia and high myopia in the international school, the myopia prevalence among the students is lower in this school than in the local school, suggesting that factors other than genetics might have a stronger protective effect in this school population. Although the father's educational level was associated with myopia in the international school system, educational level is a complex issue and closely associated with socioeconomic status. In this respect, findings of the association between socioeconomic status and myopia remain controversial. For example, myopic children were found to have myopic parents with a higher parental level of education, higher income, and white-collar or professional occupations in a Chinese study.[37] However, in the Generation R study, a higher myopia prevalence was found in children from families with low income, low maternal education, and non-European ethnicity.[38] Socioeconomic status, such as education and income, may act as a mediating effect in myopia development and represent certain living conditions and habits (eg, near work activity and outdoor time) that are more directly involved in the pathogenesis of myopia.[38]

In addition, smartphone use time in the international school was found to be associated with myopia and a longer axial length in the univariate analysis. Digital devices in recent years have led to increasing concern about their impact on the children's refractive development. Previous studies have shown that people tend to work with a closer working distance when using digital screens than printed hardcopies even when the texts were adjusted to a similar size.[39,40] We speculate that children might have adapted to a close working distance because of the increased digital screen usage. No association was found between working distance and myopia, but this could be due to the inaccurate estimation made by parents. Objective devices are therefore needed for measuring working distance to confirm this speculation. In addition, digital devices differ from typical paperwork in brightness, contrast, and resolution; whether and how these factors alter the working distance need further studies. In this study, the association between screen time and myopia was inconsistent. Myopia prevalence in Asian countries such as Singapore, Korea, or Japan was already high several decades ago, even before digital devices were introduced. Thus, further studies are also needed to investigate the influence of digital devices on refractive development.

The majority of Hong Kong parents were aware of the risk of myopia and the necessity of regular eye examinations. Parents in both schools agreed that near work–related parameters, such as continuous near-work and improper postures for reading and writing, are myopia risk factors. Although the role of outdoor time in preventing myopia had received much attention in recent years, less than half of the Hong Kong parents were aware of it. Positive parental attitudes and behaviors toward their children's vision, such as monitoring device usage, have been associated with a delayed onset and reduced progression of myopia.[41] Thus, public education including myopia risk factors and treatment options should be enhanced.

There are several limitations in the current study. First, as cycloplegic drugs to relax accommodation were not used, this may have affected the absolute value of refraction, but the relative comparison between the 2 schools should have not been affected. Although we found the difference in myopia prevalence between the 2 schools, there was no difference in axial length. The accommodative aftereffect due to noncycloplegic refraction might have induced myopic shift in some children and additional visual assessments are needed to confirm our results. Second, as keratometry was not performed, it could not be confirmed if the prevalence of increased myopia and increased astigmatism was partially attributed to a difference in corneal steepness and shape. Third, time spent on different activities and visual behaviors were collected using a questionnaire. Although it is a convenient and efficient way to collect visual habits information from a large group of participants, it suffers from recall bias.[18] An objective method, such as the Clouclip,[42] has been developed to objectively and continuously record near work duration, viewing distance, and ambient light intensity by clipping the sensor to the temple of children's spectacle, encouraging their use in the future study. Fourth, only the time spent on tablets and smartphones was evaluated in the questionnaire, other screen time, such as computer usage and TV watching time, was not considered, which could be the reason for the lack of association between screen time and myopia. Last, since there was no similar data on the prevalence of myopia at this age range, the current pilot study results provide extra information for future study. However, the participation rate in the current study is not high. We speculate that the parents (both enrolled in visual assessment and returned questionnaire) of the participated children were more concerned about their ocular health. Thus, the sample size limits the extent of the findings for risk factors and further studies are warranted.

To conclude, it was found that the myopia prevalence differed between different educational systems in Hong Kong, the myopia prevalence was higher in the local school compared with that in the international school. Furthermore, students under different educational systems were exposed to different myopia risk factors. Therefore, when formulating public health policy for myopia control, different strategies should be adopted according to individual risk factors.

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