Published in final edited form as:

Optom Vis Sci. 2012 January ; 89(1): 19–26. doi:10.1097/OPX.0b013e3182357f8c.

Spectacle Wear in Children Given Spectacles Through a School-Based Program

Dawn H. Messer, OD, MPH, G. Lynn Mitchell, MAS, FAAO, J. Daniel Twelker, OD, PhD, FAAO, Mabel Crescioni, DrPH, and The CLEERE Study Group^a

University of Arizona, Department of Ophthalmology and Vision Science, Tucson, Arizona (DHM, JDT, MC), The Ohio State University College of Optometry, Columbus, Ohio (GLM), and University of Arizona, College of Public Health, Tucson, Arizona (JDT, MC)

Abstract

Purpose—To investigate factors associated with spectacle wear in a group of primarily Native-American children provided spectacles free of charge through a school-based vision program.

Methods—Spectacle wear was studied in 247 participants provided two pairs of spectacles the previous year. Univariate and multivariate logistic regression models assessed whether gender, race, parental education levels, family income, uncorrected distance visual acuity, refractive error, or the children's attitudes and beliefs about their vision and spectacles were associated with spectacle wear.

Results—Two-thirds of the participants (165/247) were not wearing their spectacles at their annual exam. The most common reasons given for non-wear were lost (44.9%) or broken (35.3%) spectacles. A one diopter increase in myopic spherical equivalent was associated with more than a 2-fold increase in the odds of wearing spectacles (Odds Ratio [OR]=2.5, 95% CI = 1.7, 3.7). Among non-myopic participants, increasing amounts of astigmatism in the better- and worse-seeing eye were associated with an increased likelihood of spectacle wear (p -values ≤ 0.02). In multivariate analysis, only poorer uncorrected acuity in the better-seeing eye ($p < 0.001$) and shorter acceptance time ($p = 0.007$) were found to be significantly associated with spectacle wear. For each line of poorer uncorrected acuity in the better-seeing eye, the likelihood that the participant was wearing spectacles increased by 60% (adjusted OR] = 1.6, 95% CI = 1.4, 1.8). Not surprisingly, participants who reported never getting used to their spectacles were less likely to be wearing spectacles than those who reported getting used to wearing glasses in a few days (adjusted OR = 5.7, 95% CI = 1.9, 17.5).

Conclusions—Despite being provided with two pairs of spectacles, loss and breakage were the most commonly reported reasons for not wearing spectacles. The best predictive factor for determining whether participants were wearing spectacles was their uncorrected acuity.

Keywords

spectacles; eyeglasses; compliance; children; visual acuity; astigmatism

Corresponding author: Dawn H. Messer, The University of Arizona Department of Ophthalmology and Vision Science, 655 N. Alvernon Way, Suite 108, Tucson, AZ 85711, dmesser@eyes.arizona.edu.

^aMembers of the CLEERE Study Group are listed in the Acknowledgments.

Presented in part at the Annual Meeting of the American Academy of Optometry, Denver, CO, December 7-10, 2006.

Commercial relationships: None

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

One of the main priorities of The World Health Organization's "Vision 2020: The Right to Sight" initiative is the correction of refractive error in developed and developing countries.¹ As many as two million children in the United States², and 13 million worldwide³, have uncorrected refractive error. Numerous programs have attempted to address the problem of uncorrected refractive error through school-based vision testing and spectacle distribution programs; unfortunately, most programs have found that at follow-up, the majority of children provided spectacles at no charge were not wearing them.⁴⁻⁸ Reasons found for not wearing spectacles vary by study and population, but include: lost or broken eyeglasses,^{4, 9} concern about appearance or teasing,^{4, 9-11} worry that the eyeglasses will make the eyes worse,¹⁰⁻¹³ eyeglasses kept at home or used only for special occasions.^{4, 12}

Participants in the Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) study at the Southern Arizona site who were found to be in need of spectacle correction per study protocol were provided two pairs of spectacles annually. Study participants were primarily Native American children from the Tohono O'odham Nation, a population known to have high rates of astigmatism.^{14, 15} Similar to what other programs have found,^{4-6, 8, 11, 14} CLEERE investigators noted that children provided spectacles frequently were not wearing their eyeglasses at their annual visits. This paper reports on demographic, clinical, and subjective factors associated with spectacle wear in this highly astigmatic population. To our knowledge, this is the first study to investigate the effect of astigmatic correction on spectacle utilization.

METHODS

Participants

The participants of this study were children, ages 8 to 14 years, participating at the Southern Arizona site of the CLEERE study, a multi-center study of ocular development and refractive error in an ethnically diverse population of school children. The Southern Arizona site of CLEERE is composed of predominately Native American students, with participants recruited from schools on the Tohono O'odham Nation and one school adjacent to the Nation. Of the 600 children examined for the CLEERE Study at the Southern Arizona site between March of 2004 and March of 2005, 307 were prescribed and dispensed spectacles. Twenty of these participants were in 8th grade and thus ineligible to be seen the following year per the CLEERE study protocol, therefore, there were 287 potential participants. All testing took place at the participant's school during school hours.

Procedures

This research followed the tenets of the Declaration of Helsinki. Written parental informed consent was obtained prior to enrollment. Written child assent was also obtained. This study was approved by the Institutional Review Board of the University of Arizona and by the Tohono O'odham Nation.

Ethnicity, maternal and paternal highest level of education, and annual family income were collected as part of the medical history and family survey forms completed by parents of study participants at the time of enrollment in CLEERE. Grade and gender information was collected by the examiner.

A complete description of the CLEERE protocol has been reported previously¹⁶ and only procedures relevant to this study are described here. Uncorrected visual acuity measurements were taken using a Bailey-Lovie high contrast visual acuity chart. Cycloplegic refraction measurements were obtained using the Grand Seiko WR-5100K autorefractor (Grand Seiko Co. Ltd., Hiroshima, Japan). Cycloplegia for light irides (Seddon

grades 1 and 2)¹⁷ was obtained with the instillation of two drops of tropicamide 1%, separated by 5 minutes. For dark irises, one drop of tropicamide 1.0% immediately followed by one drop of cyclopentolate 1% was instilled. To minimize the discomfort of the cycloplegic drops, one drop of proparacaine 0.5% was instilled in each eye prior to instillation of the cycloplegic agents. The autorefraction findings were refined by retinoscopy and subjective cycloplegic refraction. While the study optometrist was allowed to use his or her clinical judgment in determining the final spectacle prescription, the general guidelines for prescribing spectacles were as follows: prescribe full correction for myopia ≥ -0.75 D, astigmatism ≥ 1.00 DC, and anisometropia ≥ 1 D and prescribe spectacles for hyperopia $\geq +2.50$ D, however, reduce the amount of hyperopic correction by one diopter or more, unless esotropia was present.

Participants were allowed to choose from a selection of over 30 frames, including a variety of sizes and colors in both metal and plastic materials. Mirrors were available to aid in frame selection, and the frame selection was checked to ensure proper fit. Upon completion of the examination, participants were given a form to give to their parents or guardians, explaining the results of the examination, along with a brochure describing the different types of refractive error.

Spectacles were dispensed approximately 3 weeks after the examination. Spectacles were adjusted to each participant's face and best-corrected visual acuity with the new spectacles was measured. If acuity was not 20/25 or better in each eye, the participant's record was reviewed to determine if a referral for follow-up care was indicated. An extra pair of spectacles was given to the teacher or school nurse (depending on the preference of the school) for use in the event a participant lost, broke, or forgot to bring to school his/her first pair of eyeglasses.

Participants had annual examinations 10 to 14 months after the initial examination. Although the participants were informed they would be seen for an annual visit, they did not know the exact date they would be examined. When the study coordinator went to the classroom to bring the participants for vision testing, the participants were instructed to wear their eyeglasses to the examination if they had them at school that day. It was noted by the examiner whether the participants presented to the examination with their spectacles.

At the beginning of the eye examination, the participants were given a questionnaire to fill out on their attitudes and beliefs related to their vision and eyeglasses. Most questions were forced choice with yes/no responses. For the question "How often do you get headaches or eyestrain?" the response choices were on a four-point frequency scale including "Never", "Some of the time", "Most of the time", and "All of the time". For the spectacle acceptance question, "How long did it take you to get used to wearing your glasses?", responses were also on a four-point frequency scale including "Less than a day", "A few days", "A week or two" and "Never got used to them". For students not wearing their glasses, possible choices for reasons for why they weren't wearing them were: "Broke them", "Lost them", "Didn't like them", and "Don't need them anymore".

Statistical Methods

To investigate factors associated with spectacle utilization among school children in our population, three types of data were analyzed: demographic data that consisted of gender, race, grade, paternal and maternal education level, and family income; clinical data including uncorrected distance visual acuity and refractive error; and survey data obtained from a questionnaire filled out by participants regarding their vision and their attitudes and beliefs associated with their eyeglasses. The outcome variable was whether or not the children presented with their spectacles at the time of the follow-up examination.

Logistic regression was used to investigate the relationship between each of the demographic, clinical, and survey characteristics and spectacle use. The method of forward-selection using all characteristics from Table 1 along with measures of refractive error and visual acuity was used to determine the multivariate model. The goodness-of-fit of the multivariate model was examined using the Hosmer-Lemeshow Test. A small chi-square value (large p-value) indicates that the model accurately estimates the probability of wearing spectacles. Relevant odds ratio (OR) and respective 95% confidence interval (CI) are presented. Chi Square analysis was used to determine differences in reported spectacle acceptance time among those with different levels of astigmatism. A p-value of <0.05 was considered statistically significant. All statistical analyses were conducted using SAS software (Version 9.2).

RESULTS

There was complete follow-up data on 247 of the 287 (86%) potential participants; 40 (14%) were lost to follow-up. Of the 247 participants, the sample was 84% Native American, 11% Hispanic, 4% white, and less than 1% African-American. Girls accounted for 55% of the participants. At the follow-up examination, participants were in grades 3 through 8, with a median of sixth grade and a mean age of 10.7 years ($SD = 1.4$). The mean uncorrected visual acuity in the better-seeing eye was 0.43 logMAR ($SD = 0.29$), which corresponds to 20/53 Snellen. In the worse-seeing eye, the mean uncorrected visual acuity was 0.57 logMAR ($SD = 0.28$) or 20/74 Snellen. The prevalence of astigmatism was high with 77% (190/247) of participants having at least 1D of astigmatism in at least one eye, 53% with at least 2D, and 34% with at least 3D.

At the time of the follow-up examination, only one-third (82/247) of the participants presented with spectacles. The most common reasons given for not having their spectacles were that they were lost (44.9%) or broken (35.3%). Fifteen percent did not like them, 2.4% said they didn't need the eyeglasses, and the remaining 2.4% reported that their eyeglasses were at home.

Results from the univariate logistic regression models are shown in Table 2 for those characteristics found to be significantly ($p < 0.05$) related to spectacle wear. The demographic data associated with spectacle wear were gender ($p = 0.026$) and race ($p = 0.002$). Girls were 1.8 times more likely to wear their spectacles than boys (95% CI = 1.1, 3.2). The Native-American children were less likely to wear their spectacles than other ethnicities (OR = 0.33, 95% CI = 0.2, 0.7).

Neither parental education level (p -values > 0.95) nor family income ($p = 0.39$) was associated with the likelihood of spectacle wear. Self-reported distance blur without their eyeglasses ($p < 0.001$) and liking how they looked in their eyeglasses ($p = 0.004$) were significantly related to spectacle wear. Participants who reported they never got used to wearing their eyeglasses were less likely to be wearing eyeglasses than the other participants ($p < 0.001$), while those who reported getting used to wearing their glasses in a day or two were the most likely to comply with spectacle wear. Spectacle compliance was not related to the children's attitudes about whether the eyeglasses helped them to see or made their eyes feel better (p -values > 0.20). The vast majority of children, whether they wore their eyeglasses or not, reported that the spectacles helped them to see more clearly (98% vs. 94%, respectively) and made their eyes feel better (92% vs. 88%, respectively).

Clinical factors associated with spectacle wear were uncorrected visual acuity, amount of spherical equivalent refractive error (SEQ), and amount of astigmatism in both the better- and worse-seeing eyes (p -values < 0.001). Each line of decreased visual acuity in either the

better- or worse-seeing eye was associated with a 60% increase in the likelihood of wearing spectacles. The relationship between SEQ and the odds of wearing spectacles in both the better- and worse-seeing eye was influenced by the magnitude of the refractive error ($SEQ < 0$ or ≥ 0 , p -values ≤ 0.040).

As shown in Figure 1, among those participants with a myopic SEQ in the better-seeing eye, each additional diopter of myopia was associated with more than a two-fold increase in the odds of wearing spectacles ($OR = 2.5$, 95% $CI = 1.7, 3.7$); however, in those who were hyperopic ($SEQ \geq 0$) in their better-seeing eye, a 1D increment in hyperopic correction was not significantly related to spectacle wear ($p = 0.26$). A similar yet not as pronounced relationship between SEQ and spectacle wear was observed in the worse-seeing eye.

There was also a significant interaction between the amount of astigmatism in both the better- and worse-seeing eye and the magnitude of the SEQ on the odds of wearing spectacles. Among non-myopic participants (those with SEQ in the better-seeing eye of zero or higher), each additional diopter of astigmatism was associated with a 40% increase in the odds of wearing spectacles ($OR = 1.4$, 95% $CI = 1.1, 2.0$) as illustrated in Figure 2. Higher levels of astigmatism among myopic participants (SEQ less than zero in the better-seeing eye) did not increase the odds of spectacle wear ($p = 0.74$). The same relationships between amount of astigmatism in the worse-seeing eye and spectacle wear were observed.

In multivariate analysis, the only significant factors related to spectacle wear were uncorrected visual acuity in the better-seeing eye ($p < 0.001$) and spectacle acceptance time ($p = 0.007$) as shown in Table 2. For each line of decreased acuity in the better-seeing eye, the likelihood that the participant was wearing spectacles increased by 60% ($OR = 1.6$, 95% $CI = 1.4, 1.8$). This is further illustrated in Figure 3, which shows the percentage of spectacle wear by uncorrected acuity in the better-seeing eye. Those who reported that they got used to wearing their glasses in a few days were five times more likely to be wearing spectacles compared to the participants who reported never getting used to their glasses (adjusted $OR = 5.7$, 95% $CI = 1.9, 17.5$). The likelihood of wearing spectacles was also significantly greater among participants who got used to their glasses in a few days compared to participants who took a week or two to accept wearing spectacles ($p = 0.021$). No other significant differences were observed between the levels of acceptance time (p -values ≥ 0.085). Using the results of the Hosmer-Lemeshow Goodness of Fit test, the final model accurately estimates the probability of wearing spectacles ($p = 0.86$).

Interestingly, while the reported time required to get used to wearing glasses was related to spectacle compliance, it was not related to the amount of astigmatic correction in the spectacles. It should be noted that the astigmatism was almost exclusively with-the-rule, with only 4 participants with 1D or more of astigmatism having against-the-rule or oblique orientations. Highly astigmatic participants ($> 3D$ of cylinder in at least one of their spectacle lenses) reported comparable acceptance times to those with moderate astigmatism (1 to 3D) and those with mild or no astigmatism ($< 1D$) (Chi square, p -value > 0.86).

DISCUSSION

Although it is difficult to directly compare spectacle wear compliance among different studies as the time frame and the methods used for determining compliance differ between each study, studies on spectacle wear provided through school-based programs have uniformly found poor compliance⁴⁻⁷ with only a few studies finding more than half the participants wearing their spectacles at follow-up.^{18, 19} Only one-third of our participants who had been dispensed a pair of spectacles free of charge presented for their next annual

visit wearing their prescribed spectacles, even though a replacement pair was also provided to their teacher or school nurse.

The only other study we are aware of that provided eyeglasses to students free of charge through a school-based program in the United States was conducted in the New York City public schools.²⁰ In this study, teachers were actively involved with the intervention group. Teachers kept one of the two pair of spectacles provided to the student for use in the classroom; teachers were provided a list of times and activities when glasses were to be worn for each child and were instructed that it was their responsibility to monitor and encourage student's eyeglass use. The teachers agreed to allow researchers to conduct unannounced classroom observations to determine who was wearing their glasses. This more active role for the teachers may account for the greater use of spectacles by their students compared to ours (47% vs. 33%). Another factor that may have contributed to the higher compliance rate is that spectacle wear was assessed within the same school year; therefore compared to our study, there was less opportunity for the spectacles to become lost or broken.

Despite the provision of two pairs of spectacles, breakage or loss was given as the reason for not wearing the spectacles by 80% of the participants. Other studies in which spectacles were provided free of charge have also found loss, breakage, or scratched lenses to be one of the main reasons given for not wearing their spectacles.^{4, 6, 9, 21} Fear that glasses will make their vision worse¹¹⁻¹³, parental disapproval^{10, 13}, concern over appearance or being teased^{4, 10, 11}, and leaving glasses at home or only wearing glasses part-time^{6, 8} have also been found to be major reasons for non-compliance with spectacle wear. Unfortunately, we did not collect data on how many students actually received their replacement spectacles, nor did we specifically ask the students if they had broken or lost both pairs of spectacles. Our survey also did not fully explore all possible reasons why the students were not wearing their spectacles.

Our finding that parental education level and socioeconomic status were not significantly associated with spectacle wear in children is also consistent with other studies that have looked at these factors.^{11, 13, 22, 23} Results regarding age and gender are less clear. Age was not found to be associated with spectacle wear in our study nor in most other studies;^{5, 9, 11, 13, 19, 22} however, our study and these other studies included only participants of a limited age range - such as only elementary school, or only secondary school students. Two studies that had participants with a wider range of ages found older teens more likely to wear their spectacles than younger children.^{12, 18}

A few studies have found girls significantly more likely to wear their eyeglasses than boys,^{5, 12, 18} but other studies, such as our own, have not found gender to be significantly associated with spectacle wear.^{4, 9, 11, 19} No studies have found boys more likely than girls to wear spectacles.

The most consistent factors that have been found to be associated with wearing spectacles are poorer uncorrected visual acuity and higher amounts of myopia.^{4, 11-13, 18, 19} Two studies have not found uncorrected acuity and myopia to be associated with spectacle wear.^{5, 9} In our sample, spectacle wear increases almost exponentially with decreasing uncorrected visual acuity in the better-seeing eye, with only 9% of participants whose uncorrected vision was at least 20/40 wearing their eyeglasses. Castanon Holguin, et al.⁴ found only 2% of participants with spherical equivalents of -0.50D to be wearing eyeglasses; however, even with high amounts of refractive error, spectacles are frequently not worn.¹³ Li, et al. found that only one-third of the participants with more than 2D of myopia in each eye whose parents had purchased eyeglasses for them said they usually wore

them¹³ and in our study, only 42% of the participants with more than 2D of astigmatism in each eye were wearing their spectacles.

While it is not surprising that participants who reported never getting used to wearing their glasses were less likely to be wearing glasses than those participants who reported they got used to their glasses in a few days, it is interesting that participants with more than 3D of astigmatic correction did not report taking any longer to get used to wearing their glasses than participants with lower amounts of astigmatism. This finding lends support to the view that children typically get used to astigmatic correction and that full astigmatic correction can be prescribed without fearing that it might hinder spectacle wear compliance.

The major limitations of our study are that the measure of compliance was based only on whether the participants presented wearing eyeglasses on the day of their annual visit and that many of our results were obtained from participants' self-report. Another limitation of our study is that we did not investigate cultural attitudes about spectacle wear, and the survey choices were limited to only four possible reasons for why they were not wearing their spectacles. Finally, we did not collect any information on the role teachers may have played in whether the students wore their spectacles.

Our findings on spectacle wear cannot be generalized to students who receive their eye care and spectacles through traditional means. Children prescribed spectacles in a clinic setting may be more likely to wear their spectacles than children recruited to participate in a school-based vision program for a variety of reasons. Typically there is some concern that prompts a parent to take the initiative to obtain a professional eye examination, and, often, the parent is with the child at the time of the examination, allowing the doctor to fully explain and demonstrate their child's need for spectacles. Additionally, eyeglasses that must be purchased may have greater perceived value than those received free of charge. This premise is substantiated by a study on the use of corrective lenses among adolescents given vision examinations as a component of the 1999-2002 National Health and Nutrition Examination Survey (NHANES).²⁴ This study found that of those students who reported they wore corrective lenses, 74.5% had their correction with them at the time of the examination.

In conclusion, as in other studies of spectacle wear provided through school-based programs, our study found the majority of participants not wearing their spectacles at their annual visit the following year. Although poorer uncorrected visual acuity and higher amounts of myopia have been found to be associated with compliance in many studies,^{4, 11-13, 18, 19} factors associated with compliance and primary reasons for not wearing spectacles differ among various populations. When conducting similar programs in the future, the authors plan to be more judicious in determining the spectacle prescribing guidelines and attempt to address any barriers to spectacle wear that can be identified prior to beginning the project, and recommend other organizations planning a spectacle distribution program to do the same.

Acknowledgments

We wish to thank the Tohono O'odham Nation, and the parents and children who participated in the study.

The Collaborative Longitudinal Evaluation of Ethnicity and Refractive Error (CLEERE) Study is supported by the National Eye Institute and the Office of Minority Research/National Institutes of Health, grants U10-EY08893 and R24-EY014792. The study was also supported by the Ohio Lions Eye Research Foundation, the E.F. Wildermuth Foundation, and Research to Prevent Blindness.

REFERENCES

1. World Health Organization. Vision 2020 The Right to Sight: Global Initiative for the Elimination of Avoidable Blindness Action Plan 2006-2011. Geneva, Switzerland: 2007.
2. Hellen Keller International. Preventing Blindness. United States: 2011. Available at: <http://www.hki.org/working-worldwide/united-states/>
3. 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; 86:63–70. [PubMed: 18235892]
4. Castanon Holguin AM, Congdon N, Patel N, Ratcliffe A, Estes P, Toledo Flores S, Gilbert D, Pereyra Rito MA, Munoz B. Factors associated with spectacle-wear compliance in school-aged Mexican children. *Invest Ophthalmol Vis Sci.* 2006; 47:925–8. [PubMed: 16505025]
5. Congdon NG, Patel N, Estes P, Chikwembani F, Webber F, Msithini RB, Ratcliffe A. The association between refractive cutoffs for spectacle provision and visual improvement among school-aged children in South Africa. *Br J Ophthalmol.* 2008; 92:13–8. [PubMed: 17591673]
6. 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; 80:340–5. [PubMed: 20591099]
7. Keay L, Zeng Y, Munoz B, He M, Friedman DS. Predictors of early acceptance of free spectacles provided to junior high school students in China. *Arch Ophthalmol.* 2010; 128:1328–34. [PubMed: 20938003]
8. Zeng Y, Keay L, He M, Mai J, Munoz B, Brady C, Friedman DS. A randomized, clinical trial evaluating ready-made and custom spectacles delivered via a school-based screening program in China. *Ophthalmology.* 2009; 116:1839–45. [PubMed: 19592103]
9. Yabumoto C, Hopker LM, Daguano CR, Basilio FM, Robl R, Rodrigues DB, Jimenez A, Moreira AT, Sakata LM, Sakata K. Factors associated with spectacles-use compliance in a visual screening program for children from Southern Brazil. *Invest Ophthalmol Vis Sci.* 2009; 50 E-Abstract 2439.
10. Odedra N, Wedner SH, Shigongo ZS, Nyalali K, Gilbert C. Barriers to spectacle use in Tanzanian secondary school students. *Ophthalmic Epidemiol.* 2008; 15:410–7. [PubMed: 19065434]
11. Wedner S, Masanja H, Bowman R, Todd J, Gilbert C. Two strategies for correcting refractive errors in school students in Tanzania: randomised comparison, with implications for screening programmes. *Br J Ophthalmol.* 2008; 92:19–24. [PubMed: 18156372]
12. Congdon N, Zheng M, Sharma A, Choi K, Song Y, Zhang M, Wang M, Zhou Z, Li L, Liu X, Lam DS. Prevalence and determinants of spectacle nonwear among rural Chinese secondary schoolchildren: the Xichang Pediatric Refractive Error Study Report 3. *Arch Ophthalmol.* 2008; 126:1717–23. [PubMed: 19064854]
13. Li L, Song Y, Liu X, Lu B, Choi K, Lam DS, Zhang M, Zheng M, Wang Y, Sharma A, Congdon N. Spectacle acceptance among secondary school students in rural China: the Xichang Pediatric Refractive Error Study (X-PRES)--report 5. *Invest Ophthalmol Vis Sci.* 2008; 49:2895–902. [PubMed: 18223245]
14. Harvey EM, Dobson V, Miller JM. Prevalence of high astigmatism, eyeglass wear, and poor visual acuity among Native American grade school children. *Optom Vis Sci.* 2006; 83:206–12. [PubMed: 16614575]
15. Harvey EM, Dobson V, Miller JM, Sherrill DL. Treatment of astigmatism-related amblyopia in 3- to 5-year-old children. *Vision Res.* 2004; 44:1623–34. [PubMed: 15135999]
16. Zadnik K, Manny RE, Yu JA, Mitchell GL, Cotter SA, Quiralte JC, Shipp M, Friedman NE, Kleinstein RN, Walker TW, Jones LA, Moeschberger ML, Mutti DO. Ocular component data in schoolchildren as a function of age and gender. *Optom Vis Sci.* 2003; 80:226–36. [PubMed: 12637834]
17. Seddon JM, Sahagian CR, Glynn RJ, Sperduto RD, Gragoudas ES, The Eye Disorders Case-Control Study Group. Evaluation of an iris color classification system. *Invest Ophthalmol Vis Sci.* 1990; 31:1592–8. [PubMed: 2201662]
18. Khandekar R, Al Raisi AJ. Compliance of spectacle wear and its determinants among schoolchildren of Dhakhiliya region of Oman: A descriptive study. *Sultan Qaboos Univ Med J.* 2002; 4:39–43.

19. Khandekar R, Sudhan A, Jain BK, Tripathy R, Singh V. Compliance with spectacle wear and its determinants in school students in Central India. *Asian J Ophthalmol*. 2008; 10:174–7.
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; 80:340–5. [PubMed: 20591099]
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; 87:958–65. [PubMed: 21076356]
22. He M, Xu J, Yin Q, Ellwein LB. Need and challenges of refractive correction in urban Chinese school children. *Optom Vis Sci*. 2005; 82:229–34. [PubMed: 15829844]
23. Robaei D, Kifley A, Rose KA, Mitchell P. Refractive error and patterns of spectacle use in 12-year-old Australian children. *Ophthalmology*. 2006; 113:1567–73. [PubMed: 16857261]
24. Kemper AR, Bruckman D, Freed GL. Prevalence and distribution of corrective lenses among school-age children. *Optom Vis Sci*. 2004; 81:7–10. [PubMed: 14747754]

The CLEERE Study Group (as of March 2011)

Clinical Centers:

Franklin Primary Health Center, Inc.: Sandral Hullett (Principal Investigator, 1997-2006); Robert N. Kleinstein (Co-Investigator, 1997-2006); Janene Sims (Optometrist, 1997-2001 and 2004-2006); Raphael Weeks (Optometrist, 1999-2006); Sandra Williams (Study Coordinator, 1999-2006); LeeAndra Calvin (Study Coordinator, 1997-1999); Melvin D. Shipp (Co-Investigator, 1997-2004).

University of California, Berkeley School of Optometry, Berkeley, CA: Nina E. Friedman (Principal Investigator, 1999-2001); Pamela Qualley (Study Coordinator, 1997-2001); Donald O. Mutti (Principal Investigator, 1996-1999); Karla Zadnik (Optometrist, 1996-2001).

University of Houston College of Optometry: Ruth E. Manny (Principal Investigator, 1997-2006); Suzanne M. Wickum (Optometrist, 1999-2006); Ailene Kim (Optometrist, 2003-2006); Bronwen Mathis (Optometrist, 2002-2006); Mamie Batres (Study Coordinator, 2004-2006); Sally Henry (Study Coordinator, 1997-1998); Janice M. Wensveen (Optometrist, 1997-2001); Connie J. Crossnoe (Optometrist, 1997-2003); Stephanie L. Tom (Optometrist, 1999-2002); Jennifer A. McLeod (Study Coordinator, 1998-2004); Julio C. Quiralte (Study Coordinator, 1998-2005).

Southern California College of Optometry, Fullerton, CA: Susan A. Cotter (Principal Investigator, 2004-2006, Optometrist, 1997-2004); Julie A. Yu (Principal Investigator, 1997-2004, Optometrist 2005-2006); Raymond J. Chu (Optometrist, 2001-2006); Carmen N. Barnhardt (Optometrist 2004-2006); Jessica Chang (Optometrist, 2005-2006); Kristine Huang (Optometrist, 2005-2006); Rebecca Bridgeford (Study Coordinator, 2005-2006); Connie Chu (Optometrist, 2004-2005); Soonsi Kwon (Optometrist, 1998-2004); Gen Lee (Study Coordinator, 1999-2003); John Lee (Optometrist, 2000-2003); Robert J. Lee (Optometrist, 1997-2001); Raymond Maeda (Optometrist, 1999-2003); Rachael Emerson (Study Coordinator, 1997-1999); Tracy Leonhardt (Study Coordinator, 2003-2004).

University of Arizona, Department of Ophthalmology and Vision Science, Tucson, AZ: J. Daniel Twelker (Principal Investigator, 2000-present); Dawn Messer (Optometrist, 2000-present); Denise Flores (Study Coordinator, 2000-2007); Rita Bhakta (Optometrist, 2000-2004); Katie Garvey (Optometrist, 2005-2008); Amanda Mendez Roberts (Optometrist, 2008-2009); Mabel Crescioni (Study Coordinator, 2008-present).

Resource Centers:

Chairman's Office, The Ohio State University College of Optometry, Columbus, OH: Karla Zadnik (Chairman, 1997-present); Jodi M. Malone (Study Coordinator, 1997-present).

Videophakometry Reading Center, The Ohio State University College of Optometry, Columbus, OH: Donald O. Mutti (Director, 1997-present); Huan Sheng (Reader, 2000-2006); Holly Omlor (Reader, 2003-2006); Meliha Rahmani (Reader, 2004-present); Jaclyn Brickman (Reader, 2002-2003); Amy Wang (Reader, 2002-2003); Philip Arner (Reader, 2002-2004); Samuel Taylor (Reader, 2002-2003); Myhanh T. Nguyen (Reader, 1998-2001); Terry W. Walker (Reader, 1997-2001); Vidhya Subramanian (Reader, 2006-2009); Elizabeth Perry (2010); Austen Tanner (2009-present).

Optometry Coordinating Center, The Ohio State University College of Optometry, Columbus, OH: Lisa A. Jones-Jordan (Director, 1997-present); Linda Barrett (Data Entry Operator, 1997-2007); John Hayes (Biostatistician, 2001-2007); G. Lynn Mitchell

(Biostatistician, 1998-present); Melvin L. Moeschberger (Consultant, 1997-present); Loraine Sinnott (Biostatistician, 2005-present); Pamela Wessel (Program Coordinator, 2000-present); Julie N. Swartzendruber (Program Coordinator, 1998-2000).

Project Office, National Eye Institute, Rockville, MD: Donald F. Everett.

Committees:

Executive Committee: Karla Zadnik (Chairman), Lisa A. Jones-Jordan, Robert N. Kleinstein, Ruth E. Manny, Donald O. Mutti, J. Daniel Twelker, and Susan A. Cotter.

Figure 1.
Probability of wearing spectacle correction by level of myopia in better- and worse-seeing eye.

Figure 2.
Probability of wearing spectacle correction by amount of astigmatism in non-myopic participants.

Figure 3.
Probability of wearing spectacles by uncorrected visual acuity in the better-seeing eye.

Table 1

Characteristics of participants wearing and not wearing spectacle correction

Characteristic	Level	Wearing correction	Not wearing correction
		# (%)	# (%)
Gender	Boys	29 (35.4)	83 (50.3)
	Girls	53 (64.6)	82 (49.7)
Race	Native American	60 (73.2)	147 (89.1)
	All others	22 (26.8)	18 (10.9)
Grade	Elementary school	31 (37.8)	70 (42.4)
	Middle school	51 (62.2)	95 (57.6)
Education level attained by Mother	Grade school	5 (6.9)	9 (6.3)
	Some HS	21 (28.8)	39 (27.3)
	HS graduate	25 (34.2)	52 (36.4)
	Completed college	16 (21.9)	29 (20.3)
	Post-grad/Professional	6 (8.2)	14 (9.7)
Education level attained by Father	Grade school	5 (7.6)	10 (7.5)
	Some HS	22 (33.3)	42 (31.3)
	HS graduate	23 (34.9)	53 (39.6)
	Completed college	11 (16.7)	21 (15.7)
	Post-grad/Professional	5 (7.6)	8 (6.0)
Family income	Less than \$15,000	25 (34.7)	61 (45.2)
	\$15,000 to \$24,999	19 (26.4)	36 (26.7)
	\$25,000 to \$34,999	13 (18.1)	19 (14.1)
	\$35,000 or more	15 (20.8)	19 (14.1)
Trouble seeing things at distance	Yes	67 (81.7)	97 (58.8)
	No	15 (18.3)	68 (41.2)
Trouble seeing things at near	Yes	46 (56.1)	74 (45.1)
	No	36 (43.9)	90 (54.9)
Frequency of headaches or eyestrain	Never	27 (33.3)	60 (36.8)
	Some of the time	49 (60.5)	83 (50.9)
	Most or all of the time	5 (6.2)	20 (12.3)
Do glasses help see better?	Yes	78 (97.5)	150 (93.8)
	No	2 (2.5)	10 (6.2)
Do glasses make eyes feel better?	Yes	74 (92.5)	137 (87.8)
	No	6 (7.5)	19 (12.2)
Like how look in glasses	Yes	52 (65.0)	70 (45.2)

Characteristic	Level	Wearing correction	Not wearing correction
		# (%)	# (%)
	No	28 (35.0)	85 (54.8)
Time it took to get used to wearing glasses	Less than 1 day	12 (15.0)	28 (18.0)
	A few days	45 (56.2)	44 (28.2)
	A week or two	18 (22.5)	45 (28.8)
	Never	5 (6.3)	39 (25.0)

Table 2

Results from logistic regression models predicting odds of wearing spectacles.

Characteristic	Level	Univariate Odds ratio (95% CI)	Multivariate Odds ratio (95% CI)
Gender	Boys	REF	---
	Girls	1.8 (1.1, 3.2)	NS
Race	Native American	0.3 (0.2, 0.7)	NS
	All others	REF	---
Trouble seeing things at distance	Yes	3.1 (1.7, 5.9)	NS
	No	REF	---
Like how look in glasses	Yes	2.3 (1.3, 3.9)	
	No	REF	---
Time it took to get used to wearing glasses	Less than 1 day	3.3 (1.1, 10.6)	2.5 (0.7, 9.0)
	A few days	8.0 (2.9, 22.1)	5.7 (1.9, 17.5)
	A week or two	3.1 (1.1, 9.2)	2.2 (0.7, 7.2)
	Never	REF	---
Uncorrected VA (better-seeing eye)		1.6 ^a (1.4, 1.8)	1.6 (1.4, 1.8)
Uncorrected VA (worse-seeing eye)		1.6 ^a (1.4, 1.8)	NS
SEQ (better-seeing eye)	If SEQ < 0	2.5 ^b (1.7, 3.7)	NS
	If SEQ ≥ 0	1.2 ^b (0.9, 1.7)	NS
SEQ (worse-seeing eye)	If SEQ < 0	1.4 ^b (1.1, 1.7)	NS
	If SEQ ≥ 0	1.3 ^b (0.9, 1.7)	NS
Cylinder (better-seeing eye)	If SEQ < 0	1.0 ^c (0.8, 1.2)	NS
	If SEQ ≥ 0	1.4 ^c (1.1, 2.0)	NS
Cylinder (worse-seeing eye)	If SEQ < 0	0.9 ^c (0.7, 1.1)	NS

Characteristic	Level	Univariate Odds ratio (95% CI)	Multivariate Odds ratio (95% CI)
	If SEQ ≥ 0	1.5 ^c (1.1, 2.0)	NS

REF = reference group for odds ratio; NS = non-significant ($p > 0.05$)

SEQ= spherical equivalent refractive error

^aBased on a 1 line decrease in visual acuity

^bBased on a 1.0D increase (more myopic/hyperopic) in spherical equivalent refractive error

^cBased on a 1.0D increase (more astigmatic) in cylinder