Factors Associated with Spectacle-Wear Compliance in School-Aged Mexican Children

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Purpose. To study the prevalence and determinants of compliance with spectacle wear among school-age children in Oaxaca, Mexico, who were provided spectacles free of charge.

Methods. A cohort of 493 children aged 5 to 18 years chosen by random cluster sampling from primary and secondary schools in Oaxaca, Mexico, all of whom had received free spectacles through a local program, underwent unannounced, direct examination to determine compliance with spectacle wear within 18 months after initial provision of spectacles. Potential determinants of spectacle wear including age, gender, urban versus rural residence, presenting visual acuity, refractive error, and time since dispensing of the spectacles were examined in univariate and multivariate regression models. Children not currently wearing their spectacles were asked to select the reason from a list of possibilities, and reasons for noncompliance were analyzed within different demographic groups.

Results. Among this sample of children with a mean age of 10.4 ± 2.6 years, the majority (74.5%) of whom were myopic (spherical equivalent [SE] ≤ −0.50 D), 13.4% (66/493) were wearing their spectacles at the time of examination. An additional 34% (169/493) had the spectacles with them but were not wearing them. In regression models, the odds of spectacle wear were significantly higher among younger (OR = 1.19 per year of age; 95% CI, 1.05–1.33) rural (OR = 10.6; 95% CI, 5.3–21.0) children and those with myopia ≤ −1.25 D (OR = 3.97; 95% CI, 1.98–7.94). The oldest children and children in urban–suburban areas were significantly more likely to list concerns about the appearance of the glasses or about being teased than were younger, rurally resident children.

Conclusions. Compliance with spectacle wear may be very low, even when spectacles are provided free of charge, particularly among older, urban children, who have been shown in many populations to have the highest prevalence of myopia. As screening programs for refractive error become increasingly common throughout the world, new strategies are needed to improve compliance if program resources are to be maximized. (*Invest Ophthalmol Vis Sci.* 2006;47:925–928) DOI:10.1167/iovs.05-0895

Refractive errors commonly account for half or more of impaired vision in most surveyed populations.[1–9] The prevalence of refractive errors has been found to vary across race and geographic location,[1–15] gender,[1–5,9–11,15] age,[2–9,11,13–15], educational level and amount of near work,[11,15] and parental education.[5,15] Although moderate hyperopia can be overcome by accommodation in young eyes, myopia at all levels leads to blurred distant images. Myopia is the most commonly encountered visually significant refractive error among school-aged children,[1,2,4,5,9,10,15] with those in urban settings showing a higher prevalence.[1,5–8,10,11] This condition has significant economic and educational consequences, including poor academic performance and reduced scholastic and social participation.[14,16]

Among several surveyed populations, it has been observed that only one third or less of children with visual impairment due to refractive error are wearing corrective spectacles.[1–8,12,15,17] Despite such low rates of compliance with spectacles, very few studies have been undertaken to look at the factors determining spectacle wear,[18] and most of these have been focused on amblyopic children[19–22] and adults after cataract surgery.[23,24] These groups are not representative of the population at large. Although teasing by peers[25] and the patient's self-esteem[26] have been hypothesized to be important potential factors in determining spectacle wear, their actual impact on compliance has not been evaluated.

In the present study, we performed direct examination of actual spectacle use among a random cluster sample of school-age children, all of whom had previously been provided free glasses through a joint program organized by Helen Keller International and the governmental organization Ver Bien para Aprender Mejor (Oaxaca, Mexico). Refractive error has been identified as an important cause of visual disability among children in Mexico, with 44% of children aged 12 to 13 years found to be myopic (< −0.5 D) in one study,[1] among whom only 20% were using prescription glasses. The purpose of the present study was to document actual rates of spectacle compliance at the time of an unannounced examination, assess the principal determinants of spectacle wear and reasons for nonwear among different demographic groups, and develop potential strategies to increase compliance.

Subjects and Methods

Oaxaca is a state located in southern Mexico, with a population of more than 3.4 million and a school enrollment of 800,000 students in 7,860 schools. It is an ethnically diverse state with inhabitants comprising 17 ethnic groups, including Zapotecs, Mixtecs, mixes, Chinantecos, and descendants of African slaves who live on the coast.

Ver Bien para Aprender Mejor (See Better to Learn Better), an educational organization affiliated with the government in Mexico, has been provided since September 2001 with technical assistance for the

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ChildSight program in Oaxaca by Helen Keller International (HKI), through funding from the United States Agency for International Development. ChildSight is a school-based refractive error program that provides eyeglasses and comprehensive vision care for children. During the period of this study, 178,000 children were examined at more than 700 schools under the HKI program in Oaxaca. Study subjects of this program were all primary and secondary school students in the state of Oaxaca who had received glasses within the past 18 months through the Ver Bien/HKI program.

The initial visual acuity screenings were conducted by teachers in the children's schools. Teachers were provided with a visual acuity chart and a written protocol on screening their students. In addition, some teachers received classroom and/or hands-on training on visual acuity screening and primary eye care. Screenings were performed in convenient, well-lighted areas of the school during daylight hours, but conditions were not standardized between schools.

Visual acuity in subjects wearing habitual refraction was measured at a distance of 6 m separately for each eye of each child, but was recorded only as being > or ≤6/12. Children with acuity measuring 6/12 or less 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 support staff. The optometrist performed noncycloplegic retinoscopy separately in each eye for all referred children and prescribed refractive correction. The support staff assembled and dispensed round "Harry Potter"–style glasses on the spot to the children requiring them and assisted in recording demographic information, spectacle power, and pre- and postrefraction acuity for each child. The round spectacles allowed the axis of astigmatism to be adjusted at the time of dispensing spectacles to the child.

Follow-up visits to the schools to assess whether children were wearing their glasses and to determine reasons for noncompliance, were conducted between 4 and 18 months after the students received their eyeglasses. Schools for the follow-up study (seven suburban/urban and one rural) were chosen at random from a complete list of several hundred schools in Oaxaca state, by using a random-number table. The Ver Bien/HKI team interviewed on a single day all the students indicated in program records to have received spectacles at each chosen school. The staff first noted by direct inspection if the student was wearing eyeglasses. Children not wearing glasses were asked whether they had the eyeglasses with them and to identify 1 of 13 different reasons for noncompliance, which had been identified in previous pilot work as the most common reasons for spectacle noncompliance in this program. Demographic information including age; gender and urban, suburban, or rural residence were recorded for each child from program records.

Though the precise date of the follow-up visit was not announced in advance, to assess more accurately the typical patterns of spectacle wear, the purpose and methods of the follow-up study were explained, and community consent 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 performed in compliance with the tenets of the Declaration of Helsinki.

Statistical Methods

Contingency table analysis was used to examine crude associations between compliance with spectacle wear and potential predictors (i.e., age, gender, spherical equivalent, and place of residence). A logistic regression model was built to account simultaneously for all the factors that were potentially related to spectacle wear, including myopia ≤ −1.25 D, hyperopia ≥ +0.5 D, age in years, gender, and urban versus rural location of the child's school.

Results

A total of 634 (96.9%) of 654 subjects with glasses previously given at the sample schools under the HKI/Ver Bien program were examined. Among these, demographic and refractive error data were available for 568 (89.6%). We excluded subjects aged ≥19 years, which left 493 subjects (86.8% of those with data, 75.4% of the original sample).

Table 1. Demographic and Refractive Information on Participants in a Study of Spectacle Retention among Mexican Children

Characteristic	Current Study *n* (%)	Oaxaca State *n* (%)	Ver Bien Program 1998–2001* *n* (%)
Total number	493	812,745	10,096
Gender			
Male	208 (42.2)	410,468 (50.6)	4698 (46.5)
Female	285 (57.8)	402,277 (49.4)	5398 (53.5)
Age (y)			
6–9	173 (35.1)	368,871 (45.7)	2544 (25.2)
10–12	214 (43.4)	270,103 (33.3)	3089 (30.6)
13 to 18	106 (21.5)	173,771 (21.0)†	4463 (44.2)
Location			
Urban/Suburban	427 (86.6)	365,734 (45.0)	4786 (47.4)
Rural	66 (13.4)	447,011 (55.0)	5310 (52.6)
Spherical equivalent			
≤−1.25	98 (19.9)		
>−1.25 to ≤−0.5	269 (54.6)		4908 (85.1)‡
>−0.5 to <+0.5	108 (21.9)		606 (10.4)
≥+0.5	18 (3.7)		258 (4.5)
Astigmatism			
≥0 to ≤0.25	225 (45.6)		
≥0.5 to <1.0	138 (28.0)		
≥1.0	130 (26.4)		4324 (42.8)

* The most recent time period for which these data are available

† Represents 13- and 14-year-old children. Data unavailable for children 15 to 18 years of age.

‡ Represents all myopic children (< = −0.50 D).

The mean age of the study subjects was 10.4 ± 2.6 years, with 21.3% (105/493) of them in secondary school at the time of examination. The majority of the subjects (57.8%) were girls. Students at schools classified by the Oaxaca state government as urban or suburban comprised 87% (427/493) of the subjects, whereas rural students were only 13% (66/493) of the sample. The majority of subjects were moderately myopic (54.6% of subjects with spherical equivalent > −1.25 to ≤ −0.50 D), whereas only 3.7% were hyperopic (spherical equivalent ≥ +0.50 D), and 19.9% had more significant myopia (spherical equivalent ≤ −1.25 D). Of all subjects, 45.6% had no astigmatism, with 26.4% (130/493) having 1 D or more of cylinder. (Table 1, data for Oaxaca State and for the Ver Bien Program 1998 to 2001, the most recent period for which these data are available, provided for comparison). Among children receiving spectacles, 22% had a spherical equivalent > −0.5 D to < +0.5 D, almost all of whom were being given spectacles primarily to correct astigmatism. Overall mean time between dispensing of the spectacles and examination was 12.8 ± 5.4 months (range, 0.5–17 months).

It should be noted that the study population includes only children newly receiving glasses through the HKI program and not subjects wearing intact, appropriate spectacles at the time of initial service delivery. In the study population, spherical equivalent did not differ significantly by age ($\chi^2_{(6)} = 3.4$, $P = 0.75$) or gender ($\chi^2_{(3)} = 4.98$, $P = 0.17$), although urban and suburban children (22.3%) had significantly more myopia (≤ –1.25 D) than did rural children (4.6%, $P = 0.0004$, Fisher exact test). Myopia of any degree had a similar prevalence between rural and urban children, with more rural children having mild myopia (−0.5 to −1.25 D).

At the time of examination, 13.4% (66/493) of children were wearing their spectacles, and an additional 34% (169/493) had the spectacles with them, but were not wearing

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TABLE 2. Results of a Multiple Logistic Regression Model Including Various Factors Potentially Predictive of Spectacle Wear among a Population of Mexican School Children

Independent Variable	Beta	Standard Error	*P*
Myopia < −1.25 D	1.35	0.36	0.0001
Hyperopia > +0.5 D	1.28	0.65	0.05
Age (ys)	−0.17	0.06	0.006
Gender	0.41	0.30	0.17
Time since provision of spectacles (mos)	0.04	0.62	0.43
Urban versus rural school	2.74	0.61	0.0001

Children with myopia, hyperopia, younger age, and rural residence were more likely to wear their spectacles at the time of examination.

them. In univariate models, the prevalence of spectacle wear was significantly higher in rural (40.9%) versus urban/suburban (9.1%; $\chi^2_{(1)} = 49.8$; $P = <0.0001$) areas and significantly lower among the oldest children (age, 13–19 years, 3.8%) compared with younger subjects (age, 6–12 years; 16.2%; $\chi^2_{(1)} = 10.75$; $P = 0.001$). Prevalence of spectacle wear did not differ significantly by gender. Compliance with spectacles among children with spherical equivalent of −0.50 D, the lowest level of myopia at which spectacles were given in the program (51/493, 10% of children receiving spectacles in this sample), was only 2% (1/51).

In multivariate regression models including myopia < −1.25 D, hyperopia > +0.5 D, age, gender, and urban versus rural location of the child's school, the odds of spectacle wear were significantly higher among older (OR = 1.19 per year of age; 95% CI, 1.05–1.33), rural (OR = 10.6, 95% CI, 5.35–21.0) children and those with myopia (OR = 3.97, 95% CI, 1.98–7.94) and hyperopia (OR = 3.63, 95% CI, 1.02–12.9; Table 2). Gender and time since dispensing of the spectacles were not significant predictors of spectacle wear.

The reasons given by children for nonwear of their spectacles are summarized in Table 3 (the original 13 responses have been collapsed into eight categories to avoid repetition). In multivariate regression models including the above variables, older age (OR = 1.14 per year of age, 95% CI, 1.03–1.25) and urban–suburban residence (OR 5.56, 95% CI, 1.3–25.0) were significantly associated with concerns about the appearance of the glasses or about being teased, whereas gender and refractive error were unassociated with specific self-reported causes for noncompliance.

DISCUSSION

Several studies have documented that, in many settings, only a small proportion of children with significant refractive errors are actually wearing corrective spectacles.[1–8,12,15,17] However, few studies[12] have reported medium or long-term compliance with spectacles among school-age children, and even fewer have examined risk factors for noncompliance.[1] Those few studies that have examined compliance with spectacle wear and risk factors for noncompliance have frequently focused on special populations of children, such as those participating in trials of therapy designed to reduce myopia progression[18] or to treat amblyopia.[19–22] Unlike the present study, which examined a random sample of schoolchildren in Oaxaca, Mexico, the results of these studies are likely to have very limited generalizability.

The relatively small proportion of children identified as compliant with spectacle wear in the present study, 13%, is generally in accord with other reports, such as that of Villareal et al.,[1] also in Mexico, indicating only 28% compliance among children with myopia worse than −0.75 D. Studies of aphakic spectacle compliance in adults after cataract surgery[23] have also often reported limited medium-term compliance. That our own rate of spectacle wear is even lower than those reported elsewhere in the literature may in part be because outcomes in the present study were based on actual inspection of the child in question, whereas other studies have depended on self-report, which may be expected to give higher, but less-reliable, data.

Two risk factors for noncompliance with spectacle wear in the present study, older age and urban residence, are particularly troubling. The prevalence of myopia among school-age children is well known to increase with age[2–9,11,13–15] and several studies have demonstrated a higher prevalence of myopia in urban than in rural populations.[1,5–8,10,11] Thus, precisely those children who stand to benefit most from corrective spectacles for myopia, older, urban children, are the ones at greatest risk for noncompliance. Spectacle wear among children residing in urban and suburban areas was only 9% (compared with 41% in rural children) in this population. From a programmatic standpoint, a possible interpretation of these results with regard to age may be that intervening to provide spectacles when a child is younger and more likely to comply may allow this pattern of better compliance to be maintained at a later age when the risk of more visually significant refractive error is higher. This hypothesis can be tested within the context of program delivery strategy.

The present study provides some insights into the noncompliant behavior of these older and urban children. Both groups were significantly more likely to list concerns about appearance and being teased as reasons for spectacle nonwear than were younger, rural children. This suggests the need for two-pronged strategies targeting these key at-risk groups with educational messages explaining the need for spectacle wear and also improved designs with greater esthetic appeal. A practical problem with the latter strategy is the fact that on-the-spot delivery of glasses is a critical part of HKI's strategy of school-based screening, to reduce the barriers to receipt of spectacles inherent in programs providing only chits or prescriptions for spectacles or those delivering glasses at a later date. On-the-spot delivery of glasses requires the use of round frames so that the axis of astigmatism can be adjusted at the time of assembly. Our experience in Mexico and elsewhere has suggested that such round frames ("Harry Potter" glasses) are often less appealing to children concerned about appearance. The fact that only 26% of the subjects in the present study had 1 D or more of astigmatism, this suggests that more than 70% of children requiring spectacles might be accommodated with more cosmetically acceptable oval frames. Alternatively, round frames could be used in rural areas where compliance is less problematic and later follow-up visits to dispense oval frames are presumably more expensive, and oval frames could be used in

TABLE 3. Proportion of Subjects Wearing Glasses and Self-Reported Reasons for Noncompliance with Spectacle Wear

Glasses-Wearing Status/Reason	*n* (%)
Children wearing glasses	66 (13.9)
Children not wearing glasses	427 (86.1)
Glasses broken or lost	69 (14.0)
Glasses cause headache	30 (6.1)
Forgot glasses at home	82 (16.6)
Use at special times or only occasionally	70 (14.2)
Don't feel glasses are needed	43 (8.7)
Concerned or teased about appearance of glasses	82 (16.6)
Parents disapprove of glasses	8 (1.6)
Other or no reason	43 (8.7)
Total	493 (100.0)

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urban areas where the opposite is likely to be true. The relative cost of dispensing per pair of spectacles presumably could be calculated and compared between competing scenarios to model this strategy.

Another finding in the present study with important programmatic implications is the fact that spectacle compliance was especially low among children with more modest degrees of refractive error. HKI has already implemented a new protocol, which will raise the cutoff for provision of spectacles for nonastigmatic myopia from −0.75 to −1.00 D. In the current sample, this would have reduced the number of spectacles provided by 24.3% (data not shown). This change in protocol, resulting directly from the data reported in the current article, will significantly reduce costs to the program for supplies and labor, thus allowing resources to be focused on specific programs to improve compliance among older, urban children at high risk for spectacle nonwear.

Limitations of the present study should be acknowledged. Subjects included only participants in HKI's school-based refractive error program and thus excluded children who were not attending school. Children attending school are more likely to be engaged in near work and are thus more likely to be myopic as a group, and to benefit from refractive correction, but these results still cannot be generalized to the population as a whole. Due to practical considerations and the need to complete program interventions in a timely fashion, children did not undergo cycloplegia for retinoscopy, and thus latent hyperopia was not measured, perhaps in part accounting for the low prevalence of significant hyperopia in the sample (3.7%). Vision screening for all subjects was performed by schoolteachers with only minimal training in the measurement of acuity, and the sensitivity and specificity in detecting children with refractive error affecting vision is not known and may have been limited. Visual acuity without glasses was a likely determinant of spectacle wear, but was not recorded for many subjects in this study, and thus could not be included in regression models. Only a single rural school was surveyed, and it is possible that characteristics of the school other than its rural location could have contributed to the observed associations with rural residence. Although children were not told about the date of the follow-up visit to their schools, it is possible that the fact that parents were notified in advance of the follow-up plan (though not the date) may have influenced children's patterns of spectacle wear. Finally, only three fourths of children who had been dispensed spectacles in the target schools could be located. Complete data were not available for those children who could not be examined, which may have been due to nonattendance at school on the day of examination or to the students' having moved to a new school district in the intervening period since receiving the spectacles. Thus, although the proportion of children who could be examined was fairly high, the possibility that examined children were not representative of the full population of children receiving glasses cannot be excluded. All of these limitations, though they may affect the validity of our figures as epidemiologic data, are less likely to impact the important programmatic implications of the present study for our own, and potentially other, refractive screening programs for school-aged children.

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