IQ and the Association with Myopia in Children

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Purpose. To evaluate the association between intelligence and myopia in children.

Methods. Cycloplegic refraction and ocular biometry parameters, including axial length, vitreous chamber depth, lens thickness, anterior chamber depth, and corneal curvature were obtained in 1204 Chinese school children aged 10 to 12 years from three schools who were participants in the Singapore Cohort Study Of the Risk Factors for Myopia (SCORM). Intelligence quotient (IQ) was assessed using the nonverbal Raven Standard Progressive Matrix test.

Results. After controlling for age, gender, school, parental myopia, father's education, and books read per week, myopia (spherical equivalent [SE]) of at least −0.5 D was associated with high nonverbal IQ (highest quartile) versus low IQ (lowest quartile) (odds ratio = 2.4; 95% confidence interval, 1.7–3.4). Controlling for the same factors, children with higher nonverbal IQ scores had significantly more myopic refractions (−1.86 D for children with nonverbal IQ in the highest quartile compared with −1.24 D for children with nonverbal IQ in the lowest quartile; $P = 0.002$) and longer axial lengths (24.06 mm versus 23.80 mm; $P = 0.022$). Nonverbal IQ accounted for a greater proportion of the variance in refraction compared with books read per week.

Conclusions. Nonverbal IQ may be an independent risk factor of myopia, and this relationship may not be explained merely by increased reading (books per week) among myopes. An interesting observation is that nonverbal IQ may be a stronger risk factor for myopia compared with books read per week. The complexity of the relationships between nonverbal IQ, reading, and myopia warrant additional studies to clarify any cause–effect relationship. (*Invest Ophthalmol Vis Sci.* 2004;45:2943–2948) DOI:10.1167/iovs.03-1296

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An extensive literature on the possible environmental and genetic risk factors for myopia exists, but the strength of many associations is often weak, and prior results are often contradictory. Commonly investigated risk factors include environmental factors such as near work and educational level, as well as parental history, a possible indicator of genetic susceptibility.[1] The present enigma is that the total contribution of near work and parental history (a possible measure of hereditary factors) is small. From the Orinda Longitudinal Study of Myopia, for instance, the model R^2 of refractive error with the explanatory variables of grade in school, parental history of myopia, and diopter-hours of near work was 13%.[2] These uncertainties suggest that other lesser known factors may disturb emmetropization (the process by which normal ocular growth is mediated to ensure that the adult eye remains emmetropic) and lead to development of myopia and excessive eye growth.[2]

It has long been observed in different countries (e.g., Israel, the United States, and New Zealand) that myopic children have higher intelligence quotient (IQ) test scores.[3–8] While an explanation for the association of myopia with higher IQ is lacking, it has been hypothesized that there may be a link between eyeball axial length and cerebral development, or that both myopia and IQ may be influenced by the same genes.[4,9] Further, there is uncertainty about whether IQ is associated with myopia, because children who perform better in IQ tests may simply read more, and perhaps IQ may only be a surrogate marker for near-work activity. We evaluated in this report the relationship between nonverbal IQ and myopia in Singapore children aged 10 to 12 years in the context of other myopia risk factors, including reading.

Methods

All children from grades 1 to 3 from three "normal" schools located in the Southeastern, Western, and Northern parts of Singapore were invited to join the Singapore Cohort Study Of the Risk Factors for Myopia (SCORM) in 1999 and 2001. The methodology and initial cross-sectional results have been described.[10,11] Singapore is an urban city-state and the majority of children attend "normal" schools; whereas children with known mental retardation (IQ < 50) often attend "special" schools. Children who had serious medical or eye disorders such as congenital cataract, mentally retarded children, and children who were absent from class during the 2002 school visit (years 2 and 4 of the study) were excluded. Of the 2192 eligible students, 1453 elected to enroll in the first year of the SCORM study (primary participation rate, 66.3%). The proportion who reported near-sightedness (children were asked whether they were near-sighted in the survey) did not differ significantly among participants (31.9%) and nonparticipants (30.9%; $P = 0.82$). Of the children who enrolled in SCORM, 1204 (82.9%) participated in this study. Written informed consent was obtained from the parents after the nature of the study was explained. Approval was obtained from the Ethics Committee, Singapore Eye Research Institute, and the study's protocol adhered to the tenets of the Declaration of Helsinki.

Eye Examinations

Yearly eye examinations were conducted in the three schools (235 in the Eastern school, 347 in the Northern school, and 622 in the Western school). At the 2002 follow-up examination, there were 933 (77%) 10-year-olds, 196 (16%) 11-year-olds, and 75 (6%) 12-year-olds, and 612 (50.8%) were male. In brief, cycloplegia was induced in each eye using three drops of 1% cyclopentolate instilled 5 minutes apart. One of two autokeratorefractometers (model RK 5; Canon, Ltd., Tochigiken, Japan) was used to obtain the average of five consecutive refraction readings (all readings <0.25 D apart) and the average of two corneal curvature readings in the flatter and steeper meridians was calculated. One of two biometry ultrasound units (probe frequency of 10 mHz; Echoscan US-800; Nidek Co. Ltd., Tokyo, Japan) was used to obtain axial length, anterior chamber depth, lens thickness, and vitreous chamber depth measurements. The average of six values was taken if the standard deviation of the six measurements was less than 0.12 mm.[12,13] If the standard deviation of the six measurements was 0.12 mm or greater, the data were not included, and the measurements were repeated until the standard deviation was less than 0.12 mm.

IQ and Other Risk Factor Data

The children who participated in SCORM completed a nonverbal IQ test administered by our study staff and a psychologist on the school's premises in 2002, using the Raven Standard Progressive Matrices.[14] The tests were administered in the English language, as the primary language of instruction in Singapore schools is English. The average time taken to complete the test was 30 minutes. The Raven Standard Progressive Matrices Test is a well-balanced measure of components of general nonverbal intelligence that does not require reading or linguistic ability. For children and adolescents, it has good to excellent correlation, ranging from 0.7 to 0.92, compared with conventional tests of intelligence, such as the Weschler and Stanford Binet Scales.[15,16] This test consists of a series of picture diagrams that evaluate pattern recognition ability.[17] It is a popular measure of conceptual ability because responses do not require verbalization, skilled manipulative ability, or subtle differentiation of visual–spatial information. It has been found to have a test–retest reliability of 0.80 to 0.93.[18] Because the raw Raven Standard Progressive Matrices scores are usually grouped according to specific ages, quartiles were constructed for 10-year-olds (first quartile: 10–37; second quartile: 38–43; third quartile: 44–47; fourth quartile: 48–57), 11-year-olds (first quartile: 20–40; second quartile: 41–46; third quartile: 47–50; fourth quartile: 51–59), and 12-year-olds (first quartile: 25–44; second quartile: 45–46; third quartile: 47–50; fourth quartile: 51–58).

The parents completed an eight-page questionnaire at the SCORM baseline visit (1999 and 2001). Questions included parent's completed educational level; the child's reading in books per week, as reported by parents; the child's reading in hours per day on weekdays and weekends, as reported by parents; and parental myopia (parents were asked whether they were currently wearing spectacles or contact lenses for myopia and the age when glasses were first worn).

Data Analysis

Refraction was analyzed as (spherical equivalent [SE]: sphere + half negative cylinder power). Myopia was defined as SE at least −0.5 D. Data (SE) from the right and left eye were similar (Pearson correlation coefficient = 0.95), and thus only the right eye results were presented. For each specific age (10, 11, and 12 years), nonverbal IQ was expressed in quartiles. There were 1342 children with follow-up refraction data in 2002, and the analysis was performed only on 1204 children who took the nonverbal IQ test. Multiple logistic regression models with myopia as the dependent variable and nonverbal IQ as the main covariate were constructed, adjusting for other covariates, such as age, gender, school, father's education, parental myopia, and books read per week. Multiple linear regression models with refraction as the dependent variable and nonverbal IQ as the main covariate were also constructed. There were 28 children without complete myopia data for both parents, because the parents were separated. The linear trend tests were performed by assigning consecutive integers to each nonverbal IQ quartile and regressing the dependent variables on this new score. Data analysis was conducted using the commercially available software (Stata, ver. 8.0; Stata, College Station, TX).[19]

Results

The mean refractive error was −1.56 D (SD 2.18; range, −10.85 to +4.30), mean axial length was 23.92 mm (SD 1.10; range, 21.40–28.21), and refractive error correlated with axial length (Spearman correlation coefficient, $r = -0.74$). There was a lag between study entry and the IQ phase of the study, and the prevalence rate of myopia was 709/1204 (58.9%; 95% confidence interval (CI), 56.1–61.7) in 2002. The median number of books read per week was 2.0: 119 children read no books per week, 363 read one book per week, 294 read two books per week, 158 read three books per week, and 270 read four or more books per week. There were 348 (29.6%) children with no myopic parents, 506 (43.0%) with one myopic parent, and 322 with two myopic parents (27.4%). The prevalence rates of myopia among fathers and mothers were 40.2% and 54.1%, respectively.

There were 105 (30.9%) children with nonverbal IQ in the highest quartile who read four or more books per week compared with 41 (15.6%) children in the lowest quartile ($P <$ 0.001; Table 1). The Spearman correlation coefficient of nonverbal IQ score and books read per week was 0.18 ($P < 0.001$). Children with nonverbal IQ in the highest quartile were also more likely to have fathers (30.6% versus 8.0%) and mothers (22.1% versus 3.1%) who completed college compared with children with IQ in the lowest quartile (both $P < 0.001$). Children with nonverbal IQ in the highest quartile were more likely to have two myopic parents (34.5%) compared with children with IQ in the lowest quartile (15.8%; $P < 0.001$).

In univariate analyses, myopia was marginally associated with older age (12 years) compared with younger age (10 years; odds ratio [OR] = 1.7; 95% CI 1.0–2.7), associated with paternal tertiary education versus no paternal education (OR = 2.2; 95% CI 1.1–4.6), but not associated with maternal tertiary

Table 1. Reading Activity of Singapore Chinese Children by IQ Quartiles

		Books per Week					
	n	0	1	2	3	4 or More	*P*
IQ							
Lowest quartile*	263	40 (15.2)	88 (33.5)	65 (24.7)	29 (11.0)	41 (15.6)	<0.001
Second lowest quartile	295	29 (9.8)	102 (34.6)	65 (22.0)	34 (11.5)	65 (22.0)	
Second highest quartile	306	32 (10.5)	99 (32.4)	72 (23.5)	44 (14.4)	59 (19.3)	
Highest quartile	340	18 (5.3)	74 (21.8)	92 (27.1)	51 (15.0)	105 (30.9)	

Data are number of persons, with percentage of the total group in parentheses.

IQ: 10-year-olds (1st quartile: 10–37; 2nd quartile: 38–43; 3rd quartile: 44–47; 4th quartile: 48–57). 11-year-olds (1st quartile: 20–40; 2nd quartile: 41–46; 3rd quartile: 47–50; 4th quartile: 51–59). 12-year-olds (1st quartile: 25–44; 2nd quartile: 45–46; 3rd quartile: 47–50; 4th quartile: 51–58).

education versus no education (OR = 1.6; 95% CI 0.8–3.4; Table 2). Myopia was associated with two versus no myopic parents (OR = 1.7; 95% CI 1.2–2.3), and myopia was associated with books read per week (OR = 1.1; 95% CI 1.0–1.1; P = 0.03) in univariate analyses. A final multivariate model was constructed with myopia as the outcome variable and age, gender, school, parental myopia, father's education, books read per week, and nonverbal IQ as explanatory variables. Myopia did not remain associated with age, school, father's education, or books read per week, and the association with parental myopia was marginally significant (OR = 1.4; 95% CI 1.1–1.9 for 1 vs. 0 myopic parents; OR = 1.4; 95% CI 1.0–2.0 for 2 vs. 0 myopic parents; P = 0.06). Myopia was not associated with reading in hours per day in both univariate (OR = 1.0; 95% CI 0.9–1.1) and multivariate analyses (OR = 1.0; 95% CI 0.9–1.1).

The prevalence rates of myopia in children with the lowest quartile of nonverbal IQ were 46.0%, 55.9% in the second lowest quartile, 62.8% in the second highest quartile, and 67.9% in the highest quartile of nonverbal IQ. Myopia was associated with nonverbal IQ in the highest quartile versus lowest quartile: (OR = 2.4; 95% CI 1.7–3.4) after controlling for age, gender, school, father's education, parental myopia and reading in books per week (Table 2). Myopia was also associated with unit increases in IQ quartile (OR = 1.3; 95% CI 1.2–1.5), after controlling for the same factors. Similar significant univariate (OR = 1.06; 95% CI 1.04–1.07; $P < 0.001$) and multivariate (OR = 1.05; 95% CI 1.03–1.07; $P < 0.001$) associations between myopia and IQ score were found. The nonverbal IQ–myopia relationship remained significantly positive within each strata of reading defined either by more than and two books or less books per week or more than and 1 hour or less of reading per day. There was no interaction between books read per week or hours read per day and nonverbal IQ. Moreover, there was no interaction between nonverbal IQ and parental myopia.

We evaluated the risk factors for higher myopia (SE at least −3.0 D) because higher myopia was associated with reading after controlling for other factors except IQ in prior reports.[11] The reference group for this analysis included children with no myopia (SE > −0.5 D) and those with low myopia (−3.0 < SE ≤ −0.5 D). In multivariate analyses of the risk factors for higher myopia (SE at least −3.0 D), higher myopia (SE at least −3.0 D) remained associated with books read per week, even after controlling for IQ and other factors (P = 0.01).

The relationships between axial length and refraction with nonverbal IQ, after controlling for age, gender, school, parental myopia, father's education, and books read per week are shown in Table 3. Similar to our findings of myopia as a dichotomous variable, nonverbal IQ was significantly associated with refraction, before and after controlling for books read per week. The multivariate adjusted mean refractive error for children with nonverbal IQ in the highest quartile was −1.86 D compared with −1.24 D for children with IQ in the lowest quartile (P = 0.002). For every point increase in nonverbal IQ score, there is a 0.042 D shift in refraction toward more myopic values ($P < 0.001$). For every point of increase in nonverbal IQ score, the axial length increased by 0.018 mm and vitreous chamber depth by 0.017 mm (both P's < 0.001).

The R^2, or coefficients of multiple determinations, that estimate the proportion of variance in refraction explained by the covariates were determined in several models. Explanatory variables were added to a baseline model (model 1) in a stepwise fashion, whereby the explanatory variables that explained the greatest variance in refraction were added first. The baseline model, model 1 included age, gender, and school (R^2

Table 2. Risk Factor Associations of Myopia

	n	Univariate OR for Myopia (95% CI)	*P*	Multivariate OR for Myopia† (95% CI)	*P*
Age (y)					
10	933	1 (referent)		1 (referent)	
11	196	1.6 (1.2, 2.3)	0.003	0.9 (0.6, 1.3)	0.47
12	75	1.7 (1.0, 2.7)	0.05	1.2 (0.7, 2.1)	0.59
Gender					
Male	612	1 (referent)	0.17	1 (referent)	0.25
Female	592	0.9 (0.7, 1.1)		0.9 (0.7, 1.1)	
School					
Southeastern school	235	1 (referent)		1 (referent)	
Northern school	347	0.6 (0.4, 0.9)	0.01	0.8 (0.5, 1.3)	0.40
Western school	622	0.3 (0.2, 0.5)	<0.001	0.4 (0.2, 0.6)	<0.001
Number of parents with myopia					
0	348	1 (referent)	0.001	1 (referent)	0.06
1	506	1.5 (1.1, 2.0)	(trend)	1.4 (1.1, 1.9)	(trend)
2	322	1.7 (1.2, 2.3)		1.4 (1.0, 2.0)	
Father's completed level of education					
No formal education	33	1 (referent)		1 (referent)	
Primary education	236	1.5 (0.7, 3.1)	0.28	1.8 (0.8, 4.2)	0.15
Secondary education	468	1.7 (0.9, 3.5)	0.13	2.1 (0.9, 4.8)	0.07
Polytechnic education	215	1.6 (0.8, 3.4)	0.21	1.7 (0.7, 3.9)	0.24
Tertiary education	246	2.2 (1.1, 4.6)	0.04	1.4 (1.1, 1.9)	0.15
Number of books read per week	1,204	1.1 (1.0, 1.1)	0.03	1.0 (1.0, 1.9)	0.26
IQ*					
Lowest quartile	263	1 (referent)	<0.001	1 (referent)	<0.001
Second lowest quartile	295	1.5 (1.1, 2.1)	(trend)	1.5 (1.0, 2.1)	(trend)
Second highest quartile	306	2.0 (1.4, 2.8)		2.0 (1.4, 2.8)	
Highest quartile	340	2.5 (1.8, 3.5)		2.4 (1.7, 3.4)	

SE at least −0.5 D.

* See Table 1 for description of quartiles.

† Multivariate odds ratios adjusted for all other factors in the table.

TABLE 3. Unadjusted and Adjusted Mean Axial Length and Refraction by IQ Quartiles

		Refractive Error (D)		Axial Length (mm)	
	n	Unadjusted Mean (SD)	Adjusted Mean (SD)†	Unadjusted Mean (SD)	Adjusted Mean (SD)†
IQ*					
Lowest quartile	263	−1.00 (1.97)	−1.24 (2.43)	23.64 (1.07)	23.80 (1.18)
Second lowest quartile	295	−1.44 (2.22)	−1.57 (2.47)	23.92 (1.13)	23.99 (1.20)
Second highest quartile	306	−1.78 (2.28)	−1.85 (2.50)	23.99 (1.10)	24.00 (1.21)
Highest quartile	340	−1.90 (2.14)	−1.86 (2.58)	24.07 (1.08)	24.06 (1.25)
P (trend)		<0.001	0.002	<0.001	0.022
Regression model results					
Regression coefficient		−0.064	−0.042	0.032	0.018
P (regression)		<0.001	<0.001	<0.001	<0.001

* See Table 1 for description of quartiles.
† Adjusted for age, gender, school, parental myopia, father's education, reading books per week.

= 0.072). Model 2 included the addition of nonverbal IQ, the explanatory variable that explained the greatest variance in refractive error, in addition to the base model (age, gender, school; $R^2 = 0.090$). Model 2 was a statistically significant improvement in the explanation of the variables for refractive error compared with the base model, model 1 (partial F test: $P < 0.001$). Model 3 included age, gender, school, nonverbal IQ, and parental myopia ($R^2 = 0.104$), and model 4 included books read per week, in addition to all the explanatory variables in model 3 ($R^2 = 0.116$). The R^2 values for model 3 were significantly higher than those in model 2, and the R^2 values for model 4 were also significantly higher than those in model 3 (both partial F tests: $P < 0.001$).

DISCUSSION

Singapore Chinese children aged 8 to 12 years with higher nonverbal IQ, as measured by the nonverbal Raven Standard Progressive Matrices, were more likely to be myopic, after controlling for age, gender, school, father's education, parental myopia, and books read per week. Higher nonverbal IQ scores were also associated with greater axial lengths. Our data suggest that nonverbal IQ has an association with myopia independent of near work in young Singapore students, though the mechanism underlying the nonverbal IQ-myopia relationship is not well understood. An interesting observation is that myopia (SE at least −0.5 D) is not significantly associated with books read per week, after controlling for other confounders, including IQ. Higher myopia (SE at least −3.0 D), however, remains associated with books read per week, after controlling for other factors, including IQ.

A positive association of myopia with higher academic performance, reading ability, and IQ test scores has long been recognized, of which only a few examples will be cited here. Cohn et al.[20] noted a century ago that persons who were intellectually gifted or scholarly were more likely to be myopic. Observations over the past few decades include apparent increases in the frequency of myopia among intellectually able individuals, such as university and medical students.[21,22] In a study of 157,748 Israeli male military recruits aged 17 to 19 years, the prevalence rate of myopia increased from 8% in individuals with very low intelligence scores (IQ ≤ 80 on the verbal Otis test and nonverbal matrices) to 27.3% in individuals with the highest intelligence scores (IQ ≥ 128 or higher).[3] The prevalence rates of myopia rose from below 10% in the group with lowest intelligence scores (lowest IQ group score of 0–30 in an intelligence test that includes logical, verbal, numerical, and spatial abilities) to 30% in the group with the highest intelligence scores (highest IQ group score of 61–78) in 15,834 18-year-old Danish male military draftees.[23] The mean adjusted verbal (102.6) and performance (103.5) IQs of myopic children were significantly higher compared with emmetropic children (100.3, 100.9 respectively) in 537 New Zealand children aged 11 years who completed the WISC-R IQ test.[24] Israelis and Danish recruits and children in New Zealand who are more intelligent may read more, suggesting that IQ could be a surrogate marker for reading, and the results may be a reflection of a causal relationship between reading and myopia. In the majority of prior studies, reading activity (another important confounder, because subjects with higher IQ tend to read more) was not controlled for and the effect of intelligence on myopia, independent of reading, could not be assessed. Reading ability using the Burt Word Reading Test, and not reading activity, was controlled for in the New Zealand study.[24]

Several prior surveys in which nonverbal IQ tests were used found no association with myopia.[7,25] Similarly, no association was found with IQ and myopia when reading ability was considered in interpreting IQ test scores.[26] Other prior associations of IQ with myopia that were positive may also be confounded by reading activity, and IQ may be a surrogate marker of near work. Prior epidemiologic studies in the Orinda Longitudinal Study of Myopia (OLSM) and our SCORM study have shown that the risks of myopia are 1.02 times higher for each diopter-hour per week increase in OLSM and 3.05 times greater for children who read more than two books per week in SCORM.[8,10] In the OLSM, the Iowa Test of Basic Skills (a school-based test of skills essential for school achievement), language score was not significantly related to myopia, after adjusting for reading and other factors. However, other results were similar to the SCORM study: the multivariate adjusted odds ratio of myopia for each increment in the reading local percentile score was 1.013, (95% CI 1.003–1.024). IQ test score results were not presented.[8] Several other prior studies did not measure reading activity or evaluate reading as a confounder in the evaluation of the IQ–myopia relationship.[3,23,24] A novel finding of our study is that the association of myopia with performance on a nonverbal intelligence test, after controlling for reading, suggests that myopia is associated with IQ, independent of reading or near work. Because reading is a verbal activity and may not directly correlate with a nonverbal intelligence test, future studies, using a verbal IQ test may prove useful in dissociating reading, a verbal activity, from IQ.

A positive IQ score–myopia relationship does not conclusively show that intelligence is a predictor of myopia because of several issues that should be considered. First, with repeated testing over time, a child may improve and acquire the skills needed to excel in IQ tests. IQ may not only quantify intelligence; higher IQ scores may indicate diligence and motivation as well. Second, the concept of intelligence may encompass verbal competence, problem-solving ability, memory, judgment, and social skills, and may be broader than the concepts assessed by IQ tests.[27] Verbal IQ tests generally evaluate a person's verbal reasoning skills, comprehension, and acquired knowledge, whereas nonverbal IQ tests typically measure a person's visual, spatial, and perceptual organizational abilities; visual motor coordination; and attentiveness to detail. The Raven's Standard Progressive Matrices administered in our present study is a simple, widely used, nonverbal test that assesses a person's visual alertness and spatial and abstract pattern-recognition abilities.

Several hypotheses of possible causal pathways of the role of IQ in the development of myopia have been discussed in the literature. Myopia usually occurs from a failure of the coordination of postnatal growth with the refractive components of the eye. Part of the mechanism for the development of myopia may involve central nervous system influences on the eye. The importance of genes in the development of individual IQ has been established over time. Cerebral and ocular development may be closely linked because both IQ and myopia may be genetically determined. The association between genetically driven IQ and myopia of hereditary predisposition could be forged because of a pleiotropic relationship between IQ and myopia in which the same causal factor is reflected in both genetic traits.[20] For example, there may be similar genes affecting eye size or growth (associated with myopia) and neocortical size (possibly associated with IQ).[28]

In this study, a model with known predictive factors of myopia, including books read per week and nonverbal IQ, only describes 11.6% of the variance in refractive error. The known "conventional" risk factors may have a minimal role in explaining who becomes myopic and the degree of refractive error. For example, the role of reading may not be large, and the strength of associations from prior studies in the United States and in the SCORM study are not particularly strong.[8,10] Furthermore, the complex and often poorly understood nature of the relationships between the major risk factors, reading and intellectual ability, may preclude any definite conclusions.

Nonverbal IQ is associated with both myopia (SE at least −0.5 D) and higher myopia (SE at least −3.0 D). The findings of a prior report revealed that higher myopia (SE at least −3.0 D) was associated with books read per week, after controlling for other factors except IQ. Our study shows that higher myopia (SE at least −3.0 D), but not myopia (SE at least −0.5 D) remains significantly associated with books read per week, after controlling for all other factors, including IQ.[11] Nonverbal IQ contributed to a greater variance in refraction compared with books read per week. This suggests that nonverbal IQ may contribute more to the risk of myopia and the association between books read per week and higher myopia may be partially explained by nonverbal IQ. In other words, books read per week may be a surrogate for nonverbal IQ. Whether it is also a surrogate for verbal IQ requires further study. Other possible reasons for the lack of association between books read per week and myopia include the possibility that the measurements for reading are too crude and that any cause–effect relationship may not be inferred from cross-sectional data.

Strengths of our study include a large sample size, the use of a nonverbal IQ test, adjustments for reading as a confounder, and the availability of ocular biometry parameter measures. In addition, there are limited confounding effects of age on the nonverbal IQ-myopia association, because the majority of the children (77%) were 10 years old. There are several limitations in our study that should be considered. The cross-sectional nature of the study does not allow inferences regarding possible causal relationships. The participation rate in SCORM is 66.3%, and spurious results may be present if the nonverbal IQ-myopia association is different among participants compared with nonparticipants. This participant bias seems unlikely, because the percentage of children who report near-sightedness is similar among participants and nonparticipants.

In conclusion, nonverbal IQ may be associated with myopia, independent of books read per week, in young school children. Nonverbal IQ contributes to a greater variance in refraction compared with books read per week. Further large cohort studies of the risk factors of myopia with detailed measures of reading and IQ (both verbal and nonverbal) should be conducted in both Asian and non-Asian children and adults.

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