Visual Disability, Visual Function, and Myopia among Rural Chinese Secondary School Children: The Xichang Pediatric Refractive Error Study (X-PRES)—Report 1

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PURPOSE. To evaluate visual acuity, visual function, and prevalence of refractive error among Chinese secondary-school children in a cross-sectional school-based study.

METHODS. Uncorrected, presenting, and best corrected visual acuity, cycloplegic autorefraction with refinement, and self-reported visual function were assessed in a random, cluster sample of rural secondary school students in Xichang, China.

RESULTS. Among the 1892 subjects (97.3% of the consenting children, 84.7% of the total sample), mean age was 14.7 ± 0.8 years, 51.2% were female, and 26.4% were wearing glasses. The proportion of children with uncorrected, presenting, and corrected visual disability (≤6/12 in the better eye) was 41.2%, 19.3%, and 0.5%, respectively. Myopia < -0.5, < -2.0, and < -6.0 D in both eyes was present in 62.3%, 31.1%, and 1.9% of the subjects, respectively. Among the children with visual disability when tested without correction, 98.7% was due to refractive error, while only 53.8% (414/770) of these children had appropriate correction. The girls had significantly ($P < 0.001$) more presenting visual disability and myopia < -2.0 D than did the boys. More myopic refractive error was associated with worse self-reported visual function (ANOVA trend test, $P < 0.001$).

CONCLUSIONS. Visual disability in this population was common, highly correctable, and frequently uncorrected. The impact of refractive error on self-reported visual function was significant. Strategies and studies to understand and remove barriers to spectacle wear are needed. (*Invest Ophthalmol Vis Sci.* 2008; 49:2888–2894) DOI:10.1167/iovs.07-1160

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Uncorrected refractive error is the leading cause of visual disability among school-aged children in the world today, a fact that has been documented among children of Asian,[1–4] Hispanic,[5] and European descent.[6] Among secondary-school students in China, 43% to 78% of 15-year-old children suffer from refractive error, which accounts for over 95% of visual disability when tested without correction.[3,7,8] Between 60% and 70% of refractive error was uncorrected by spectacles in population-based studies in Chile[5] and China,[7] while even in Australia, one of four children needing glasses did not have them.[9]

The fact that a large number of children are without sight-improving glasses is particularly concerning in view of recent studies demonstrating significant improvement in self-reported visual function associated with spectacle wear among children with only moderate levels of myopia.[10] The provision of spectacles is a noninvasive and inexpensive intervention potentially capable of improving the visual function of a large number of school-aged children; however, the full impact of this intervention has not been achieved in many populations.

The reasons for not wearing the spectacles are poorly understood and are likely to differ among populations. Although lack of access to services may play an important role in many areas, a recent report from rural Mexico indicates that, among children provided free spectacles, fewer than one in six were wearing them at an unannounced follow-up, and fewer than half had the glasses with them at all.[11]

In addition to outright failure to wear the spectacles, the provision of inaccurate or poorly fitting glasses may add to the burden of visual disability associated with refractive error in many populations. Although few reports on the accuracy of habitually worn spectacles exist in the developing world, a population-based study in Australia found that fully a third of children wearing spectacles had no measurable refractive error.[9]

Few if any population-based studies have been conducted to quantify the impact of prevalent refractive error on self-reported visual function among school-aged children. The full visual burden of uncorrected and inadequately corrected refractive error cannot be quantified without adequate measures of the impact on visual function in at-risk populations.

The Xichang Pediatric Refractive Error Study (X-PRES) is a school-based evaluation of refractive error prevalence, patterns of spectacle wear, self-reported visual function, attitudes toward and use of refractive services, and factors determining refractive error and glasses wear among 1900 children in junior middle school years 1 and 2 (ages, 13–17 years) in rural China. Because of compulsory education in this age range, the sample is probably representative of the population at large. The current report provides data on (1) the prevalence of refractive error and visual disability and (2) the association between refractive error and self-reported visual function.

METHODS

Xichang is a rural village located within 2 hours of the town of Shantou in eastern Guangdong province. Eye services are provided principally through a free-standing eye clinic run in cooperation between the government-run village-level medical clinic and the Caring is Hip eye care program, supported by the Li Kai Shing Foundation. Basic refractive services and spectacles are available at the eye clinic and also at a small number of privately run optical shops in Xichang. The population of Xichang was 109,673 in 2002.[12]

In April to July 2007, we performed a school-based survey on a cluster-based random sample, selected by class (class size was approximately 60 students) among children in junior middle school years 1 and 2 at all three middle schools in Xichang. Compulsory education in China extends through the age of 16 years (third year of junior middle school), and so the sample is likely representative of the population in this age-range. The purpose of the survey was to determine the prevalence and predictors of visual disability, refractive error, spectacle wear, and uptake of refractive services among Chinese rural-dwelling children. The protocol was approved by the Ethics Committee at the Joint Shantou International Eye Center in Shantou, the parent hospital for the Xichang Eye Clinic. Informed consent was obtained from one or more parents of all participating children, and the Declaration of Helsinki was adhered to throughout.

Participants

The parents of all children in randomly selected junior middle school year 1 and 2 classes at the three middle schools in Xichang Village were sent letters of invitation explaining the purpose and methods of the study. The parents were asked to check a box indicating whether they were willing for their child to participate in the study, and to return the form to school with the child. There were 2235 children in the sample. Among 2197 (98.2%) returned forms, permission was granted for 1945 children (88.5% of returned forms, 87.0% of the sample), and 1892 of these (97.3% of children with consenting parents, 84.7% of the sample) were examined (Fig. 1).

Assessment of Vision

Teachers observed vision measurement and then performed measurements with monitoring by study ophthalmologists in a total of 10 subjects of the same age range as those participating in the study. Teachers then performed vision screening for all children in their class (approximately 60 subjects), unobserved by study personnel. All teachers gave written informed consent and answered a brief questionnaire regarding their age, sex, teaching history, glasses wear, and beliefs about the importance and impact of glasses wear on children's school performance.

All subjects then underwent assessment of vision a second time in a separate room by study personnel, all of whom were trained vision professionals (optometrists and ophthalmologists). Data included in the current report are based solely on measurements by study personnel.

Both teachers and study personnel measured uncorrected visual acuity and visual acuity in the children who were wearing habitual refraction if available, in well-lighted areas during daylight hours, at a

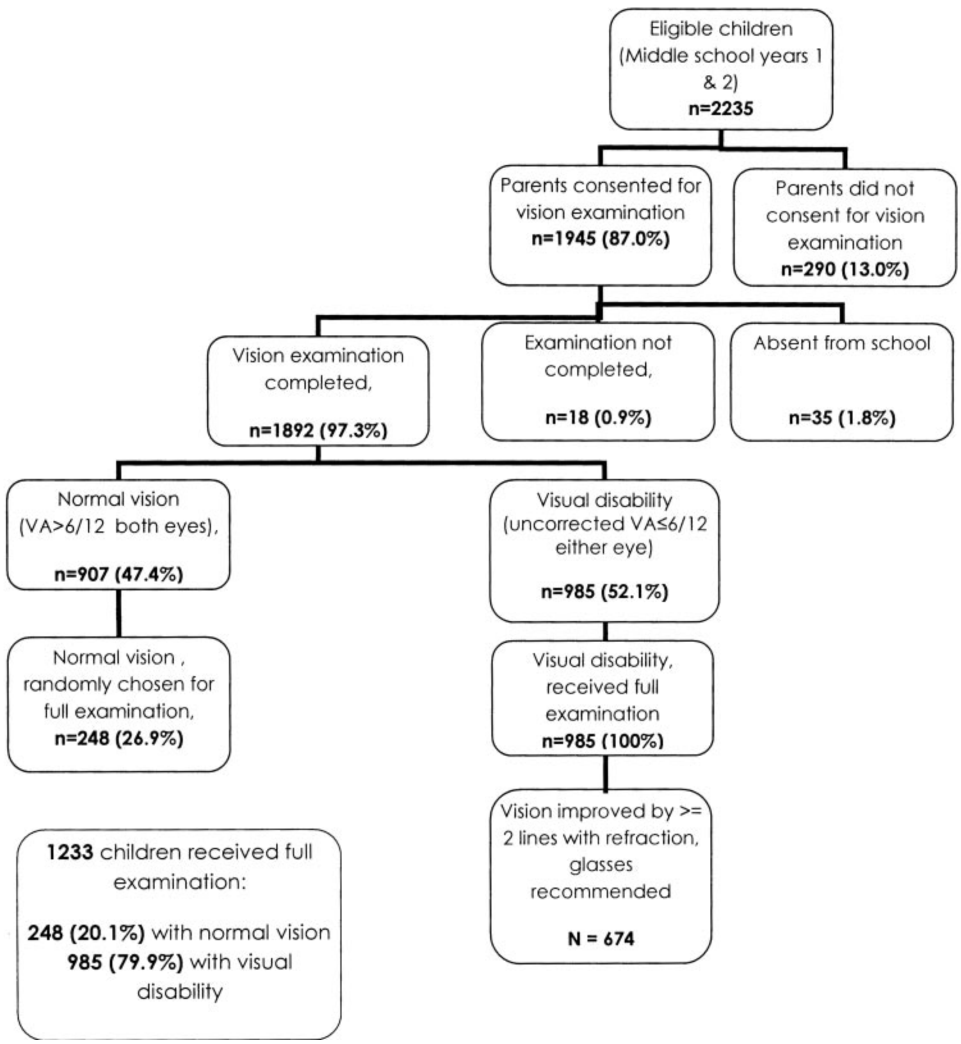

FIGURE 1. Flowchart detailing recruitment and examination of subjects for the Xichang Pediatric Refractive Error Study (X-PRES).

distance of 6 m, separately for each eye of each child. Children who did not have their spectacles at school were asked to bring them for vision assessment on a separate day. Identical illuminated Snellen tumbling E vision chart (Shantou City Medical Equipment Ltd., Shantou, China) were used for all testing. The nontested eye was covered by the subject with a handheld occluder, with proper occlusion and neutral head position monitored by the examiner. The right eye was tested first. A single optotype of each size was presented first, starting at 6/30. If the child failed to read a letter, testing began two lines above, with the child being asked to read all optotypes on the line sequentially. A subject had to identify correctly more than half of the letters on a given line (e.g., three of five) to be considered to have achieved that level of acuity.

Basic Questionnaire

All study subjects ($n = 1892$; Fig. 1) were administered a basic questionnaire by study personnel before being told the results of their vision assessments. The basic questionnaire included questions on age, sex, parental education, history of glasses wear, reasons for not wearing the glasses, and time spent in a variety of near-work activities including reading, video games, and computer use and in outdoor activities.

The basic questionnaire included a Chinese translation of an instrument developed originally by Fletcher et al.,[13] to assess self-reported visual function (VF) in rural Asia. All questions were administered in mandarin or the local dialect (Chaoshanhua) by one of six native speakers after a period of training and standardization. This instrument has been validated for use in Chinese,[14,15] and is described elsewhere in detail.[13]

Briefly, the VF questionnaire assesses overall vision, visual perception, limitation in daily activities, peripheral vision, near vision, sensory adaptation, light–dark adaptation, visual search, color discrimination, glare disability, and depth perception. The questionnaire could be administered in 5 to 10 minutes. Each of 13 responses was scored from one (no problems) through four (maximum problems), with scales in each of the areas calibrated between 100 (the best possible score) and 0 (the worst score). The overall VF scale score was calculated by averaging the scores for the different areas, thus giving a summary score of 0 to 100.[13] Although the questionnaire was originally developed for use in adults, none of the questions describe adult-specific situations or activities. Thus, the questionnaire was not modified from its original format for use in children, nor were any questions omitted.

Detailed Examination

All subjects with uncorrected vision of 6/12 or worse in either eye, and a 25% random sample of subjects with vision of >6/12 in both eyes ($n = 1233$, Fig. 1), underwent a detailed examination consisting of the following elements:

- Cycloplegia with cyclopentolate 1% and tropicamide 1%: one drop of each every 5 minutes for a total of three drops of each medication, followed by autorefraction (model RK-F1 Refractometer/Keratometer; Canon, Inc., Tochigi, Japan) with refinement in each eye by an ophthalmologist.
- Slitlamp (YZ5F1; Suzhou Liuliu, Suzhou, China) examination of the anterior and poster segment by an ophthalmologist.
- Measurement of intraocular pressure, corneal hysteresis, and corneal resistance factor (Ocular Response Analyzer; Reichert Instruments, Depew, NY).
- Measurement by ultrasound A-scan (ODM 2200; Tianjin Maida Medical Technology Co., Ltd., Tianjin, China) of axial length, anterior chamber depth, and lens thickness.
- Ultrasound measurement of central corneal thickness (IOP_{AC} Advanced; Heidelberg Engineering and Starfish, Victoria, British Columbia, Canada).

Referral for Spectacles and Detailed Questionnaire

Recommendation was made for new spectacles for the following children:

- All subjects with presenting VA ≤6/12 in either eye (with or without spectacles), and whose vision could be improved by two or more lines in either eye with refraction.
- Children with spectacles improving the vision to >6/12, but whose vision could be improved by ≥2 lines with refraction.

All such children ($n = 674$, Fig. 1), received a card with a map depicting the location of the Xichang eye clinic, their refraction and a message indicating that glasses were recommended. The parents of these children received a telephone call from the child's teacher explaining the need to obtain new or corrected spectacles and the potential benefit in classroom performance. These children and their teachers also were given a brief lecture in Mandarin on refractive error and the benefit of spectacles.

Statistical Methods

Raw data were presented as mean (SD) or frequency (%), as appropriate. Average presenting vision of the two eyes (minimum angle of resolution, MAR) was minus log-transformed to correct its skewness before statistical analyses, though the untransformed numbers are presented in tables for the sake of clarity.

The data for astigmatism, hyperopia, and myopia prevalence (with cutoffs of −0.5 and −2.0 D) include estimates for refractive error prevalence among unrefracted children with vision >6/12 in both eyes. These estimates were based on the 248 children with normal vision who were randomly chosen for full examination and refraction, who had a range of refractions from −2.25 to +5.0 D (mean between the two eyes). Among children with normal vision, only one had refractive error > +2.0 in both eyes, two had myopia <−2.0 D in both eyes, and none had <−6.0 D in both eyes. The 95% confidence interval for the prevalence was estimated using the Clopper-Pearson method.[16]

All univariate comparisons were made using the *t*-test, Pearson χ^2 test or the Fisher exact test. The ANOVA trend test was used to assess the linear trend of visual function score across the different spherical equivalent groups. Multiple comparisons on visual function scores between the reference spherical equivalent group (SE ≥ −0.5) and each of the other groups were analyzed with the Dunnett test. Univariate analyses of the association between visual function and its potential predictors were assessed with the bivariate correlation coefficient or *t*-test. Multivariate analysis was performed with multiple regression. All statistical analyses were performed with commercial software (SPSS 14.0; SPSS Inc., Chicago, IL). All statistical tests were two sided, and $P < 0.05$ was considered statistically significant.

Results

The mean age of the 1892 children examined was 14.7 ± 0.8 years (range, 11.4 – 17.1 years), 969 (51.2%) were female, and 26.4% were wearing glasses at the time of examination. Less than a third of the children indicated that their more-educated parent had completed high school. The girls were significantly more likely to have failed vision screening (uncorrected vision in either eye ≤6/12) than were the boys ($P < 0.001$). The mean self-reported visual function of children failing screening (67.8 ± 15.9) was significantly worse than for children with normal vision (84.7 ± 11.3, $P < 0.001$; Table 1).

Among the 1892 children examined, 780 (41.2%) had uncorrected vision ≤6/12 in the better-seeing eye. The number was 365 (19.3%) for presenting vision ≤6/12 in the better-seeing eye (our study definition of visual disability), which was measured with glasses if available. Only 10 children (0.5%) had best-corrected vision ≤6/12 in the better-seeing eye. The girls

TABLE 1. Basic Demographic, Glasses Wear, and Visual Function Characteristics of 1892 Middle School Children in Rural China who Passed or Failed Initial Vision Screening

	All (n = 1892)	Failed Screening (Uncorrected VA ≤6/12 in Either Eye; n = 985)	Passed Screening (Uncorrected VA >6/12 in Both Eyes; n = 907)	P
Age (y)*	14.7 (0.8)	14.7 (0.8)	14.7 (0.8)	0.252
Sex				
Male	923 (48.8%)	401 (40.7%)	522 (57.6%)	<0.001
Female	969 (51.2%)	584 (59.3%)	385 (42.4%)	
Wearing glasses				
No	1392 (73.6%)	494 (50.2%)	898 (99.0%)	<0.001
Yes	500 (26.4%)	491 (49.8%)	9 (1.0%)	
Parent's education				
Primary or below	413 (21.8%)	226 (22.9%)	187 (20.6%)	0.542
Junior school	880 (46.5%)	444 (45.1%)	436 (48.1%)	
High school	576 (30.4%)	303 (30.8%)	273 (30.1%)	
College or above	23 (1.2%)	12 (1.2%)	11 (1.2%)	
Visual function score*	75.8 (16.3)	67.8 (15.9)	84.7 (11.3)	<0.001

* Mean (SD); all the others are n (%).

had significantly worse uncorrected, presenting, and best-corrected vision than did the boys (Table 2).

A large majority (98.7%, 770/780) of bilateral uncorrected vision ≤6/12 was due to refractive error and was correctable (Table 2). However, only 53.8% (414/770) of these children with uncorrected vision ≤6/12 due to refractive error had appropriate correction (data not shown). Causes of uncorrectable bilateral vision ≤6/12 in this population included amblyopia (n = 6), hypoplastic optic nerve (n = 2), myopic retinopathy (n = 1), and cataract (n = 1).

When cutoffs of < −0.5, < −2.0, and < −6.0 D in both eyes were used to define myopia prevalence among the 1892 examined children, the figures were 62.3% (1178/1892), 31.1% (588/1892), and 1.9% (35/1892), respectively. Astigmatism of > +0.75 D in both eyes was present in 1.7% (33/1892) of the subjects, and hyperopia ≥ +2.0 D was even more uncommon (Table 2). The girls had significantly more myopia < −2 D and more astigmatism than did the boys (Table 2).

Among the 1233 children undergoing refraction, a more myopic refractive error was significantly associated with worse

TABLE 2. Visual and Refractive Information on 1892 Middle School Children in Rural China

	All (n = 1892)*	Boys (n = 923)	Girls (n = 969)*	P†
Uncorrected vision in the better eye				
≤6/60	26 (1.4%)	11 (1.2%)	15 (1.5%)	<0.001
>6/60–≤6/12	754 (39.9%)	302 (32.7%)	452 (46.6%)	
>6/12–<1.0	275 (14.5%)	142 (15.4%)	133 (13.7%)	
≥1.0	837 (44.2%)	468 (50.7%)	369 (38.1%)	
Presenting vision in the better eye				
≤6/60	1 (0.1%)	0	1 (0.1%)	0.020
>6/60–≤6/12	364 (19.2%)	169 (18.3%)	195 (20.1%)	
>6/12–<1.0	419 (22.1%)	184 (19.9%)	235 (24.3%)	
≥1.0	1108 (58.6%)	570 (61.8%)	538 (55.5%)	
Best corrected vision in the better eye				
≤6/60	0	0	0	0.928
>6/60–≤6/12	10 (0.5%)	5 (0.5%)	5 (0.5%)	
>6/12–<1.0	119 (6.3%)	56 (6.1%)	63 (6.5%)	
≥1.0	1763 (93.2%)	862 (93.4%)	901 (93.0%)	
Myopia				
< −0.5 D in both eyes	1178 (62.3%)‡	535 (58.0%)‡	643 (66.4%)‡	<0.001
Prevalence (95% CI)	62.3% (60.1%–64.5%)	58.0% (54.7%–61.2%)	66.4% (63.4%–69.4%)	
Myopia				
< −2.0 D in both eyes	588 (31.1%)‡	239 (25.9%)‡	349 (36.1%)‡	<0.001
Prevalence (95% CI)	31.1% (29.0%–33.2%)	25.9% (23.1%–28.9%)	36.1% (33.0%–39.2%)	
Myopia				
< −6.0 D in both eyes	35 (1.9%)‡	17 (1.8%)‡	18 (1.9%)‡	0.977
Prevalence (95% CI)	1.9% (1.3%–2.6%)	1.8% (1.1%–2.9%)	1.9% (1.1%–2.9%)	
Astigmatism				
> +0.75 D in both eyes	33 (1.7%)	9 (1.0%)‡	23 (2.4%)‡	0.018
Prevalence (95% CI)	1.7% (1.2%–2.4%)	1.0% (0.4%–1.8%)	2.4% (1.5%–3.5%)	
Hyperopia				
≥ +2.0 D in both eyes	4 (0.2%)‡	1 (0.1%)‡	3 (0.3%)‡	0.340
Prevalence (95% CI)	0.2% (0.06%–0.5%)	0.1% (0.0%–0.6%)	0.3% (0.06%–0.9%)	

* One subject with visual disability (uncorrected VA ≤0.5 in either eye) was missing data for spherical equivalent refraction.

† Probability for comparison between boys and girls.

‡ The numbers and percentages were estimated using projections from the 248 children with normal vision that were randomly chosen for full examination, in addition to the data for children with visual disability. Among the 248 normal children, 1 had refractive error > +2D in both eyes, 2 had < −2D in both eyes, and none had < −6 D in both eyes.

Table 3. Association between Average Spherical Equivalent and Visual Function Score among 1233 Chinese Middle School Children Undergoing Cycloplegic Autorefraction with Subjective Refinement by an Ophthalmologist

	n (%)	VF Mean (SD)	*P* (Trend)*	*P* (Dunnett)†
Average Spherical Equivalent of the Two Eyes (D)			<0.001	
≥ −0.5‡	185 (15.0%)	82.6 (13.9)		
≥ −1.5 to < −0.5	224 (18.2%)	78.5 (11.7)		0.022
≥ −2.5 to < −1.5	290 (23.5%)	71.7 (15.1)		<0.001
≥ −3.5 to < −2.5	246 (20.0%)	66.4 (14.5)		<0.001
≥ −4.5 to < −3.5	142 (11.5%)	62.9 (15.2)		<0.001
≥ −5.5 to < −4.5	86 (7.0%)	58.1 (18.0)		<0.001
< −5.5	59 (4.8%)	57.6 (15.5)		<0.001
All	1232§	75.8 (16.3)		

* One way ANOVA trend test on visual function across the seven spherical equivalent groups.
† Dunnett test adjusts for multiple comparisons between the reference group (≥ −0.5) and each of the other groups.
‡ Reference group for comparisons.
§ One subject missing data for spherical equivalent.

self-reported visual function (ANOVA test for trend, $P < 0.001$; Table 3). Children with refractive error ≥ −0.5 D ($n = 185$) had a mean self-reported visual function of 82.6 ± 13.9, which declined monotonically to 57.6 ± 15.5 for children with myopia < −5.5D ($n = 59$; Table 3). Spherical equivalent was more strongly associated with visual function than was presenting vision (average between the two eyes) in multivariate models (Table 4).

Discussion

Visual disability in this rural Chinese middle school population was common, highly correctable, and frequently uncorrected. Nearly one in five children had presenting vision of ≤6/12 in both eyes, whereas >98% of visual disability as measured without correction in this cohort could be further improved with spectacles. However, due to a combination of spectacle nonownership, nonwear, and inaccurate prescriptions, only slightly more than half of children whose vision could be corrected bilaterally to better than 6/12 with refraction actually wore glasses that could improve their vision to this level, even after repeated examinations were performed to accommodate children who had not brought their glasses to school. Given the likely lower rates of glasses wear under actual day-to-day conditions, the proportion of children regularly benefiting from spectacle correction is probably even lower. These results are consistent with other reports of low rate of spectacle ownership and wear in rural China[7] and of low utilization in other regions of spectacles made available through free distribution programs aimed at school-aged children.[11] Of note, a relatively high rate of spectacle wear among children with refractive error (74%) has been reported for urban China.[17]

Presenting vision of ≤6/12 in both eyes (visual disability) was observed in >19% of children in this cohort. The definition of presenting visual disability used in the present report was identical with that in a series of population-based studies of refractive error, the Refractive Error Study in Children (RESC).[18] Direct comparison of data is difficult because of different age compositions of the samples and the higher prevalence of myopia among older children. Nonetheless, the prevalence of presenting visual disability in the current report is higher than that for any of the RESC samples, with the next-highest figure of 16.6% being for the RESC study from rural China.[7] Based on the results of the present study, it appears that a high prevalence of myopia and relatively low rates of spectacle wear to a large extent explain the heavy burden of visual disability present among rural Chinese secondary school children.

It has recently been estimated that when uncorrected refractive error is included as a cause of visual disability, the

Table 4. Potential Predictors of Self-Reported Visual Function among 1233 Chinese Middle School Children Undergoing Cycloplegic Autorefraction with Subjective Refinement by an Ophthalmologist

	Univariate Analysis		Multivariate Analysis		
Independent Variables	Correlation*/ Mean (SD)†	*P*	β	Standard Error	*P*
Sex					
Male‡	71.3 (16.2)				
Female	70.5 (16.7)	0.407	−0.071	0.848	0.933
Age	−0.02	0.555	0.077	0.520	0.882
Parental education (Highest level attended)					
Primary or below‡	68.1 (16.1)				
Junior school	71.4 (16.2)	0.006	3.511	1.087	0.001
High school	72.2 (17.1)	0.002	3.788	1.160	0.001
College or above	68.5 (13.1)	0.911	4.204	3.913	0.283
Average presenting vision§	−0.19	<0.001	−1.945	1.889	0.303
Average spherical equivalent	0.46	<0.001	3.763	0.234	<0.001

* Pearson's correlation coefficient between visual function and continuous variables (age, presenting vision, spherical equivalent).
† Mean (SD) of visual function for each level of categorical variables (sex, parental education).
‡ Reference group for analyses involving categorical variables.
§ Log of the minimum angle of resolution (logMAR).

estimated number of persons worldwide with visual impairment is increased by 61%.[19] Although such data have led to a renewed appreciation of uncorrected refractive error as a cause of disability, the impact of refractive error on self-reported visual function has not, to the best of our knowledge, been described for a school-aged population. In this cohort of middle school children, myopia was significantly and monotonically associated with worse self-reported visual function (Table 3). Myopic refractive error was more strongly associated with self-reported visual function than was presenting vision. This finding may suggest that myopia is associated with visual disabilities not completely captured by Snellen acuity measurements, potentially including micropsia and deficits of peripheral vision among children wearing spectacle correction.

To place these results into perspective, the difference in self-reported visual function between children with the least amount of refractive error (≥ -0.5 D) and those with 0.5 to 1.5 D of myopia was 4.1 points, which exceeded the 3.2-point benefit accruing from second-eye cataract surgery, as measured using the identical instrument among adults in the same region.[20] The decrement in visual function reported by children with ≥ -3.5 to < -2.5 D of myopia compared with those with refractive error ≥ -0.5 D was 16.2 points, which exceeds the difference in self-reported visual function between persons with postoperative vision above and below 6/60 in the surgical eye in the above-cited study. This very significant impact of refractive error on self-reported visual function is consistent with our recent report of significant improvement in visual function with provision of spectacles among school-aged children having modest levels of refractive error in rural Mexico.[10]

More than 60% of these teen-aged rural Chinese children had myopia (spherical equivalent < -0.5 D in both eyes), whereas more significant near-sightedness (< -2.00 D in both eyes) was present in nearly a third. The reported prevalence of myopia in Chinese children is among the highest in the world.[2–4,7,8] Population-based studies of school-aged children in Asia have generally reported a higher prevalence of myopia among urban groups[2,8] as opposed to rural-dwellers.[1,7] Our finding of a high prevalence of refractive error in this rural Chinese population is nonetheless consistent with the report of He at al.,[7] who found myopia (spherical equivalent ≤ -0.5 D in either eye) in 33% of Chinese 13- to 17-year-olds at rural schools in Yangxi County, Guangdong. That myopia and associated poor vision should be so common among rural Chinese school-children is of particular importance to public health policy-makers: access to vision care and health services generally is an increasingly recognized problem for Chinese rural-dwellers.[21]

Our finding of a higher prevalence of visual disability and refractive error among girls as opposed to boys in this population is consistent with results reported for rural China by He et al.,[7] where girls had a myopia prevalence of 51% versus 34% for boys. A similar preponderance of myopia among school-age girls versus boys has been reported for populations in urban China,[17] rural India,[1] and Malaysia.[22] However, population studies using a protocol identical with that used in some of the articles just described[17,22] failed to report a tendency toward higher myopia prevalence among school-aged girls in South Africa,[23] urban India (where girls were actually more hyperopic),[24] Chile,[25] or Nepal (again, with a tendency toward more hyperopia in girls).[26] Given these variable results, it may be that the sex distribution of myopia among school-aged children in different societies reflects a complex of behavioral and biological factors. However, the tendency toward higher myopia prevalence among girls in China appears to be consistent across studies involving rural and urban populations.[7,18]

The limitations of the X-PRES study must be acknowledged. Although we were able to examine a large proportion of the children of consenting parents (1892/1945 = 97%), consent could not be obtained for 290 potential subjects. We were not able to obtain demographic information on these children without parental consent; though approximately 85% of subjects in our sample were examined, we cannot exclude the possibility that those children for whom we could not obtain parental consent differed in important ways from examined children.

Although our results are in many ways similar to those from another published study of myopia prevalence among school-aged children in rural China,[7] application of our results to the population of rural China as a whole may only be made out with caution. Our sample was school based, rather than population based. There is some evidence to suggest that children engaged in larger amounts of near work may be at greater risk for myopia.[27] If so, our sample may overrepresent the prevalence of myopia in the population as a whole. However, school attendance is compulsory for children in the age range included in our study, and secondary school enrollment rates of greater than 91% have been reported for nearby areas of rural Guangdong.[28] Thus, our sample is likely to be fairly representative of the population as a whole.

Finally, estimates of myopia prevalence at the < -0.5-D level for this population depended on projections among children with vision >6/12 in both eyes based on 248 children with normal vision (a 25% random sample) who underwent refraction. The confidence interval around this statistic is thus wider than it would otherwise be if all subjects had been refracted.

Nonetheless, the X-PRES study is the first of which we are aware to report the population impact of refractive error on self-reported visual function among school-aged children. This study documents significant visual disability associated with refractive error in this rural Chinese population, a result with potential significance for vision program planners because of the very large number of children affected. Subsequent reports from X-PRES will discuss determinants of spectacle wear in this population and will outline and describe the impact of interventions to increase uptake of refractive services.

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