Spectacle Acceptance among Secondary School Students in Rural China: The Xichang Pediatric Refractive Error Study (X-PRES)—Report 5

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Purpose. To assess determinants of spectacle acceptance and use among rural Chinese children.

Methods. Children with uncorrected acuity ≤ 6/12 in either eye and whose presenting vision could be improved ≥2 lines with refraction were identified from a school-based sample of 1892 students. Information on obtaining glasses and the benefits of spectacles was provided to children, families, and teachers. Purchase of new spectacles and reasons for nonpurchase were assessed by direct inspection and interview 3 months later.

Results. Among 674 (35.6%) children requiring spectacles (mean age, 14.7 ± 0.8 years), 597 (88.6%) were followed up. Among 339 children with no glasses at baseline, 30.7% purchased spectacles, whereas 43.2% of 258 children with inaccurate glasses replaced them. Most (70%) subjects paid US$13 to $26. Among children with bilateral vision ≤ 6/18, 45.6% bought glasses. In multivariate models, presenting vision < 6/12 ($P < 0.009$), refractive error < −2.0 D ($P < 0.001$), and amount willing to pay for glasses ($P = 0.01$) were predictors of purchase. Reasons for nonpurchase included satisfaction with current vision (78% of those with glasses at baseline, 49% of those without), concerns over price or parental refusal (18%), and fear glasses would weaken the eyes (13%). Only 26% of children stated that they usually wore their new glasses.

Conclusions. Many families in rural China will pay for glasses, though spectacle acceptance was <50%, even among children with poor vision. Acceptance could be improved by price reduction, education showing that glasses will not harm the eyes, and parent-focused interventions. (*Invest Ophthalmol Vis Sci.* 2008;49:2895–2902) DOI:10.1167/iovs.07-1531

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Uncorrected refractive error is the leading cause of visual disability among school-aged children of European,[1,2] South Asian,[3] and East Asian[4,5] descent. The proportion of children who could benefit from spectacle correction and do not yet own or wear glasses has been found to be high in many settings: on the order of 60% in rural China[5,6] and 50% in suburban Chile,[1] with a similar percentage among Native Americans in the western United States.[7] The high prevalence of uncorrected refractive error is of particular concern given recent evidence that provision of spectacles improves vision-related quality of life in adults[8] and self-reported visual function (VF) among children.[9]

Despite the importance of uncorrected refractive error as a cause of visual disability in children, little published research has focused on barriers and strategies to improve spectacle acceptance in this age group. It has been shown that spectacle retention among school-aged children at the time of unannounced follow-up visits several months after the provision of free glasses may be as low as one in seven,[10] but few if any studies have examined how to improve this percentage.

Attitudes and behavior of adults with regard to spectacle acceptance have been somewhat better characterized. Among persons who have undergone cataract surgery in rural China, only approximately one third of subjects whose vision could be improved by two or more lines would accept prescriptions, although use of reading glasses was not uncommon in this population.[11] Some 96% of persons older than 40 years with refractive error in Timor-Leste would be willing to accept spectacles, and more than 50% would pay US$1 for them.[12]

The problem of uncorrected refractive error appears to be particularly severe in rural China, where 40% to 60% of secondary school children are myopic,[5,13] but nearly two thirds are without the necessary spectacles to improve vision.[5,6] We examined the results of an intervention to promote the use of spectacles among secondary school children in rural China, performed in conjunction with the Xichang Pediatric Refractive Error Study (X-PRES). X-PRES is a school-based evaluation of the prevalence of refractive error, patterns of spectacle wear, self-reported VF, attitudes toward and acceptance of refractive services, and factors determining refractive error and glasses wear among 1900 children in junior high school years 1 and 2 (ages, 13–17 years) in rural Guangdong Province. The current report describes:

1. Whether, where, and for what amount recommended new spectacles had been purchased at the time of the 3-month follow-up by children whose vision was ≤6/12 in either eye and could be improved ≥2 lines with refraction.
2. The demographic and clinical factors determining the purchase and wear of new spectacles among children needing them.

3. The barriers to purchasing glasses and strategies for improving spectacle acceptance and use in this highly affected population.

Materials and Methods

The methods of the X-PRES study have been presented elsewhere in detail[13] and are summarized for reference. Xichang is a rural town with a population of 109,673 in 2002,[14] located within 2 hours of the town of Shantou in eastern Guangdong Province. Eye services are provided through a facility run cooperatively by the local government 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.

A school-based survey was administered from April to June 2007 on a cluster-based random sample of children in junior middle school years 1 and 2 at all three middle schools in Xichang. The sample is likely to be representative of the population in this age range, because there is compulsory education in China through the age of 16 years. The purpose of the survey was to determine the prevalence and predictors of visual disability, refractive error, and spectacle wear among Chinese rural-dwelling children, while also assessing the effectiveness of a multipart educational intervention to encourage the purchase of spectacles among children found to need them. The protocol was approved by the Ethics Committee at the Joint Shantou International Eye Center in Shantou, parent hospital for the Xichang Eye Clinic. Informed consent was obtained from the parents of all participating children, and the Declaration of Helsinki was adhered to throughout.

Participants

Classes of approximately 60 children each were chosen at random from class lists for junior high school years 1 and 2 provided by the three secondary schools in Xichang Town, with 35 classes being chosen, for a target sample size of 2100. Parents of all children in the selected classes were sent invitation letters explaining the purpose and methods of the study and asked to return a form indicating whether they were willing for their child to participate in the study.

Assessment of Vision

Uncorrected visual acuity and visual acuity when wearing habitual refraction, if available, were measured in well-lighted areas during daylight hours, at a 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 another day. Identical illuminated Early Treatment of Diabetic Retinopathy Study (ETDRS)[15] tumbling-E vision charts (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 subject failed to read a letter, testing began 2 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., 3/5) to pass successfully to the next line.

Basic Questionnaire

Data presented in this report were collected exclusively from children selected for participation. All 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 sought to determine age, sex, parental education, history of glasses wear, and reasons for not wearing glasses.

The questionnaire included a Chinese translation of an instrument developed originally by Fletcher et al.,[16] to assess self-reported VF in rural Asia. All questions were administered in Mandarin or the local dialect (Chaoshanhua/Teochew) by one of six native speakers after a period of training and standardization. This instrument is described elsewhere in detail.[16] It 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 and has been validated for use in Chinese.[17,18]

Detailed Examination

All subjects with uncorrected vision of ≤6/12 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: cyclopentolate 1% and tropicamide 1%, one drop of each every 5 minutes for a total of 3 drops of each medication; autorefraction (Canon RK-F1 Refractometer/Keratometer; Canon, Inc., Tochigi, Japan), with refinement by an ophthalmologist in each eye; and slit lamp (model YZ5F1; Suzhou Liuliu, Suzhou, China) examination of the anterior and posterior segment by an ophthalmologist.

Referral for Spectacles and Intervention Promoting Spectacles

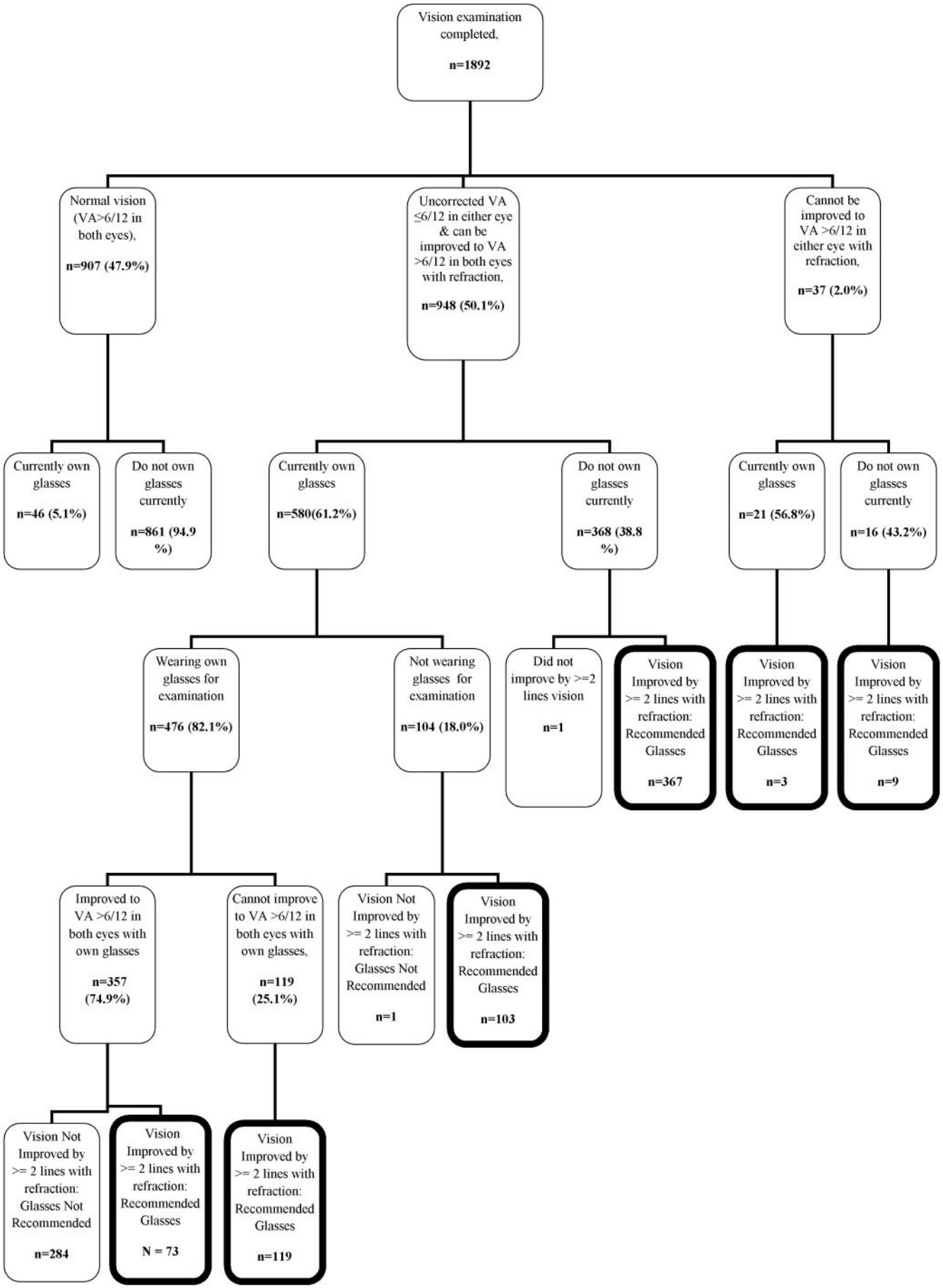
Recommendation was made for new spectacles for the following children: all subjects with presenting VA ≤ 6/12 in either eye (e.g., with or without spectacles) and whose vision could be improved by two or more lines in either eye with refraction by an ophthalmologist; and children with spectacles improving vision to >6/12, but whose vision could be improved by ≥2 lines with refraction. For example, a subject with presenting vision of 6/9 in both eyes with currently worn spectacles, but whose vision could be improved with refraction by 2 lines in each eye to 6/6, would have been referred.

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 terms of classroom performance. These children also were given a slideshow in Mandarin describing myopia, reviewing the high prevalence of uncorrected refractive error in the area, and describing the benefit of spectacles.

Follow-up Visit and Assessment of Spectacle Acquisition

Review of records from the Xichang Eye Clinic indicated that children most frequently presented for refraction during the summer holidays. The interventions were thus administered in June 2007, just before the end of school. A return visit to the school was carried out in September 2007, roughly a month after the close of vacation, and 597 (88.6%) of the 674 students for whom spectacles had been recommended were located and administered a questionnaire to ascertain whether spectacles had been purchased, where and for what amount, whether they were currently being worn, and the reasons for nonpurchase or nonwear among those without glasses. Visual acuity was also remeasured and the VF instrument administered as at baseline (Fig. 1). Children who indicated that they had purchased new spectacles and could produce them at school at the time of scheduled examination or at a

Figure 1. Flowchart depicting enrollment of children in the Xichang Pediatric Refractive Error Study (X-PRES) and indicating children in whom new spectacles were recommended (*boxes with bold outline*).



later time were considered to have provided adequate evidence of spectacle acceptance.

Statistical Methods

Raw data were presented as the mean (SD) or frequency (%), as appropriate. Visual acuity was expressed as the minimum angle of resolution (MAR, that is, as the decimal equivalent of the Snellen fraction). Average uncorrected and presenting vision of the two eyes was minus log transformed to correct its skewness before entering the data into statistical analyses, although the untransformed value is retained in tables for clarity's sake. Amount willing to pay for glasses and mean home floor space per household resident were also log transformed during statistical analyses, although the nontransformed data are presented in the tables. All univariate comparisons were made using *t*-test, Pearson χ^2 test, or the Fisher exact test, as appropriate. Logistic regression was used to assess potential factors associated with purchasing new glasses among those school children advised to buy spectacles. All statistical analyses took account of the cluster design effect and were performed with commercial software (SPSS 14.0; SPSS Inc., Chicago, IL). All tests were two-sided and $P < 0.05$ was considered statistically significant.

Results

Among the 2235 children in the sample, 2197 (98.2%) returned the forms, permission to participate was granted for 1945 children (88.5% of returned forms, 87.0% of the sample), and 1892 of these (97.3% of consenting children, 84.7% of the sample) were examined (Fig. 1).

Among the 1892 children participating in the study, 674 (35.6%) were advised to purchase new spectacles (Fig. 1). These children had significantly worse presenting vision, self-reported VF, and refractive error than did the group of participants as a whole, and 88.0% ($n = 593$) of them indicated a willingness to pay something for new spectacles at baseline (Table 1).

At the time of follow-up examination 3 months later, 597 (88.6%) of children advised to purchase spectacles were contacted, interviewed, and examined. Among these children, 339 (56.8%) had no glasses at baseline and 258 (43.2%) had glasses that failed to provide adequate correction (Fig. 2). Among those without glasses at baseline, 104 (30.7%) had purchased spectacles at the time of follow-up, whereas106 (41.1%) of those with glasses at baseline had purchased new ones. Thus, in total, 210 (35.2%) of children advised to purchase glasses had obtained them on follow-up (Fig. 2).

Baseline presenting vision, self-reported VF, and myopic refractive error were all worse among children with glasses at baseline (compared with those without) and among children who had obtained the recommended glasses (compared with those who had not; Table 2). In multivariate logistic regression models, presenting vision < 6/12 (OR 1.72, $P < 0.009$), refractive error < −2.0 D (OR 2.19, $P < 0.001$), and amount willing to pay for glasses at baseline ($P = 0.01$) were all independent predictors of the purchase

Table 1. Demographic, Visual, and Refractive Information for the Study Subjects

Characteristic	Glasses Not Recommended ($n = 1218$)				Glasses Recommended ($n = 674$)				Comparison of Groups
	All ($n = 1218$)	Boys ($n = 640$)	Girls ($n = 578$)	P*	All ($n = 674$)	Boys ($n = 283$)	Girls ($n = 391$)	P*	P†
Age (y)‡	14.7 (0.8)	14.7 (0.8)	14.6 (0.8)	0.114	14.7 (0.8)	14.7 (0.8)	14.7 (0.8)	0.386	0.712
Wearing glasses at baseline	305 (25.0)	116 (18.1)	189 (32.7)	<0.001	195 (28.9)	60 (21.2)	135 (34.5)	<0.001	0.066
Parents' highest education									
Primary or below	256 (21.0)	128 (20.0)	128 (22.1)	0.201	157 (23.3)	65 (23.0)	92 (23.5)	0.211	0.720
Junior high school	571 (46.9)	315 (49.2)	256 (44.3)		309 (45.8)	121 (42.8)	188 (48.1)		
High school	376 (30.9)	187 (29.2)	189 (32.7)		200 (29.7)	95 (33.6)	105 (26.9)		
College or above	15 (1.2)	10 (1.6)	5 (0.9)		8 (1.2)	2 (0.7)	6 (1.5)		
SE < −2.0 D in both eyes	218 (17.9)	90 (14.1)	128 (22.2)	<0.001	370 (54.9)	149 (52.7)	221 (56.5)	0.319	<0.001
Baseline uncorrected vision‡§‖	0.99 (0.54)	1.09 (0.54)	0.87 (0.52)	<0.001	0.38 (0.19)	0.38 (0.18)	0.38 (0.20)	0.297	<0.001
Baseline presenting vision‡§‖	1.16 (0.38)	1.22 (0.41)	1.09 (0.33)	<0.001	0.49 (0.18)	0.47 (0.18)	0.51 (0.19)	0.019	<0.001
Baseline VF score‡	79.3 (15.8)	81.1 (15.1)	77.4 (16.3)	<0.001	69.5 (15.3)	68.9 (14.6)	69.9 (15.8)	0.402	<0.001
Postintervention presenting vision‡§‖¶	—	—	—	—	0.94 (0.17)	0.92 (0.17)	0.95 (0.18)	0.552	—
Postintervention VF score‡#	—	—	—	—	71.5 (14.8)	69.9 (15.2)	72.6 (14.4)	0.033	—
Willing to pay anything for glasses	1019 (83.7)	528 (82.5)	491 (84.9)	0.249	593 (88.0)	243 (85.9)	350 (89.5)	0.151	0.011

Data are for 1892 rural Chinese secondary school children from a school-based sample, 1218 of whom were not advised to purchase glasses and 674 who were (due to vision improvement of ≥2 lines with refraction in at least one eye). SE, spherical equivalent.

* Boys versus girls.

† Those for whom glasses were recommended versus those for whom they were not.

‡ Data are expressed as the mean (SD); the remaining data are count (%).

§ Mean of the two eyes.

‖ Vision is reported as the MAR (that is, the decimal equivalent of the Snellen fraction). The log-transformed value (logMAR) is used for all statistical analyses, but the untransformed value is presented here for clarity.

¶ Postintervention visual acuity was measured only in those who bought new glasses.

Postintervention VF score was available only for those who completed the follow-up form ($n = 597$).

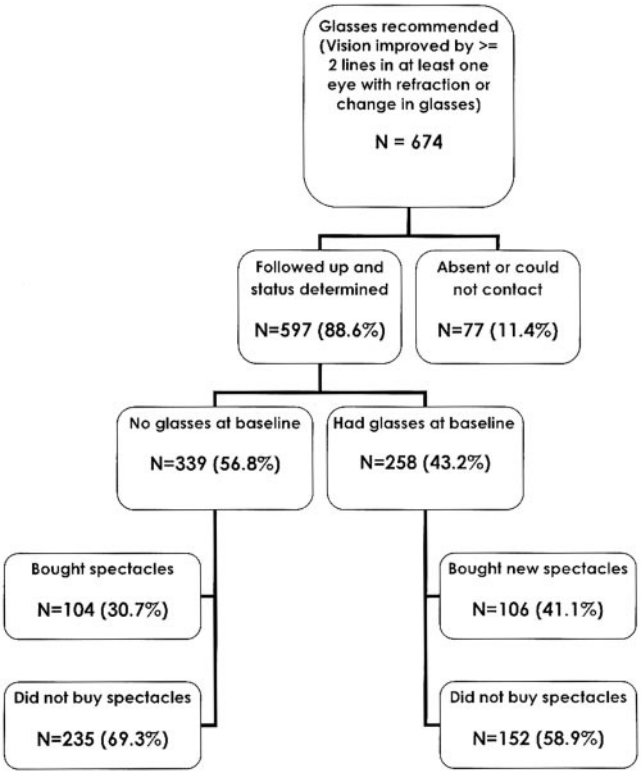


FIGURE 2. Flowchart depicting the spectacle-purchasing behavior of 674 rural Chinese secondary school children who are advised to buy spectacles in the Xichang Pediatric Refractive Error Study (X-PRES).

of new glasses, although sex, parental education, and house size as an index of socioeconomic status were not significant (Table 3).

Although purchase of spectacles was strongly associated with baseline vision in this population, the distribution of presenting acuities among those not having obtained glasses (Fig. 3) revealed that substantial visual deficits existed among many children who failed to buy glasses. Among 114 children with vision ≤ 6/18 in both eyes, 52 (45.6%) obtained glasses.

Only 21% (n = 44) of children purchasing new glasses obtained them from the Xichang eye clinic recommended in project promotion materials, whereas 50% (n = 105) reported buying them at other optical shops in the Xichang and 15.2% (n = 32) outside of Xichang. Nearly half of the subjects had indicated at baseline that they would pay <100 renminbi (RMB; Chinese currency amounting to ~US$13 at the time of the study) for glasses, but in fact only 16.3% of those buying glasses reported paying this little, with the majority (n = 134; 70.2%) paying between 100 and 200 RMB (US$13–$26).

The reasons for not having purchased glasses varied with the child's glasses-wearing status at baseline. Among children who already owned glasses, a large majority (n = 109; 77.9%) indicated that they were satisfied with their current spectacles, and a smaller proportion (n = 16; 11.4%) reported that price was an obstacle (Table 4). Among children without glasses at baseline, close to half (n = 110; 48.7%) responded that they did not need glasses, and concerns over expense (n = 40; 17.6%) and harmful effects of glasses on vision (n = 29; 12.8%) played a somewhat larger role than it did among children owning glasses at baseline (Table 4). Even among children with presenting vision ≤ 6/18 in both eyes, 50% (31/62) of those not purchasing glasses indicated "glasses not needed" as the reason.

At the time of the previously announced follow-up examination, 36.1% (76/210) of children who had bought new glasses were not wearing them. When asked about their usual pattern of wear, only 26.1% (55/210) reported that they usually wore their glasses. Such children were more likely to wear glasses at baseline; had worse baseline presenting vision, self-reported VF, and myopic refractive error; and were willing to pay more for spectacles than children who sometimes or seldom wore their new glasses (Table 5).

TABLE 2. Status at Follow-up among 597 Chinese Rural Secondary School Children Advised to Purchase Glasses

Characteristic	No Glasses at Baseline But Bought New Ones (n = 104)	Had Glasses at Baseline and Bought New Ones (n = 106)	No Glasses Still (n = 235)	Old Glasses Still (n = 152)	P
Age (y)*	14.5 (0.7)	14.7 (0.9)	14.7 (0.8)	14.7 (0.8)	0.419
Female	63 (60.6%)	61 (57.5%)	128 (54.5%)	90 (59.2%)	0.692
Wearing glasses at baseline	0	75 (70.8%)	0	98 (64.5%)	<0.001
Parents' highest education					
Primary or below	22 (21.2%)	25 (23.6%)	56 (23.8%)	35 (23.0%)	0.098
Junior high school	61 (58.7%)	50 (47.2%)	106 (45.1%)	61 (40.1%)	
High school	21 (20.2%)	31 (29.2%)	70 (29.8%)	52 (34.2%)	
College or above	0	0	3 (1.3%)	4 (2.6%)	
Spherical equivalent < −2.0 D in both eyes at baseline	50 (48.1%)	93 (87.7%)	69 (29.4%)	117 (77.0%)	<0.001
Baseline presenting vision*†‡	0.41 (0.16)	0.49 (0.20)	0.50 (0.19)	0.54 (0.17)	<0.001
Postintervention presenting vision‡	0.97 (0.17)	0.92 (0.17)	—	—	—
Baseline VF score	72.5 (12.8)	61.0 (15.3)	76.4 (13.0)	63.3 (14.8)	<0.001
Postintervention VF score	71.7 (15.1)	66.3 (13.0)	76.7 (13.4)	66.7 (15.0)	<0.001
Amount willing to pay for new glasses at baseline (RMB)	100 (50–150)	120 (100–200)	100 (20–150)	120 (80–200)	<0.001
Home floor space per resident (square meters)	12.0 (7.5–20.0)	12.0 (7.5–20.0)	13.3 (9.6–20.0)	15.0 (10.0–21.4)	0.354

Children in whom vision could be improved ≥2 lines with refraction in at least one eye were advised to purchase spectacles.

* Data expressed as the mean (SD); remaining data are count (%).

† Mean results in the two eyes.

‡ Vision is reported as the MAR (that, is the decimal equivalent of the Snellen fraction). The log-transformed value (logMAR) is used for all statistical analyses, but the untransformed value is presented for clarity.

TABLE 3. Logistic Regression Model for Potential Predictors of Purchasing New Glasses among 597 Rural Chinese Secondary School Children Advised to Buy Spectacles

Potential Predictors	Bought New Glasses		Univariate Analysis		Multivariate Analysis	
	No (n = 387)	Yes (n = 210)	OR	P	OR (95% CI)	P
Age (y)	14.7 (0.8)	14.6 (0.8)	0.94	0.586	NS	
Female	218 (56.3%)	124 (59.0%)	1.12	0.522	NS	
Wearing glasses at baseline	100 (25.8%)	75 (35.7%)	1.59	0.012	NS	
Parents' highest education						
Primary or below	91 (23.5%)	47 (22.4%)	1		NS	
Junior high school	167 (43.2%)	111 (52.9%)	1.29	0.246	NS	
High school or above	129 (33.3%)	52 (24.8%)	0.78	0.309	NS	
Spherical equivalent < -2.0 D in both eyes at baseline	186 (48.1%)	143 (68.1%)	2.31	<0.001	2.19 (1.45–3.30)	<0.001
Baseline presenting vision <6/12*	236 (61.0%)	97 (46.2%)	0.55	0.001	1.72 (1.15–2.56)	0.009
Baseline VF score	71.2 (15.2)	66.6 (15.2)	0.98	0.001	NS	
Amount willing to pay for glasses (RMB)†‡	100 (50–150)	110 (70–180)	1.70	0.010	1.91 (1.17–3.12)	0.010
Home floor space per resident (square meters)†	13.7 (9.9–20.0)	12.0 (7.5–20.0)	0.82	0.205	NS	

Children in whom vision could be improved ≥2 lines with refraction in at least one eye were advised to purchase spectacles. NS, not significant in multivariate logistic regression when the step-wise entering method is used.

* Mean of the two eyes.

† Natural log-transformed when calculating the odds ratio.

‡ Odds ratio indicates those willing to pay ≥100 RMB versus those willing to pay <100 RMB.

DISCUSSION

Few studies have reported on interventions to improve spectacle use among school-age children, an issue of particular importance in rural China, where the burden of refractive error is high,[5,13] but fewer than half of children needing glasses are wearing the appropriate correction.[5,6] Our results indicate that only about a third of children recommended to obtain spectacles on the basis of poor vision in at least one eye correctable with refraction actually obtain them over a 3-month period (Fig. 2), and only a quarter of those wear the glasses regularly (Table 5). Although children with worse vision and more myopic refractive error are significantly more likely to buy and wear glasses (Tables 3, 5), a significant proportion of children with low vision (more than half of those with presenting vision ≤ 6/18 in both eyes, for example) in our study remained without spectacles after intervention. Better strategies are needed to further improve spectacle acceptance.

Besides the visual factors described earlier, a child's self-reported estimate of the family's willingness to pay for glasses was a significant determinant of both spectacle purchase and wear, even though that few children reported financial barriers to the purchase of spectacles. Thus, willingness to pay for

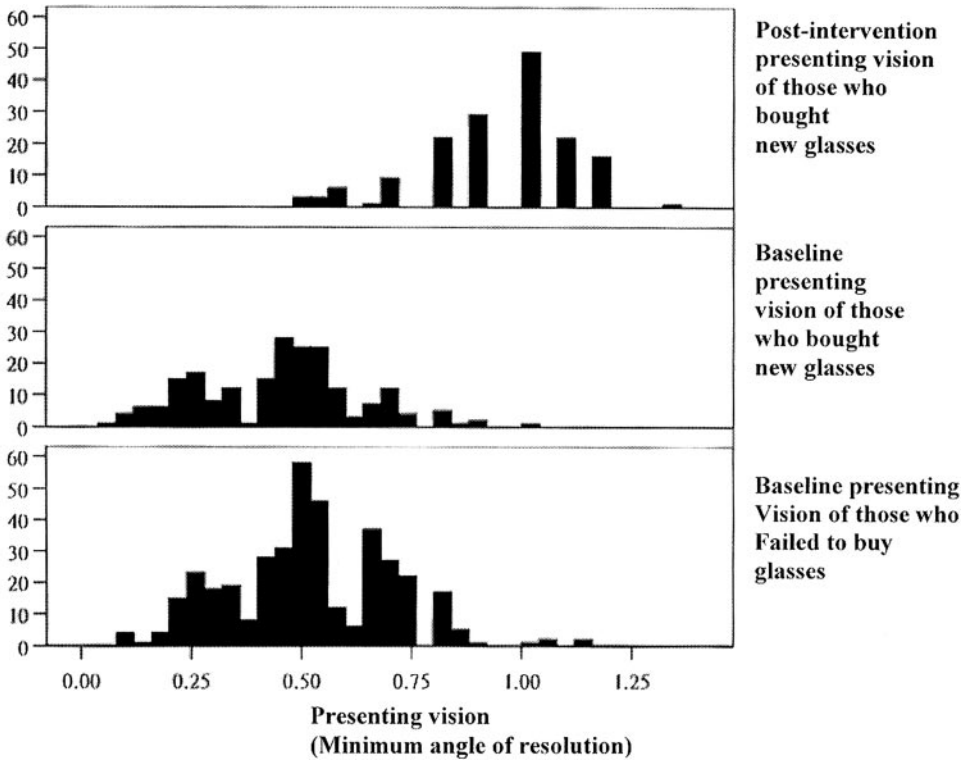


FIGURE 3. The distribution of presenting vision (mean between the two eyes, presented as the MAR—that is, the decimal equivalent of the Snellen fraction) among children purchasing (n = 210) and not purchasing (n = 387) the recommended glasses.

TABLE 4. Reasons for Not Having Bought New Glasses among Those Whose Glasses Provided Inadequate Correction at Baseline and Those Who Did Not Own Glasses at Baseline

Reasons	*n* (%)
Owned glasses that provided inadequate correction at baseline (*n* = 140)*	
Current glasses are good enough	109 (77.9)
Glasses too expensive	16 (11.4)
Have symptoms from current glasses	9 (6.4)
Worried about appearance, being teased	6 (4.3)
Did not own glasses at baseline, but were advised to purchase them (*n* = 226)†	
Do not need glasses	110 (48.7)
Glasses too expensive, parents unwilling to buy	40 (17.6)
Worried glasses will make eyes weak	29 (12.8)
Too inconvenient, do not know where to buy	16 (7.1)
Worried about headache or other symptoms	10 (4.4)
Afraid glasses quality would not be good	9 (4.0)
Worried about appearance, being teased	2 (0.9)
Other	10 (4.4)

* Could not improve both eyes to ≥6/12 with currently owned glasses. Data missing for 12 subjects.

† Uncorrected VA of ≤6/12 at baseline could be improved by ≥2 lines in either eye with refraction. Data missing for 9 subjects.

glasses may serve as an index of motivation for better vision and may be of interest to program planners, not only for setting prices. The fact that baseline glasses ownership was also significantly associated with wear of new spectacles further supports the idea of a cohort of children committed to spectacle wear across the spectrum of acuity and refractive error. Previous ownership of glasses was similarly strongly predictive of purchase of new spectacles among adults after cataract surgery in rural China.[11]

It is interesting that vision, but not self-reported VF, improved significantly among the 210 children who purchased new glasses (Tables 1, 2). This contradicts reports from rural Mexico that correction of even modest refractive errors can improve VF in school-aged children.[9] The reasons for failure of VF to improve in tandem with presenting vision in this setting are not clear, though the fact that only a minority of children were using the new glasses regularly is a potential explanation.

A principal focus of the X-PRES study has been to inform program strategies to improve use of refractive services among rural Chinese school children. The strongest message for program planners from the current investigation is that a large cohort of persons willing to pay for children's glasses exists in rural China and that economic barriers do not appear to be paramount even among families not purchasing spectacles. Naturally, these findings relate to Guangdong Province where the study was performed, and may be applied only with caution to poorer areas of western China. This finding is consistent, however, with reports of 50% of adults being willing to pay for presbyopic spectacles in other rural Asian settings.[12] An important corollary finding is that programs hoping to obtain significant cost recovery from the sale of spectacles need to be prepared to compete in cost and quality with other local providers, even in rural areas. Only about one fifth of families purchasing glasses in this study bought them from the facility where the X-PRES program was based and which was mentioned by name in program materials distributed to families.

Based on the findings of this study, improving spectacle acceptance among children with poor vision and no glasses at baseline should be a priority. Such children made up nearly 60% of the cohort needing glasses who were identified in our screening, and less than a third of them purchased recommended spectacles, a lower proportion than that of children who had glasses needing replacement. Specific strategies based on the barriers to spectacle acceptance identified in our survey would include:

1. Education to overcome the erroneous belief, common in this cohort, that wearing spectacles will make the eyes "weak." In fact, a comprehensive review of the literature on myopia prevention concluded that delay in spectacles provision and reduced spectacle wear time were not effective in retarding myopia's progression.[19]
2. More effective efforts to target parents with health messages emphasizing the importance of glasses. Several subjects indicated that their parents did not support the purchase of spectacles. A weakness of school-based interventions such as ours is difficulty in reaching out directly to families. In the future, we hope to combine the school-based approach with a potentially synergistic home outreach strategy, such as the door-to-door sale of presbyopic spectacles promulgated by Scojo Vision (Minneapolis, MN)[20] and similar organizations.
3. Cost was cited as an issue by some children, particularly among those without spectacles at baseline. The cost of spectacles can be reduced through strategies such as

TABLE 5. Self-Reported Wear among 210 Rural Chinese Secondary School Children Who Bought New Glasses

	Usually (*n* = 55)	Sometimes (*n* = 132)	Seldom (*n* = 23)	*P*
Age (y)*	14.4 (0.8)	14.7 (0.8)	14.6 (0.7)	0.115
Wearing glasses at baseline	33 (60.0)	37 (28.0)	5 (21.7)	<0.001
Parents' highest education				
Primary or below	12 (21.8)	29 (22.0)	6 (26.1)	0.399
Junior high school	30 (54.5)	66 (50.0)	15 (65.2)	
High school	13 (23.6)	37 (28.0)	2 (8.7)	
College or above	0	0	0	
Spherical equivalent <−2.0 D in both eyes	48 (87.3)	82 (62.1)	13 (56.5)	0.002
Baseline uncorrected vision*†‡	0.22 (0.13)	0.34 (0.16)	0.37 (0.15)	<0.001
Baseline VF score	62.2 (14.3)	68.8 (15.0)	64.9 (16.4)	0.021
Mean postintervention presenting vision‡	0.90 (0.18)	0.95 (0.17)	0.96 (0.15)	0.216
Postintervention VF score	65.0 (14.3)	71.6 (12.8)	63.8 (19.0)	0.003
Amount willing to pay for glasses at baseline (RMB)	120 (100–200)	105 (70–158)	80 (50–120)	0.005

* Data expressed as the mean (SD); remaining data are count (%).

† Mean results in the two eyes.

‡ Vision is reported as the MAR (that, is the decimal equivalent of the Snellen fraction). The log-transformed value (logMAR) is used for all statistical analyses, but the untransformed value is presented for clarity.

bulk purchasing through consortia similar to those organized by ICEE (International Center for Eyecare Education) in Australia and South Africa.[21]

It can be argued that provision of free spectacles would further improve acceptance. Such strategies are in widespread use[10,22] and are appropriate in some settings. However, such strategies do not provide for long-term sustainability through cost recovery. Moreover, provision of free spectacles may be associated with relatively low (<20%) rates of subsequent spectacle compliance.[10]

Alternatively, results from this and other[10] program-based studies suggest that more stringent visual criteria for providing or recommending glasses may be associated with higher rates of spectacle utilization. However, recent work suggests that correction of even modest amounts of myopia (−1 D) and vision loss (6/9) is associated with significant improvements in vision[22] and VF,[9] respectively. As with many healthcare interventions, the crux of managing the myopia problem in rural China appears to be creating demand for a service that is of objective benefit but for which a limited perceived need may exist.

The results of the X-PRES study must be understood in the context of its limitations. Foremost among these is that this was an uncontrolled intervention. Thus, although we are able to draw conclusions about factors associated with spectacle acceptance and to elucidate barriers to their purchase and wear, we could not conclude with certainty that any of the families purchasing spectacles in this setting did so as a result of program interventions. A randomized trial is currently under way in this setting to address this shortcoming.

Second, we cannot be sure that the children enrolled in X-PRES are broadly representative of rural China. A high (85%) enrollment rate was achieved in a random sample of children drawn from all the secondary schools in Xichang. The fact that compulsory education with high reported enrollment[23] exists in the area means that the sample is more likely to be representative of the population, but the degree to which Xichang is representative of other rural areas in China cannot be known. Though Xichang is in Chaoshan, a relatively poor region of Guangdong, Guangdong itself is among the richest provinces in China.

Finally, the school-based design of our study meant that data on such key factors as family willingness to pay for spectacles, parental education, and total floor space in the home were based entirely on the responses of children aged 13 to 17 years. Such data may be of questionable validity, particularly with regard to children's assessment of parental willingness to purchase spectacles.

Nonetheless, X-PRES is the first study of which we are aware that obtained prospective data on the acceptance of recommended spectacles in a large cohort of children with visual impairment due to refractive error in rural China. These results are of potential relevance to the growing number of school refractive programs in this large population, with one of the world's highest levels of uncorrected refractive error.

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