JAMA Ophthalmology | Original Investigation

Predictors of Spectacle Wear and Reasons for Nonwear in Students Randomized to Ready-made or Custom-made Spectacles

Results of Secondary Objectives From a Randomized Noninferiority Trial

Priya Morjaria, PhD; Jennifer Evans, PhD; Clare Gilbert, MD

IMPORTANCE Visual impairment from uncorrected refractive errors affects 12.8 million children globally. Spectacle correction is simple and cost-effective; however, low adherence to spectacle wear, which can occur in all income settings, limits visual potential.

OBJECTIVE To investigate predictors of spectacle wear and reasons for nonwear in students randomized to ready-made or custom-made spectacles.

DESIGN, SETTING, AND PARTICIPANTS In planned secondary objectives of a noninferiority randomized clinical trial, students aged 11 to 15 years who fulfilled eligibility criteria, which included improvement in vision with correction by at least 2 lines in the better eye, were recruited from government schools in Bangalore, India. Recruitment took place between January 12 and July 15, 2015, and analysis for the primary outcome occurred in August 2016. Data analysis for the secondary outcome was conducted in August 2018. Spectacle wear was assessed by masked observers at unannounced visits to schools 3 to 4 months after spectacles were distributed. Students not wearing their spectacles were asked an open-ended question to elicit reasons for nonwear.

MAIN OUTCOMES AND MEASURES Predictors of spectacle wear and reasons for nonwear.

RESULTS Of 460 students recruited and randomized (52.2% male; 46 students aged 11 to 12 years and 13 to 15 years in each trial arm), 78.7% (362 of 460) were traced at follow-up, and 25.4% (92 of 362) were not wearing their spectacles (no difference between trial arms). Poorer presenting visual acuity (VA) and improvement in VA with correction predicted spectacle wear. Students initially seen with an uncorrected VA less than 6/18 in the better eye were almost 3 times more likely to be wearing their spectacles than those with less than 6/9 to 6/12 (adjusted odds ratio, 2.84; 95% CI, 1.52-5.27). Improvement of VA with correction of 3 to 6 lines or more than 6 lines had adjusted odds ratios of 2.31 (95% CI, 1.19-4.50) and 2.57 (95% CI, 1.32-5.01), respectively, compared with an improvement of less than 3 lines. The main reason students gave for nonwear was teasing or bullying by peers (48.9% [45 of 92]). Girls reported parental disapproval as a reason more frequently than boys (difference, 7.2%).

CONCLUSIONS AND RELEVANCE Three-quarters of students receiving spectacles were wearing them at follow-up, which supports the use of the prescribing guidelines applied in this trial. Predictors of spectacle wear, poorer presenting VA, and greater improvement in VA with correction are similar to other studies. Interventions to reduce teasing and bullying are required, and health education of parents is particularly needed for girls in this setting.

TRIAL REGISTRATION isrctn.org Identifier: ISRCTN14715120

JAMA Ophthalmol. doi:10.1001/jamaophthalmol.2018.6906
Published online January 31, 2019.

Invited Commentary

Author Affiliations: Clinical Research Unit, Infectious Tropical Diseases, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, London, England.

Corresponding Author: Priya Morjaria, PhD, Clinical Research Unit, Infectious Tropical Diseases, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, England (priya.morjaria@lshtm.ac.uk).

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

Refractive errors (REs) affect people of all ages, both sexes, and in all settings (ie, high-, middle-, and low-income regions and urban and rural locations). Uncorrected RE (uRE) is the most common cause of avoidable visual impairment and the second leading cause of blindness.[1,2] Data from the Global Burden of Disease Study indicate that there are 6.6 million people who are blind (presenting visual acuity [VA] worse than 3/60 in the better eye) and that 101.2 million are visually impaired (presenting VA worse than 6/18 in the better eye) simply because they do not have a pair of spectacles.[3] In the United States, half of the population older than 20 years has an RE.[4] Some regions and countries are disproportionately affected by visual impairment due to REs because of the increasing prevalence of myopia in Asia.[5]

Despite correction of REs being highly cost-effective,[6-8] uREs are the most common cause of visual impairment in children. Global estimates from 2004 indicate that there are 12.8 million children visually impaired from uREs[2] (ie, 1% of all children), and this is set to rise with the increasing incidence of myopia in what is now an "epidemic" in East Asia, Europe, and the United States.[5,9,10] Although the prevalence of REs varies by region, uREs are the leading cause of visual impairment in school-age children in all regions.[2]

Visual impairment can negatively alter a student's academic performance,[11] visual functioning,[12] behavioral development,[12] and quality of life.[8] For example, self-reported visual function improved with spectacle wear in a study[13] in Mexico. An Australian study[14] found that children who failed vision screening had significantly lower academic achievement than their peers who passed screening. There is also evidence from a study[15] in the United States that providing children with spectacles was associated with better academic performance and improved psychosocial well-being.

The high prevalence of visual impairment due to uREs and the benefits of spectacle wear have led to large-scale school eye health screening programs in many countries, including India. However, the delivery of these programs is not standardized, and many do not monitor whether students actually use their spectacles.[16] Where studies have reported spectacle wear, it is difficult to compare the findings because different methods have been used (ie, observed wear or self-reported wear), with variable intervals and definitions (ie, some studies define wear as spectacles were being used at the time of assessment, whereas other studies included students who had their spectacles at school). The available evidence suggests that low rates of spectacle wear are a significant issue in all income settings. For example, only 33.2% of Native American students in the United States were wearing their spectacles[17] and 29.4% of schoolchildren in rural areas near Delhi, India.[18]

Numerous studies have investigated reasons why students do not wear their spectacles, which include loss or breakage,[19-22] misconceptions that using spectacles will make their vision worse,[16,23,24] parental disapproval,[18,25] being teased,[16,19,20,24-26] and forgetfulness.[20,21,23,25,27,28] In a 2013 study[29] from India, reasons for not wearing spectacles included being teased (19.9%), the spectacles were broken (17.4%) or lost (9.3%), and the child did not like his or her spectacles (12%). Students with more severe uREs[17] and girls[23] are more likely to wear their spectacles. The evidence of associations between socioeconomic status and parental education and spectacle wear is inconclusive.[16,24,30,31]

Key Points

Question Are there predictors of spectacle wear and reasons for nonwear in children randomized to ready-made or custom-made spectacles?

Findings In a planned analysis of the secondary objectives of a noninferiority randomized clinical trial among 460 students, 2 predictors of spectacle wear were poorer presenting visual acuity and greater improvement in visual acuity with correction; these findings support the use of prescribing guidelines. The main reason for nonwear was teasing or bullying by peers.

Meaning These results suggest that, in school-based eye health programs, the use of improvement in the better eye as a basis for prescribing spectacles means that students are more likely to wear them; interventions to address teasing and bullying might address nonwear.

The results presented in this article reflect the planned secondary objectives of a noninferiority randomized clinical trial undertaken in Bangalore, India, the goal of which was to compare spectacle wear in school students randomized to ready-made or custom-made spectacles.[32] Spectacle wear in both trial arms was similar, including 139 of 184 students (75.5%) in the ready-made arm and 131 of 178 students (73.6%) in the custom-made arm (risk difference, 1.8%; 95% CI, −7.1% to 10.8%).[33] Herein, we report reasons for nonwear and predictors of wear among students recruited to this trial.

Methods

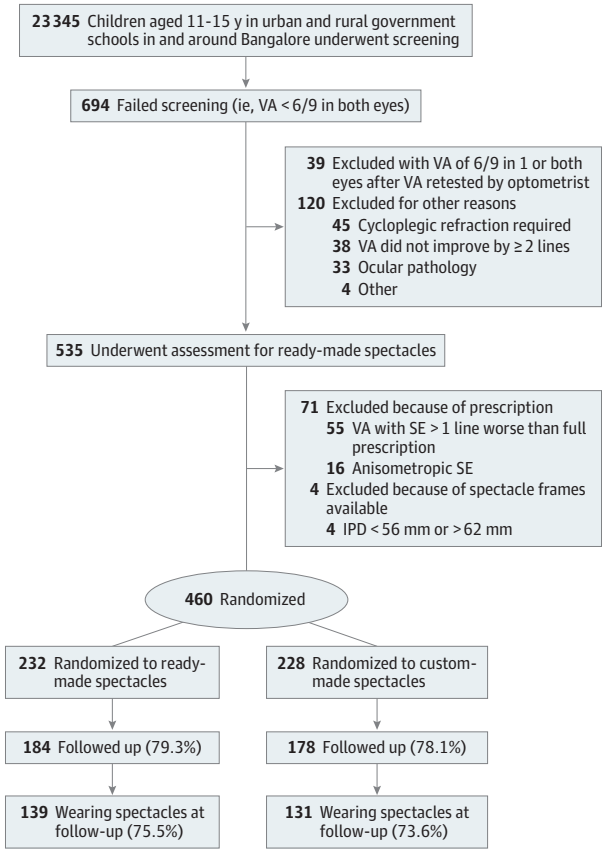
The trial protocol[32] was published in January 2016. Primary outcome data[33] (ie, spectacle wear at unannounced follow-up visits) were published in June 2017. Institutional review board approval was from the ethics committee at London School of Hygiene and Tropical Medicine and the institutional review board at Sankara Eye Institute, Bangalore, India. An information sheet in the local language was sent to the parents of each child aged 11 to 15 years before screening. If parents did not want their child to be screened, they were requested to complete and return the form.

Recruitment took place between January 12 and July 15, 2015, from government schools in urban and periurban areas surrounding Bangalore, India (**Figure**). Spectacle wear was analyzed in March 2016, and the reasons for nonwear were analyzed in August 2018. Students were screened in the schools. Those who did not pass screening (ie, presenting VA less than 6/9 in one or both eyes) were referred to the study optometrist for complete objective and subjective refraction and to assess their eligibility for recruitment, which included improvement in vision with correction by at least 2 lines in the better eye. To be eligible, all children had to fail vision screening (ie, have a presenting VA less than 6/9 in the better eye)

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

Figure. Study Flowchart



Reprinted from Morjaria et al.[32] IPD indicates interpupillary distance; SE, spherical equivalent; VA, visual acuity.

and be suitable for ready-made spectacles according to the following criteria: (1) the spherical equivalent corrected the VA to not more than 1 line less than best-corrected VA with a full prescription in the better eye, (2) the difference between the spherical equivalent of right and left eyes was not more than 1.0 diopter, (3) interpupillary distance matched that of ready-made spectacle frames available (ie, 54-62 mm), and (4) spectacle frames were of acceptable size and fit. In both trial arms, students were only prescribed spectacles if their VA with full correction improved by 2 or more lines in the better eye, regardless of presenting VA or degree of RE.

Eighty-six percent (460 of 535) of those who failed screening were eligible for recruitment. Students selected the spectacle frame they preferred from a range of 6 different colors of metal and plastic frames. The spectacles (ready-made and custom-made) were provided free and were delivered to students in schools at the same time. Students not meeting the strict eligibility criteria were dispensed spectacles but were not included in the trial. This included students with reduced VA in only 1 eye. Data on the following sociodemographic variables were collected from students recruited to the trial: parental literacy, parental spectacle wear, ownership of a mobile phone, and assets (mobile phone, radio, television, motorbike/moped, or bicycle owned).

Spectacle wear and reasons for nonwear were assessed at the time of unannounced visits to the schools 3 to 4 months after students were given their spectacles. Spectacle wear was assessed by field workers masked to which trial arm the students were allocated. Spectacle wear was categorized as follows: (1) students were wearing their spectacles at the time of the visit, (2) students were not wearing their spectacles but had them at school, (3) students were not wearing their spectacles but said they were at home, or (4) students said they no longer had the spectacles because they were broken or lost.[16] Categories 1 and 2 were defined as wearing and categories 3 and 4 as nonwearing. At this visit, students in categories 3 and 4 were asked an open-ended question to elicit reasons for nonwear. A list of themes was developed based on a review of the literature, with the addition of further themes as required. All responses were coded accordingly.

Data for adherence to spectacle wear and reasons for nonwear were double entered into a database created in EpiData (version 3.1; EpiData Association) by the lead investigator (P.M.). For the analysis of predictors of wear, descriptive analyses were used, which tabulated the proportion of students wearing spectacles against the following predictors: age, sex, presenting VA in the better eye, improvement in VA with correction, parental literacy, parental spectacle wear, ownership of a mobile phone, and number of assets owned. We analyzed all these variables in a multivariable logistic regression model. Presenting VA in the better eye and improvement in VA with correction were collinear and were included in separate models. Data were analyzed using statistical software (Stata, version 15.1; StataCorp LP).

Results

A total of 460 students eligible for ready-made spectacles were recruited and randomized (232 to ready-made spectacles and 228 to custom-made spectacles). At follow-up, 362 students (78.7%) were traced (79.3% [184 of 232] in the ready-made arm and 78.1% [178 of 228] in the custom-made arm). Ninety-two of the 362 students (25.4%) were not wearing their spectacles, with no difference between trial arms. Of the 362 students, 182 (50.3%) were boys, and 46 were aged 11 to 12 years and 13 to 15 years in each trial arm.

Table 1 summarizes the association between predictors of wear (age, sex, presenting VA in the better eye, improvement in VA with correction, parental literacy, parental spectacle wear, ownership of a mobile phone, assets owned, and allocation to the trial arm) and wearing spectacles at 3 to 4 months after they were prescribed. Only presenting VA in the better eye (crude odds ratio [OR] for presenting VA <6/18, 2.91 [95% CI, 1.56-5.44]) and improvement in VA with correction (crude OR for improvement >6 lines, 2.75 [95% CI, 1.42-5.29]) were associated with spectacle wear, and this association remained after adjusting for all the variables in the table (adjusted OR, 2.84 [95% CI, 1.52-5.27] for presenting VA of <6/18 and 2.57 [95% CI, 1.32-5.01] for improvement >6 lines). These variables were collinear and were not included in the same multivariable model. Students initially seen with an uncorrected VA less than

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

Table 1. Univariate and Multivariable Analysis of Factors Associated With Spectacle Wear

Variable	No. (%)		Odds Ratio (95% CI)	
	Wear (n = 270)	Nonwear (n = 92)	Crude	Adjusted[a]
Age group, y				
11-13	125 (46.3)	44 (47.8)	1 [Reference]	1 [Reference]
14-15	145 (53.7)	48 (52.2)	1.06 (0.66-1.71)	1.02 (0.62-1.67)
Sex				
Male	134 (49.6)	48 (52.2)	1 [Reference]	1 [Reference]
Female	136 (50.4)	44 (47.8)	1.11 (0.69-1.78)	1.12 (0.68-1.84)
Presenting VA in the better eye[b]				
<6/9 to 6/12	60 (22.2)	33 (35.9)	1 [Reference]	1 [Reference]
<6/12 to 6/18	83 (30.7)	35 (38.0)	1.30 (0.73-2.34)	1.28 (0.71-2.32)
<6/18	127 (47.0)	24 (26.1)	2.91 (1.56-5.44)	2.84 (1.52-5.27)
Improvement in VA with correction[b]				
<3 Lines	82 (30.4)	38 (41.3)	1 [Reference]	1 [Reference]
3-6 Lines	93 (34.4)	38 (41.3)	1.13 (0.66-1.94)	2.31 (1.19-4.50)
>6 Lines	95 (35.2)	16 (17.4)	2.75 (1.42-5.29)	2.57 (1.32-5.01)
Parental literacy				
Father				
Cannot read	97 (35.9)	36 (39.1)	1 [Reference]	1 [Reference]
Can read	156 (57.8)	49 (53.3)	1.18 (0.73-1.95)	1.23 (0.73-2.10)
No father	17 (6.3)	7 (7.6)	0.90 (0.34-2.36)	1.01 (0.37-2.77)
Mother				
Cannot read	124 (45.9)	36 (39.1)	1 [Reference]	1 [Reference]
Can read	144 (53.3)	53 (57.6)	0.79 (0.48-1.28)	0.73 (0.44-1.24)
No mother	2 (0.7)	3 (3.3)	0.19 (0.03-1.24)	0.21 (0.33-1.37)
Parental spectacle wear				
Neither parent	206 (76.3)	74 (80.4)	1 [Reference]	1 [Reference]
One or both parents	64 (23.7)	18 (19.6)	1.28 (0.71-2.30)	0.78 (0.42-1.47)
Ownership of a mobile phone				
Both	133 (49.3)	50 (54.3)	1 [Reference]	1 [Reference]
Mother only	37 (13.7)	13 (14.1)	1.07 (0.52-2.18)	0.85 (0.34-2.09)
Father only	86 (31.9)	23 (25.0)	1.41 (0.80-2.48)	0.67 (0.36-1.23)
Neither parent	14 (5.2)	6 (6.5)	0.88 (0.32-2.42)	0.87 (0.30-2.60)
Assets owned[c]				
None or 1	119 (44.1)	45 (48.9)	1 [Reference]	1 [Reference]
2	117 (43.3)	37 (40.2)	1.20 (0.72-1.98)	1.19 (0.70-2.01)
3-4	34 (12.6)	10 (10.9)	1.29 (0.59-2.82)	1.28 (0.57-2.90)
Trial arm				
Ready-made spectacles	139 (51.5)	45 (48.9)	1 [Reference]	1 [Reference]
Custom-made spectacles	131 (48.5)	47 (51.1)	1.11 (0.69-1.78)	1.10 (0.67-1.80)

Abbreviation: VA, visual acuity.

[a] Adjusted for all variables in the model.

[b] Included in separate models because of collinearity.

[c] Indicates mobile phone, radio, television, motorbike/moped, or bicycle owned.

6/18 in the better eye were almost 3 times more likely to be wearing their spectacles than those with less than 6/9 to 6/12 (adjusted OR, 2.84; 95% CI, 1.52-5.27). The odds of spectacle wear also increased with increasing improvement in VA with correction. Improvement of 3 to 6 lines of VA had an adjusted OR of 2.31 (95% CI, 1.19-4.50) compared with an improvement of less than 3 lines, and an improvement of more than 6 lines had an adjusted OR of 2.57 (95% CI, 1.32-5.01).

The 2 most frequent reasons for nonwear in this cohort were teasing or bullying by peers (48.9% [45 of 92]) and lost or forgot or stolen spectacles (26.1% [24 of 92]) (**Table 2**). These 2 reasons accounted for three-quarters of nonwear. Headaches or uncomfortable spectacles were uncommon reasons and did not differ according to whether the child had ready-made or custom-made spectacles. Reasons for nonwear were explored by age and sex (**Table 3**) using the age groups 11 to 12 years (preadolescent) and 13 to 15 years (adolescent). In both age groups, teasing or bullying by peers was the main reason for nonadherence, followed by lost or forgot or stolen spectacles. Girls reported parental disapproval as a reason for nonwear more frequently than boys (11.4% [5 of 44] and 4.2% [2 of 48], respectively), a difference of 7.2%, and boys reported headaches or discomfort more often than girls (10.4% [5 of 48] and 4.5% [2 of 44], respectively), a difference of 5.9%. Younger

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

Table 2. Reasons for Not Wearing Spectacles by Allocation Group

Variable	No. (%)		
	Ready-Made Spectacles	Custom-Made Spectacles	Total
Teasing or bullying by peers	24 (53.3)	21 (44.7)	45 (48.9)
Lost or forgot or stolen spectacles	14 (31.1)	10 (21.3)	24 (26.1)
Parental disapproval	2 (4.4)	5 (10.6)	7 (7.6)
Headache or spectacles feel uncomfortable	3 (6.7)	4 (8.5)	7 (7.6)
Broken spectacles	2 (4.4)	3 (6.4)	5 (5.4)
Does not wear for sports	0	1 (2.1)	1 (1.1)
No perceived benefit of spectacles	0	1 (2.1)	1 (1.1)
Does not like the appearance of spectacles	0	1 (2.1)	1 (1.1)
Moved to the front of the class	0	1 (2.1)	1 (1.1)
Total	45 (100)	47 (100)	92 (100)

Table 3. Reasons for Not Wearing Spectacles by Age and Sex

Variable	No. (%)				
	Age Group, y		Sex		
	11-12	13-15	Male	Female	Total
Teasing or bullying by peers	20 (43.5)	25 (54.3)	24 (50.0)	21 (47.7)	45 (48.9)
Lost or forgot or stolen spectacles	15 (32.6)	9 (19.6)	10 (20.8)	14 (31.8)	24 (26.1)
Parental disapproval	3 (6.5)	4 (8.7)	2 (4.2)	5 (11.4)	7 (7.6)
Headache or spectacles feel uncomfortable	2 (4.3)	5 (10.9)	5 (10.4)	2 (4.5)	7 (7.6)
Broken spectacles	4 (8.7)	1 (2.2)	4 (8.3)	1 (2.3)	5 (5.4)
Does not wear for sports	1 (2.2)	0	1 (2.1)	0	1 (1.1)
No perceived benefit of spectacles	1 (2.2)	0	0	1 (2.3)	1 (1.1)
Does not like the appearance of spectacles	0	1 (2.2)	1 (2.1)	0	1 (1.1)
Moved to the front of the class	0	1 (2.2)	1 (2.1)	0	1 (1.1)
Total	46 (100)	46 (100)	48 (100)	44 (100)	92 (100)

students were more likely to report that their spectacles were broken than older students (8.7% [4 of 46] and 2.2% [1 of 46], respectively). There were no significant differences in the proportion of boys or girls or younger or older students for any of the reasons for nonwear (2-sample test of proportions). As reasons for nonwear, one student reported no perceived benefit of spectacles (presenting VA of 6/24 corrected VA of 6/18), and another student reportedly does not like the appearance of spectacles. Seven students herein reported nonwear because of headache or spectacles feel uncomfortable.

Discussion

In multivariable analysis, the 2 statistically significant predictors of spectacle wear were poorer presenting VA and greater improvement in VA with correction. Our findings support the use of prescribing guidelines, which in this study was that the corrected VA had to improve by 2 or more lines in the better eye, meaning that only students likely to perceive a benefit are prescribed spectacles. Prescribing guidelines will also reduce overprescribing, increasing the cost-effectiveness and reputation of school eye health programs. Two studies report the use of prescribing protocols, one in Australia[31] and a group of studies in China.[24] The Australian study[31] was population based, where children were considered "in need of refractive correction" if the VA improved in the better eye by at least 2 lines. The authors highlighted the need for evidence-based prescribing of spectacles because students seldom wear low prescription spectacles. In the Xichang Pediatric Refractive Error Study,[24] a school-based investigation of spectacle wear among 1900 students in China, a referral protocol was used. Spectacles were recommended for students whose VA improved by 2 or more lines with refraction. The same guideline of improvement in VA with correction was used in the present study.

As in other studies,[26,29,34,35] the main reason students herein gave for not wearing their spectacles was teasing or bullying by peers. It would have been useful to explore this in more depth through interviews with the students given spectacles, as well as among a group of students not requiring spectacles. Teasing and bullying may also have been underreported because students may not have been comfortable in expressing these views, instead reporting that the spectacles were lost or broken or that their parents disapproved.

The second reason for nonadherence in both age groups and in boys and girls was lost or forgot or stolen spectacles. This has also been cited in studies from Saudi Arabia,[36] Chile,[35] the United States,[17] and Mexico[19] and in other studies in India.[29,34,37] One way to address this would be for class teachers to be given a spare pair of spectacles. To our knowledge, 2 studies[17,20] have used this strategy, both in the United States. The first study[20] actively in-

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

volved teachers by giving them a list of the students in their class prescribed spectacles and when the students should wear them. The teacher was responsible for monitoring and encouraging students to use their spectacles. In the second study,[17] teachers were also given a spare pair of spectacles but had no other responsibility with regard to spectacle wear. In the first study,[20] at follow-up, 11.2% of students reported that their spectacles were broken, and 2.7% reported that they were lost. Eighty percent of students in the second study[17] reported that their spectacles were broken or lost. This suggests that supplying a spare pair of spectacles via teachers can help to address nonwear, but the engagement of teachers is also important.

In our study, girls were more likely to express parental disapproval as a reason for nonwear than boys, which has been reported in other studies,[19,23,29,34,36,38,39] as well as 2 studies[18,40] in India. In the studies from India, parents were concerned that wearing spectacles would adversely affect the marriage prospects of their daughters[18] and that girls would be "singled out" for wearing spectacles.[40] Unpublished data (P.M., July 2017) from another study[41] undertaken in India provide an explanation for these views because parents considered that spectacle wear implied a disability. Therefore, parents in India are more likely to stop girls from wearing spectacles and have greater anxiety about them wearing spectacles.[42]

Seven students herein reported nonwear because of headache or because spectacles felt uncomfortable. All of the students reporting headache underwent refraction again, and only 1 required a modified prescription. The other students had their spectacle frame adjusted and were satisfied. Only 1 student reported not wearing spectacles because of no perceived benefit of spectacles (presenting VA of 6/24; corrected VA of 6/18), which likely reflects the presenting VA. Several studies from different regions of the world have also reported no perceived benefit as a reason for nonwear, varying from 2.4% in the United States[17] to 8.7% in Mexico[19] to 25.6% in Saudi Arabia.[36]

In our study, only 1 child reported that he or she did not like the appearance of spectacles as a reason for nonwear, which is in contrast to many other studies[16,17,19,29,34-36] undertaken in a range of high-, middle-, and low-income settings, including India. Herein, a range of different metal and plastic colored frames was offered for students to choose from. This highlights the importance of giving students the opportunity to decide what they want to wear.

Limitations and Implications for Programs

Our study has some limitations. We did not ask students who were wearing their spectacles why this was the case. Therefore, we are not able to confirm that those children who wore their spectacles did so because they perceived a visual benefit. This would be of benefit, providing insights that could be used in health education. Another limitation was that we were not able to have in-depth discussions with the students about reasons they gave for nonwear. For further studies, it would be beneficial to explore the attitudes of parents and the role they could have in influencing spectacle wear, particularly among girls. This will ensure that relevant and appropriate messages are sent to parents of students who require spectacles. Our study highlights the importance of building culturally relevant and sex norms within any intervention. There are examples of this from other interventions in India from HIV research,[43] where the authors recommended preliminary qualitative research to influence and guide the intervention strategies.

To date and to our knowledge, only 2 other studies[24,31] have reported the use of prescribing guidelines in school programs, and most programs prescribe on the basis of the degree of RE. The use of improvement in VA in the better eye means that students are likely to perceive an improvement in their vision when wearing their spectacles. This guideline also reduces unnecessary costs to programs and parents. However, it is important to ensure that the decision to prescribe spectacles is based on the improvement in visual function of a child.

Conclusions

Three-quarters of students receiving spectacles were wearing them at follow-up, which supports the use of the prescribing guidelines applied in this trial. Programs for the correction of REs in school students should address the most important reasons for nonadherence with spectacle wear. In our study, adherence might have improved by increasing awareness of the benefits of spectacle wear among teachers and parents and by giving a spare pair of spectacles to classroom teachers and asking them to encourage spectacle wear. Interventions to reduce teasing and bullying and disapproval among parents, particularly of girls, is more challenging because interventions would need to address societal norms and attitudes.

ARTICLE INFORMATION

Accepted for Publication: December 4, 2018.

Published Online: January 31, 2019. doi:10.1001/jamaophthalmol.2018.6906

Open Access: This article is published under the JN-OA license and is free to read on the day of publication.

Author Contributions: Dr Morjaria had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: All authors.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Morjaria, Evans.
Obtained funding: Morjaria, Gilbert.
Administrative, technical, or material support: Morjaria.
Supervision: Morjaria, Gilbert.

Conflict of Interest Disclosures: None reported.

Funding/Support: This study was supported by L'Occitane Foundation (Prof Gilbert) and the Vision Impact Institute (Dr Morjaria).

Role of the Funder/Sponsor: The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: We thank the staff of Sankara Eye Hospital, Bangalore, India.

REFERENCES

1. Bourne RR, Stevens GA, White RA, et al; Vision Loss Expert Group. Causes of vision loss worldwide, 1990-2010: a systematic analysis. *Lancet Glob Health*. 2013;1(6):e339-e349. doi:10.1016/S2214-109X(13)70113-X

2. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. *Bull World Health Organ*. 2008;86(1):63-70. doi:10.2471/BLT.07.041210

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019

3. Stevens GA, White RA, Flaxman SR, et al; Vision Loss Expert Group. Global prevalence of vision impairment and blindness: magnitude and temporal trends, 1990-2010. *Ophthalmology*. 2013; 120(12):2377-2384. doi:10.1016/j.ophtha.2013.05.025

4. Vitale S, Ellwein L, Cotch MF, Ferris FL III, Sperduto R. Prevalence of refractive error in the United States, 1999-2004. *Arch Ophthalmol*. 2008; 126(8):1111-1119. doi:10.1001/archopht.126.8.1111

5. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology*. 2016;123(5):1036-1042. doi:10.1016/j.ophtha.2016.01.006

6. Fricke TR, Holden BA, Wilson DA, et al. Global cost of correcting vision impairment from uncorrected refractive error. *Bull World Health Organ*. 2012;90(10):728-738. doi:10.2471/BLT.12.104034

7. Kodjebacheva G, Brown ER, Estrada L, Yu F, Coleman AL. Uncorrected refractive error among first-grade students of different racial/ethnic groups in southern California: results a year after school-mandated vision screening. *J Public Health Manag Pract*. 2011;17(6):499-505. doi:10.1097/PHH.0b013e3182113891

8. Pizzarello L, Tilp M, Tiezzi L, Vaughn R, McCarthy J. A new school-based program to provide eyeglasses: ChildSight. *J AAPOS*. 1998;2(6): 372-374. doi:10.1016/S1091-8531(98)90038-6

9. Morgan AL. Myopia. *CMAJ*. 1947;56(4):406-408.

10. Rudnicka AR, Kapetanakis VV, Wathern AK, et al. Global variations and time trends in the prevalence of childhood myopia: a systematic review and quantitative meta-analysis: implications for aetiology and early prevention. *Br J Ophthalmol*. 2016;100(7):882-890. doi:10.1136/bjophthalmol-2015-307724

11. Ma X, Zhou Z, Yi H, et al. Effect of providing free glasses on children's educational outcomes in China: cluster randomized controlled trial. *BMJ*. 2014;349:g5740. doi:10.1136/bmj.g5740

12. Dirani M, Zhang X, Goh LK, Young TL, Lee P, Saw SM. The role of vision in academic school performance. *Ophthalmic Epidemiol*. 2010;17(1): 18-24. doi:10.3109/09286580903450320

13. Esteso P, Castanon A, Toledo S, et al. Correction of moderate myopia is associated with improvement in self-reported visual functioning among Mexican school-aged children. *Invest Ophthalmol Vis Sci*. 2007;48(11):4949-4954. doi:10.1167/iovs.07-0052

14. White SLJ, Wood JM, Black AA, Hopkins S. Vision screening outcomes of grade 3 children in Australia: differences in academic achievement. *Int J Educ Res*. 2017;83(suppl C):154-159. doi:10.1016/j.ijer.2017.03.004

15. Dudovitz RN, Izadpanah N, Chung PJ, Slusser W. Parent, teacher, and student perspectives on how corrective lenses improve child wellbeing and school function. *Matern Child Health J*. 2016;20(5): 974-983. doi:10.1007/s10995-015-1882-z

16. Wedner S, Masanja H, Bowman R, Todd J, Bowman R, Gilbert C. Two strategies for correcting refractive errors in school students in Tanzania: randomised comparison, with implications for screening programmes. *Br J Ophthalmol*. 2008;92 (1):19-24. doi:10.1136/bjo.2007.119198

17. Messer DH, Mitchell GL, Twelker JD, Crescioni M; CLEERE Study Group. Spectacle wear in children given spectacles through a school-based program. *Optom Vis Sci*. 2012;89(1):19-26. doi:10.1097/OPX.0b013e3182357f8c

18. Rustagi N, Uppal Y, Taneja DK. Screening for visual impairment: outcome among schoolchildren in a rural area of Delhi. *Indian J Ophthalmol*. 2012; 60(3):203-206. doi:10.4103/0301-4738.95872

19. Castanon Holguin AM, Congdon N, Patel N, et al. Factors associated with spectacle-wear compliance in school-aged Mexican children. *Invest Ophthalmol Vis Sci*. 2006;47(3):925-928. doi:10.1167/iovs.05-0895

20. Ethan D, Basch CE, Platt R, Bogen E, Zybert P. Implementing and evaluating a school-based program to improve childhood vision. *J Sch Health*. 2010;80 (7):340-345. doi:10.1111/j.1746-1561.2010.00511.x

21. Vincent JE, Netek S, Parry A, Mladenovich D, Thein NN, Amendola PR. Reported wearing compliance of ready-made spectacles at 6 and 12 months. *Optom Vis Sci*. 2010;87(12):958-965. doi:10.1097/OPX.0b013e3181fef3a9

22. Yabumoto C, Hopker LM, Daguano CR, et al. Factors associated with spectacles-use compliance in a visual screening program for children from Southern Brazil. *Invest Ophthalmol Vis Sci*. 2009;50 (13):2439. https://iovs.arvojournals.org/article.aspx?articleid=2364848. Accessed June 2018.

23. Congdon N, Zheng M, Sharma A, et al. Prevalence and determinants of spectacle nonwear among rural Chinese secondary schoolchildren: the Xichang Pediatric Refractive Error Study Report 3. *Arch Ophthalmol*. 2008;126(12):1717-1723. doi:10.1001/archopht.126.12.1717

24. Li L, Song Y, Liu X, et al. Spectacle acceptance among secondary school students in rural China: the Xichang Pediatric Refractive Error Study (X-PRES): report 5. *Invest Ophthalmol Vis Sci*. 2008; 49(7):2895-2902. doi:10.1167/iovs.07-1531

25. Zeng Y, Keay L, He M, et al. A randomized, clinical trial evaluating ready-made and custom spectacles delivered via a school-based screening program in China. *Ophthalmology*. 2009;116(10): 1839-1845. doi:10.1016/j.ophtha.2009.04.004

26. Odedra N, Wedner SH, Shigongo ZS, Nyalali K, Gilbert C. Barriers to spectacle use in Tanzanian secondary school students. *Ophthalmic Epidemiol*. 2008;15(6):410-417. doi:10.1080/09286580802399094

27. Nirmalan PK, John RK, Gothwal VK, Baskaran S, Vijayalakshmi P, Rahmathullah L; Kariapatti Pediatric Eye Evaluation Project. The impact of visual impairment on functional vision of children in rural South India: the Kariapatti Pediatric Eye Evaluation Project. *Invest Ophthalmol Vis Sci*. 2004; 45(10):3442-3445. doi:10.1167/iovs.04-0233

28. Congdon N, Li L, Zhang M, et al. Randomized, controlled trial of an educational intervention to promote spectacle use in rural China: the See Well to Learn Well study. *Ophthalmology*. 2011;118(12): 2343-2350. doi:10.1016/j.ophtha.2011.06.016

29. Gogate P, Mukhopadhyaya D, Mahadik A, et al. Spectacle compliance amongst rural secondary school children in Pune district, India. *Indian J Ophthalmol*. 2013;61(1):8-12. doi:10.4103/0301-4738.99996

30. He M, Xu J, Yin Q, Ellwein LB. Need and challenges of refractive correction in urban Chinese school children. *Optom Vis Sci*. 2005;82(4):229-234. doi:10.1097/01.OPX.0000159362.48835.16

31. Robaei D, Kifley A, Rose KA, Mitchell P. Refractive error and patterns of spectacle use in 12-year-old Australian children. *Ophthalmology*. 2006;113(9):1567-1573. doi:10.1016/j.ophtha.2006.02.066

32. Morjaria P, Murali K, Evans J, Gilbert C. Spectacle wearing in children randomised to ready-made or custom spectacles, and potential cost savings to programmes: study protocol for a randomised controlled trial. *Trials*. 2016;17:36. doi:10.1186/s13063-016-1167-x

33. Morjaria P, Evans J, Murali K, Gilbert C. Spectacle wear among children in a school-based program for ready-made vs custom-made spectacles in India: a randomized clinical trial. *JAMA Ophthalmol*. 2017;135(6):527-533. doi:10.1001/jamaophthalmol.2017.0641

34. Pavithra MB, Hamsa L, Madhukumar S. Factors associated with spectacle-wear compliance among school children of 7-15 years in South India. *Int J Med Public Health*. 2014;4(2):146-150. https://ijmedph.org/sites/default/files/IntJMedPublicHealth_2014_4_2_146_133110.pdf. Accessed June 2018. doi:10.4103/2230-8598.133110

35. von-Bischhoffshausen FB, Muñoz B, Riquelme A, Ormeño MJ, Silva JC. Spectacle-wear compliance in school children in Concepción Chile. *Ophthalmic Epidemiol*. 2014;21(6):362-369. doi:10.3109/09286586.2014.975823

36. Aldebasi YH. A descriptive study on compliance of spectacle-wear in children of primary schools at Qassim Province, Saudi Arabia. *Int J Health Sci (Qassim)*. 2013;7(3):291-299. doi:10.12816/0006057

37. Bhatt NK, Rathi M, Dhull CS, Sachdeva S, Phogat J. Spectacle compliance amongst school children of Rohtak, Haryana, India. *Int J Community Med Public Health*. 2017;4(3):734-737. doi:10.18203/2394-6040.ijcmph20170749

38. Khandekar R, Mohammed AJ, Al Raisi A. Compliance of spectacle wear and its determinants among schoolchildren of Dhakhiliya region of Oman: a descriptive study. *J Sci Res Med Sci*. 2002; 4(1-2):39-43.

39. Li L, Lam J, Lu Y, et al. Attitudes of students, parents, and teachers toward glasses use in rural China. *Arch Ophthalmol*. 2010;128(6):759-765. doi:10.1001/archophthalmol.2010.73

40. Narayanan A, Kumar S, Ramani KK. Spectacle compliance among adolescents: a qualitative study from Southern India. *Optom Vis Sci*. 2017;94(5): 582-587. doi:10.1097/OPX.0000000000001070

41. Morjaria P, Bastawrous A, Murthy GVS, Evans J, Gilbert C. Effectiveness of a novel mobile health education intervention (Peek) on spectacle wear among children in India: study protocol for a randomized controlled trial[published correction appears in *Trials*. 2017;18(1):309]. *Trials*. 2017;18(1): 168. doi:10.1186/s13063-017-1888-5

42. Kumaran SE, Balasubramaniam SM, Kumar DS, Ramani KK. Refractive error and vision-related quality of life in South Indian children. *Optom Vis Sci*. 2015;92(3):272-278. doi:10.1097/OPX.0000000000000494

43. Kostick KM, Schensul SL, Singh R, Pelto P, Saggurti N. A methodology for building culture and gender norms into intervention: an example from Mumbai, India. *Soc Sci Med*. 2011;72(10):1630-1638. doi:10.1016/j.socscimed.2011.03.029

© 2019 American Medical Association. All rights reserved.

Downloaded from jamanetwork.com by Judith Williams on 02/01/2019