Correction of Moderate Myopia Is Associated with Improvement in Self-Reported Visual Functioning among Mexican School-Aged Children

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Purpose. To quantify the impact on self-reported visual functioning of spectacle provision for school-aged children in Oaxaca, Mexico.

Methods. The Refractive Status Vision Profile (RSVP), a previously validated tool to measure the impact of refractive correction on visual functioning, was adapted for use in rural children and administered at baseline and 4 weeks (27.3 ± 4.4 days) after the provision of free spectacles. Visual acuity with and without correction, age, sex, and spherical equivalent refraction were recorded at the time of follow-up.

Results. Among 88 children (mean age, 12 years; 55.7% girls), the median presenting acuity (uncorrected or with original spectacles), tested 4 weeks after the provision of free spectacles, was 6/9 (range, 6/6–6/120). Significant improvements in the following subscales of the RSVP were seen for the group as a whole after the provision of free spectacles: function, 11.2 points ($P = 0.0001$); symptoms, 14.3 points ($P < 0.0001$); total score, 10.3 points ($P = 0.0001$). After stratification by presenting vision in the better-seeing eye, children with 6/6 acuity ($n = 22$) did not have significant improvement in any subscale; those with acuity of 6/7.5 to 6/9 ($n = 34$) improved only on function ($P = 0.02$), symptoms ($P = 0.005$), and total score ($P = 0.003$); and those with acuity of 6/12 or worse improved on total score ($P < 0.0001$) and all subscales. Subjects ($n = 31$) with uncorrected myopia of −1.25 D or more had a mean improvement in total score of 15.9 points ($P < 0.0001$), whereas those with uncorrected myopia between −0.50 and −1.00 D inclusive ($n = 53$) had a mean improvement of 8 points ($P = 0.01$).

Conclusions. Provision of spectacles to children in this setting had a significant impact on self-reported function, even at modest levels of baseline visual disability. The correlation between presenting vision/refraction and improvement and the failure of children 6/6 at baseline to improve offer evidence for a real effect. (*Invest Ophthalmol Vis Sci.* 2007;48:4949–4954) DOI:10.1167/iovs.07-0052

Refractive error is the leading cause of visual impairment among school-aged children of European,[1] Hispanic,[2] and Asian[3,4] descent. Even in developed countries,[5] approximately 25% of refractive error goes uncorrected, whereas in the developing world, 69%[2] to 93%[4] of refractive error may be untreated. Partly as a result of an improved understanding of the importance of refractive error as a cause of visual disability in children, school-based refractive error programs are becoming more common. Recent research in the context of such programs has attempted to elucidate factors determining compliance with refractive correction[6] and to validate refractive cutoffs for the provision of spectacles.[7]

However, one of the most important aspects of refractive correction, its impact on visual functioning, surprisingly remains little studied. Several instruments have been developed to measure visual functioning[8,9] and quality of life[10,11] in the context of refractive error. However, these instruments have largely been used in demonstrating the impact of refractive surgery[12,13] or contact lens wear[14] on quality of life and visual functioning. The effect on visual functioning of refractive correction with spectacles has received comparatively little attention, particularly in the developing world, where access to glasses often remains poor and where scarce resources make the question of program impact highly relevant. The paucity of data in this area is further complicated by the comparative lack of quality of life and visual functioning instruments appropriate for use in children.[15]

Studies of refractive interventions have also tended to contrast one modality against another[16] without directly assessing whether an intervention, such as refractive correction, has an impact on visual functioning and, if so, at what level of presenting acuity. The comparative rarity of such data may in large part be attributed to the difficulty of implementing a control group in refractive studies and the possibility of a substantial placebo effect when subjects are asked to rate the impact of spectacle provision on visual functioning.

We sought to assess the impact of spectacle provision on self-reported visual functioning in the context of a school-based refractive error program carried out in collaboration between Helen Keller International (HKI) and Ver Bien Para Aprender Mejor in Oaxaca, Mexico. The program protocol calling for follow-up to determine spectacle compliance allowed us to measure visual functioning with a previously validated instrument[8] before and 4 weeks after the provision of spectacles. The existence of a substantial minority of children receiving glasses with little or no apparent deficit in presenting vision had the unexpected result of providing a control group in assessing the effect of refractive correction on self-reported visual functioning in this group of school-aged children.

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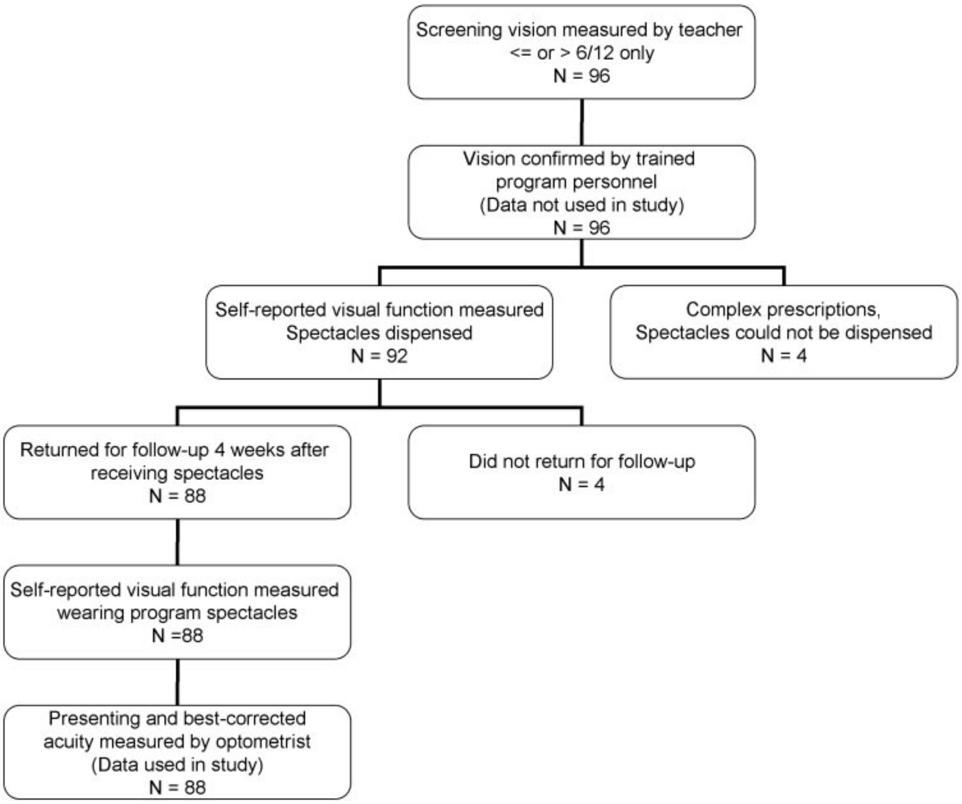

FIGURE 1. Flow chart showing measurement of vision, dispensing of spectacles, and assessment of self-reported visual function among children receiving free spectacles in a program in Oaxaca, Mexico.

MATERIALS AND METHODS

The state of Oaxaca is located on the southern Atlantic coast of Mexico. Its population is 3.4 million, and approximately 800,000 students are enrolled in 7860 primary and secondary schools. Oaxaca, with its 17 ethnic groups, is the most ethnically diverse state in Mexico.

Subjects

Ver Bien Para Aprender Mejor (See Better to Learn Better), an educational organization in Mexico affiliated with the government, has collaborated since September 2001 with HKI in providing eyeglasses and comprehensive vision care for school children in Oaxaca. Subjects in the present study were all primary and secondary school students receiving vision screening and glasses between June and August 2005 through the Ver Bien/HKI program.

Examination

The purpose and methods of the study, including the follow-up visit, were explained, and community consent was obtained from parents during meetings held in each village before data collection. This method of obtaining consent and all study procedures were approved by the Institutional Review Board of the Johns Hopkins University School of Medicine and the Oaxaca State Government. The study was carried out in compliance with the tenets of the Declaration of Helsinki.

Visual acuity with children wearing habitual refraction, if available (only two children wore spectacles), was measured in well-lit areas during daylight hours, at a distance of 6 m, separately for each eye of each child. A vision chart (Grafco Snellen Plastic chart; MedexSupply, Monsey, NY) with Snellen letters on a matte finish was used for all testing. The nontested eye was covered by the subject using a hand-held 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, starting at 6/120. If a letter was failed, testing began two lines above, and the child was asked to read all optotypes on the line sequentially. The child had to identify correctly more than half the letters on a given line (e.g., three out of five, four out of six) to be considered to have achieved that level of acuity.

Acuity was initially assessed by teachers after a half-day of training by program personnel and was recorded only as more than 6/12 or as 6/12 or worse. Children with acuity measuring 6/12 or worse in either eye were referred for further examination and refraction by a Ver Bien/HKI team consisting of an optometrist with extensive pediatric experience and a nonoptometric support staff. Acuity was first confirmed as 6/12 or worse by HKI/Ver Bien support staff, who had received 1 week of standardized training in acuity measurement (Fig. 1). The optometrist then performed noncycloplegic retinoscopy, with subjective refinement, separately in each eye for all referred children and prescribed spectacles to children with myopia more severe than −0.75 D, hyperopia greater than 0.50 D, and astigmatism greater than 0.5 D. The support staff assembled and dispensed round "Harry Potter" glasses (to permit on-the-spot adjustment of the axis of astigmatism) to children requiring them and assisted in recording demographic information, spectacle power, and acuity with and without correction for each child. Consecutive children between the ages of 9 and 15 years provided spectacles by the Ver Bien/HKI program were selected for the study.

Measure of Self-Reported Visual Functioning

The Refraction Status Vision Profile (RSVP)[8] was designed specifically to measure the impact of refractive error and its correction on visual functioning, as opposed to other instruments better suited to assess visual functioning changes associated with more severe central vision loss.[17] The instrument has been translated into and validated in Spanish by the MAPI Formulaire Institute and has undergone two forward translations and one backward translation.

The RSVP is described in detail elsewhere.[8,9] It consists of four subscales—perception, satisfaction, function, and symptoms—and is scored on the basis of subject responses to 42 questions. Each question has five possible responses, which are scored from 1 to 5, with 5 indicating the most frequent or severe trouble. Thus, higher scores indicate worse visual functioning on each subscale and on the total score. The mean score for each subscale is rescaled from 0 to 100,[8,9] and total score is calculated as the arithmetic mean of the four subscales. The odds of satisfaction have been reported for the RSVP total score as 0.48 for every 10-point increase,[8] indicating that a total score increase of 10 points is half as likely to reflect a satisfied patient.

In the absence of specific instruments to measure visual functioning in children within the range associated with modest refractive error, we modified the RSVP for use in this population. Specifically, we eliminated references to driving (RSVP questions 24 and 38) and contact lens wear (RSVP questions 4–7, 9, 13, 54, 55). When appropriate (RSVP questions 36 and 37) we replaced the word *driving* with the phrase *riding your bicycle*. Three questions were modified from *discomfort with contacts* to apply to *discomfort with spectacles*. A question regarding problems with spectacles breaking was also added because repair or replacement is often unavailable in the participating communities. Therefore, a total of 10 questions were eliminated; however, only the two questions regarding driving could be expected to have an effect on RSVP validity because any patient not wearing contacts would simply answer "not applicable" to contact lens questions in the original document. Thus, additional validation testing of the RSVP in this context was not performed as part of the present study.

Children were administered the RSVP orally by study personnel before receipt of program spectacles and thus responded on the basis of their presenting acuity, either without correction or with previous spectacles (only two children presented wearing spectacles). Children were unaware of the results of their testing and whether they would be receiving spectacles when they responded to the RSVP. Follow-up visits to reassess self-reported visual functioning on the RSVP were announced in advance and conducted approximately 4 weeks after the initial visit (mean, 27.3 ± 4.4 days; range, 20–34 days). Children responded to the RSVP again at follow-up based on their experience with their new spectacles in the period since they were dispensed (Fig. 1).

Follow-up Vision Testing

Visual acuity with the new spectacles and presenting vision (without spectacles or, in two children, wearing their former spectacles) were measured by program optometrists in each eye at 6 m and was recorded over the full range of Snellen values (that is, not simply as more than 6/12 or as 6/12 or worse, as in the first visit; Fig. 1). Presenting acuity was, in all cases, measured first. Staff members who measured visual acuity were unaware of children's responses on the RSVP, and interviewers administering the RSVP were unaware of subjects' visual acuity or refraction.

Statistical Analysis

The change in RSVP total score and the various subscale scores was calculated for the entire group of subjects and then stratified according to presenting visual acuity, as measured by the study optometrist at follow-up (e.g., reflecting habitually worn correction, if present) in the better-seeing eye. Spearman correlation coefficient was calculated for change in acuity and change in RSVP total score after the provision of spectacles. RSVP total score and subscale scores were also stratified by spherical equivalent of the program-provided spectacles in the presenting better-seeing eye, into the following groups: myopia (spherical equivalent −1.25 D or more severe), mild myopia (spherical equivalent between and including −0.50 D and −1.00 D), and all others. Bonferroni correction was used for multiple comparisons involving the total score and the four subscale scores of the RSVP. Thus, for these comparisons involving five possible values, the *P*-value for significance was $P \leq 0.05/5$ (0.01). All analyses of visual acuity results were based on the presenting and best-corrected acuities measured by optometrists at the follow-up examination.

Table 1. Presenting (Uncorrected or with Original Spectacles) and Best-Corrected Visual Acuity in the Better-Seeing Eye

Level of Acuity	Children with Presenting Acuity (*n*)	Children with Best-Corrected Acuity (*n*)
6/6	22	62
6/7.5	16	10
6/9	18	9
6/12	7	3
6/15	9	3
6/21	8	1
6/30	7	0
6/60	1	0
Total	88	88

Participants were 88 Mexican schoolchildren in a program to receive free eyeglasses. Presenting acuity and best-corrected acuity were measured 4 weeks after distribution of the spectacles.

The log of the minimum angle of resolution (logMAR) was used for all calculations involving vision. Mean values are given throughout the text as ±1 SD.

Results

Ninety-six subjects were enrolled in the study, with complete RSVP, visual acuity, and refractive data before and after the provision of program spectacles available for 88 (92%) of them. Four children required more complex spectacle prescriptions that could not be distributed at baseline, and four children were unavailable at the time of follow-up (Fig. 1). The mean age of participating children with complete data was 12 ± 1.9 years; 49 (55.7%) were girls. Median acuity, uncorrected or with original spectacles, measured at the time of the follow-up visit was 6/9 in the better-seeing eye (logMAR equivalent, 0.18; range, 6/6–6/120); 22 (25%) children had visual acuity of 6/6, 34 (39%) had visual acuity of 6/7.5 or 6/9, and 32 (36%) had presenting visual acuity of 6/12 or worse (Table 1).

Spherical equivalent refractive error of −1.25 D or worse in the better-seeing eye at presentation was present in the spectacles dispensed by the program in 31 (35%) children; 53 (60%) received spectacles between and including −0.50 D and −1.00 D in the better-seeing eye, and four (5%) children received other prescriptions. Mean spherical equivalent refraction in the better-seeing eye was −1.37 ± 1.34 D (range, −7.00 to +1.25 D).

Median best-corrected visual acuity in the better-seeing eye was 6/6; 62/88 (70.5%) of children achieved 6/6 best-corrected visual acuity in the better-seeing eye after refraction, and 72/88 (81.8%) had 6/7.5 or better best-corrected visual acuity (Table 1). Subjects with best-corrected vision 6/12 or worse in both eyes ($n = 7$) were referred for ophthalmic examination.

After stratification by presenting visual acuity in the better-seeing eye, children with the best (6/6) visual acuity had the best presenting RSVP total scores (26.3 ± 22), children with the worst presenting visual acuity (6/21 or worse) had the worst total scores (42.8 ± 19; $P < 0.0001$, *t*-test, compared with children with 6/6), and children with intermediate visual acuity had intermediate scores (Table 2).

The mean total score for all study participants improved (decreased) by 10.3 points (range, −61 to +29; $P = 0.0001$, paired *t*-test) after correction of refractive error. Significant improvement was also seen on the symptoms (14.3 points, $P < 0.0001$, paired *t*-test), function (11.2 points, $P = 0.0001$, paired *t*-test), and satisfaction (5.7 points, $P = 0.02$, paired *t*-test) subscale scores of study participants, though the latter was not significant with the Bonferroni correction.

Table 2. Score on the RSVP Total Score at Baseline and Follow-up (before and after Spectacles Were Dispensed)

Presenting Vision (Measured 4 wk after Provision of Glasses)	Children (n)	Mean Baseline RSVP (± SD)	Mean Follow-up RSVP	Difference	Difference between Baseline and Follow-up (t-test)
6/6	22	26.3 ± 22	20.7 ± 21	−5.6	0.3
6/7.5–6/9	34	36.0 ± 22	27.9 ± 23	−8.1	0.003
6/12–6/15	16	39.6 ± 21	23.3 ± 19	−16.3	0.001
6/21–6/60	16	42.8 ± 19	24.1 ± 22	−18.7	0.001
Total, mean	88	35.5 ± 22	25.2 ± 21	−10.3	0.001

Participants were 88 Mexican schoolchildren in a program to receive free eyeglasses. Presenting acuity and best-corrected acuity were measured 4 weeks after distribution of the spectacles.

Children with presenting visual acuity of 6/6 in the better-seeing eye did not have improved acuity on the total score ($P = 0.3$, paired t-test) or any of the subscale scores (satisfaction, $P = 0.97$; function, $P = 0.46$; perception, $P = 0.65$; symptoms, $P = 0.10$; paired t-test; Table 2; Fig. 2). Children with intermediate presenting visual acuity (6/7.5 and 6/9) improved on total score ($P = 0.003$, paired t-test), symptoms ($P = 0.0005$, paired t-test), and function ($P = 0.02$, paired t-test) subscales (though the latter was not significant with the Bonferroni correction) but not satisfaction ($P = 0.45$, paired t-test) or perception ($P = 0.64$, paired t-test) subscales (Table 2; Fig. 2). Children with the worst (6/12 or worse) presenting visual acuity in the better-seeing eye improved significantly in the total score ($P < 0.0001$, paired t-test) and all subscales: perception ($P = 0.005$, paired t-test), satisfaction ($P = 0.002$, paired t-test), function ($P = 0.0003$, paired t-test), and symptoms ($P = 0.0003$, paired t-test; Table 2; Fig. 2).

Change in RSVP total score showed modest correlation with change in logMAR acuity between baseline and follow-up ($r = 0.6$; $P < 0.001$; Spearman correlation coefficient; Fig. 3).

After stratification by refractive error in the better-seeing eye at presentation, children with myopia (−1.25 D or worse) had a significant (−15.9 point; $P < 0.0001$, paired t-test) mean improvement in total score. Mean improvement of children with mild myopia (between and including −0.5 D to −1.0 D) was more modest but still significant (−8 points; $P = 0.01$, paired t-test), whereas the four children with other refractive errors had no significant mean improvement in total score ($P = 0.74$, paired t-test). Neither age nor sex was associated with RSVP score at presentation or follow-up or with change in score.

Discussion

Children receiving spectacles in this program had significant improvements in their RSVP total score and all subscales, suggesting that the program has a measurable beneficial effect on vision. An improvement of 10 points on the RSVP, as observed here, has been associated with a twofold increase in the odds of patient satisfaction.[8,9] That a measurable effect was still detectable among children with only modest vision decrement (presenting visual acuity of 6/7.5 or 6/9 in the better-seeing eye) suggests that similar programs providing refractive services in a school setting, where modest improvements in vision appear to be meaningful, might want to provide spectacles to such children.

Though subjective report of visual functioning, as described here, is in principle prone to a placebo effect associated with spectacle provision, the strong dose effect with regard to presenting vision and refractive error, and especially the lack of improved vision in children receiving spectacles who had 6/6 presenting vision in the better-seeing eye, provide strong evidence in favor of a real impact on visual functioning associated with spectacle provision.

One quarter of the children participating in the present study received spectacles despite having a presenting acuity of 6/6 in the better-seeing eye at the time of the follow-up examination. Of these 22 children, two either had vision less than 6/6 in the fellow eye or received spectacles in the current program as replacements for existing, damaged glasses.

Several possibilities exist with regard to the remaining 20 children. The presenting (wearing either no correction or the recorded presenting correction) and best-corrected (wearing the program spectacles) acuity reported in the present study are those measured at the time of the follow-up examination. One possibility is that the acuity was measured incorrectly to be 6/12 or worse at the time of the initial examination, when the decision was made to give spectacles. Another is that the acuity measured at the time of the study visit was incorrect. This seems unlikely in view of the fact that children with measured presenting acuity of 6/6 had RSVP scores at baseline

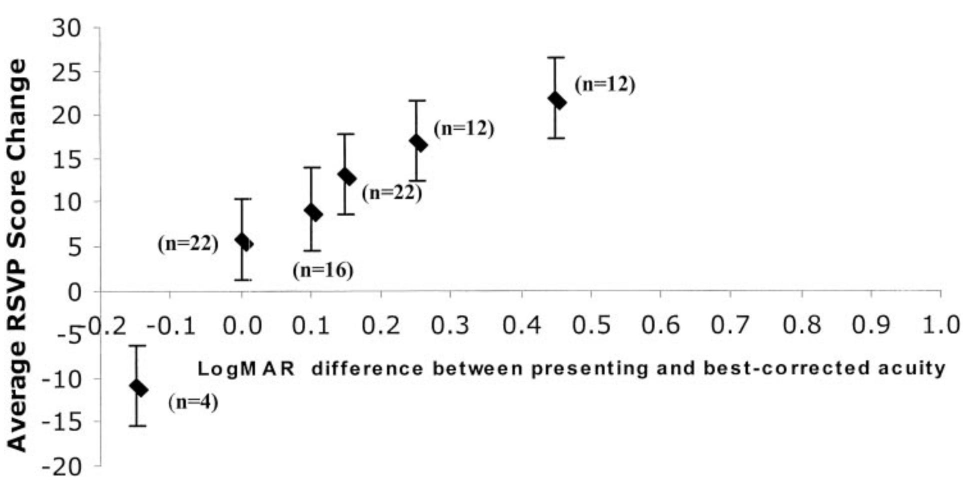

Figure 2. Mean change in total score and subscale scores on the RSVP between testing administered before receipt of program spectacles and 3 to 5 weeks after receipt of program spectacles, for children with presenting visual acuity (uncorrected or with original spectacles) in the better-seeing eye of 6/6 (n = 22), 6/7.55 or 6/9 (n = 34), and 6/12 or worse (n = 32). Positive change indicates improvement, and negative change indicates worsening in RSVP scores. Improvement in visual functioning on the RSVP was greater for children with worse presenting acuity. Children with 6/6 presenting vision did not show an improvement with spectacles in any of the RSVP subscales or on the RSVP total score.

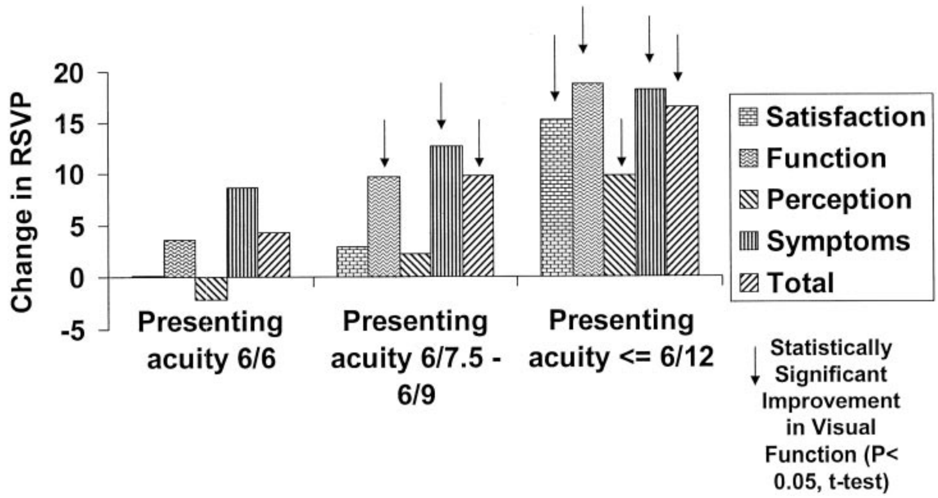

FIGURE 3. Improvement in logMAR (presenting and best-corrected acuity both measured at follow-up) versus change in total score on the RSVP over 4 weeks after the provision of spectacles (Spearman correlation coefficient [ρ] = 0.6; $P < 0.001$.

similar to those of other children when wearing program spectacles and the fact that the children with presenting VA of 6/6 failed to report improvement in visual functioning. A third possibility is that the vision of some children actually improved between the time of the first examination and follow-up. Improved best-corrected vision with refraction in children amblyopia has been reported, even with relatively short-term follow-up such as this.[18,19] For example, a recent report by the Pediatric Eye Disease Investigator Group (PEDIG) noted that refractive correction alone could improve visual acuity by two or more lines in 77% and by three or more lines in 60% of children tested, leading to the resolution of moderate amblyopia (20/40 to 20/100). It is important, however, to recognize that the PEDIG paper refers to improvement in corrected acuity; it is uncertain which improvement could occur in uncorrected acuity, as would have been the case here. Finally, to lend perspective to the figure of 23% of children in this cohort who might have received glasses unnecessarily, Robaei et al.[20] report that 38.3% of Australian children wearing spectacles had no significant refractive error in either eye.

Few studies have assessed the impact of refractive correction with spectacles on visual functioning. A recent randomized trial among 131 community-dwelling persons aged 65 years and older[21] found that persons randomly assigned to receive spectacle prescriptions had significantly greater improvement in the NEI-VFQ than did control subjects. All participants had presenting vision of 20/32 or worse. The study design, which provided spectacles only to subjects in the treatment group, did not completely exclude the possibility of a placebo effect.

The RSVP has been used primarily in the setting of refractive surgery,[12] though a trial of contact lenses has also been evaluated.[14] In a refractive surgery trial of 176 patients completing the RSVP before and after surgery, 100% of patients reported using some correction before surgery, and 87% had myopia of 3 D or greater. Among these subjects, 87% had preoperative best-corrected visual acuity of 20/20 or better, and 58.3% achieved presenting postoperative vision of 20/20 or better in the better eye. In this clinical setting, postsurgical RSVP total score improved by an average of 10.8 points,[12] an amount comparable to that observed in the present study.

The principal finding of this study was that children had significantly improved self-reported visual functioning even at modest levels of presenting visual decrement, given our recently reported finding of low (13%) spectacle compliance in the same population.[6] Further research will be needed to target the important question of why children fail to wear spectacles even when they report improved vision when glasses are used. (It was not possible to examine compliance in the setting of the present study because children were told in advance of the follow-up examination. We have found that such examinations are only helpful in assessing true patterns of compliance if they are unannounced.) It is encouraging that the results of the current paper suggest that strategies to improve spectacle compliance can build on children's own self-reported perception of the benefit of spectacles.

The results of this study must be understood within the context of its limitations. The sample size examined was relatively modest, and the possibility cannot be excluded that a small number of children might have exerted undue influence on the observed findings. It may be that these results cannot be generalized to other populations, either those with a higher prevalence of refractive error, as in East Asia, or a lower prevalence, as in Africa. A number of children in the current study who did not appear to need glasses nevertheless received them, raising the possibility of measurement error with regard to visual acuity or refraction. However, in view of the strong observed correlations between presenting vision and improved self-reported visual functioning, it would appear that the magnitude of such errors was unlikely to have been large. It has been reported that the reproducibility of subjective refraction is in the range of 0.5 D for myopia, hyperopia, and astigmatism,[22,23] with a 95% confidence interval stated as 0.6 D.[24]

The current report is the first we are aware of to document a significant impact on self-reported visual functioning from spectacle correction of modest amounts of refractive error in a program setting in the developing world. It is hoped that further work in this area, examining other outcomes of interest such as educational attainment, may help to better elucidate the benefit of school-based refractive error programs.

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