

# Baltimore Reading and Eye Disease Study (BREDS): compliance and satisfaction with glasses usage



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<b>PURPOSE</b>	To assess the patterns and predictors of glasses wear in a 2-year school-based study.
<b>METHODS</b>	Second and third graders underwent an eye examination at school. Two pairs of glasses were provided if they met prescribing criteria. Replacements were provided as needed. Students received follow-up examinations and completed survey questionnaires during the same and the following academic year.
<b>RESULTS</b>	Of the 197 students prescribed glasses who completed year 1 follow-up, 172 (87%), were observed to still be wearing glasses. However, less than two-thirds of students reported wearing glasses as prescribed (eg full-time if prescribed full-time). Most students, 175 (89%), reported being happy with their glasses and 135 (69%) reported improvement in vision. Thirty-nine students (20%) reported being teased about their glasses. Replacement glasses were required by 136 students (66%). Refractive error was not associated with likelihood of requiring replacement. Being observed wearing glasses correlated with parent (OR = 4.2; 95% CI, 1.2-15.0) and teacher reminders (OR = 6.4; 95% CI, 1.5-28.4) in year 2.
<b>CONCLUSIONS</b>	Most children continued to wear glasses during follow-up, yet not always as prescribed. A substantial proportion of students required replacements, underscoring the importance of school-based programs developing mechanisms to monitor eyeglasses usage and mechanisms to replace lost or broken pairs. (J AAPOS 2019;23:207.e1-6)

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Up to 25% of schoolchildren in the United States have a vision problem, most commonly due to uncorrected refractive error.<sup>1,2</sup> Vision screenings and eye examinations are also key for detection of amblyopia risk factors and treatment.<sup>2</sup> In addition, uncorrected vision problems in children interfere with development and learning and also affect their health and well-being as adults.<sup>1</sup> For children who fail a vision screening, access to eye care may be a significant barrier to treatment, especially in low-income, urban settings, where the rate of vision problems has been reported to be as high as 53%, more than double the national average of

25%.<sup>3</sup> Furthermore, poor follow-up rates for eye care referrals and low use of prescribed glasses has been the norm.<sup>1,2,4</sup> School-based eye care models aim to overcome these barriers.<sup>2,5</sup> Few studies have examined outcomes after school-based interventions, including whether students continue to wear glasses provided through such programs.<sup>6-8</sup> In one study, glasses wear at 6 months post-intervention was 73%, while others have reported usage rates ranging from 58%-71% at 1 year.<sup>7,9,10</sup>

The Baltimore Reading and Eye Disease Study (BREDS) was a pilot study that sought to examine the impact of prescribing glasses on reading performance in 12 high-poverty elementary schools in Baltimore.<sup>11</sup> We report usage of prescribed glasses by second and third graders after in-school eye examination with provision of glasses. We also report student satisfaction with their glasses and the effect of reminders on glasses wear.

## Subjects and Methods

BREDS was conducted during the 2014-15 and 2015-16 academic years. The study was approved by the Johns Hopkins School of Medicine Institutional Review Board and the Baltimore City Public Schools and was performed in accordance with the tenets of the Declaration of Helsinki.

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Briefly, we conducted school-based vision and reading assessments on second and third-grade students attending 12 Baltimore city public schools in the 2014-15 academic year. Glasses were prescribed to students based on study-specified refractive error criteria: full-time use (all waking hours) for myopia  $\geq -3.00$  D, hyperopia  $\geq +4.50$  D, astigmatism  $\geq 2.00$  D, and/or anisometropia  $\geq 2.00$  D spherical or cylindrical refraction in either eye and part-time use (classroom and homework) for myopia  $\geq -0.50$  D, hyperopia  $\geq +1.00$  D, astigmatism  $\geq 1.00$  D, and/or anisometropia  $\geq 1.00$  D spherical or cylindrical refraction in either eye. We used liberal prescribing criteria (ie part-time wear) to examine the possible benefit of lower-power corrections on reading performance with results reported elsewhere.<sup>11</sup> Students chose their frames from a selection of 20 styles, including both wire and acetate options, provided by Hellen Keller International and based on their prior experience with school-based programs. For students prescribed glasses, two pairs were provided: one to be kept and used at school and the other for home. Students with an ocular condition not amenable to a school-based treatment (eg amblyopia suspect) were referred to a pediatric eye care provider.

Initially designed to follow students over one academic year, the study was extended into the following academic year to provide longer follow-up on glasses usage and satisfaction. Parents were recontacted in the fall of year 2 to obtain written permission for the study's extension phase.

A team from Johns Hopkins comprised of pediatric ophthalmologists, optometrists, and research staff performed all vision examinations. Baseline demographics and study methodology are reported elsewhere.<sup>12</sup> For students who were prescribed glasses at the initial examination, follow-up examinations were conducted 3-6 months later during the same academic year to observe use of glasses and effects on visual acuity. A second follow-up examination was conducted during year 2. All visits were scheduled in advance with schools and teachers. During follow-up visits, the study team recorded whether students prescribed glasses were observed to be wearing them. All students who had been prescribed glasses, regardless of whether they were wearing them during the follow-up visit, were asked about glasses usage, loss and breakage, satisfaction with wearing glasses, whether or not they were being teased, and the effects of glasses on their vision and reading. During year 2, students were also asked whether parents or teachers reminded them to wear their glasses.

All glasses provided in the study were replaced whenever needed. Students, parents, and teachers were instructed to notify the study team if glasses were broken or lost. Replacement glasses were ordered on the same day the team was notified. Time to replacement was determined as the time between original dispensing date and the dispensing date of the replacement. The study team made school visits to replace and repair glasses as needed in both study years.

Baseline characteristics including age, sex, ethnicity, and the student's grade level were compared between students who did and did not require glasses replacement during the study period. Proportions of students observed wearing glasses at follow-up visit as well as each response to the questions about satisfaction and use of glasses were calculated. Univariate and multivariate lo-

gistic regression analyses were performed to assess the odds ratio and 95% confidence intervals of needing replacement and glasses usage in different groups of students. All analyses were conducted in Stata version 14.

## Results

A total of 321 students completed baseline examinations during the 2014-15 academic year, of whom 206 (64%) were prescribed glasses based on study-specified refractive error criteria (Figure 1). A follow-up vision examination was performed later during the same academic year on 197 of 206 (96%) students who had been prescribed glasses. The remaining 9 students were lost to follow-up because they transferred out of study schools within the same academic year. Of the 197 students who completed year 1 testing (enrollment and follow-up), 86 (44%) transferred the following year to schools not participating in the study, leaving 111 students eligible for the year 2 extension phase. Of the 111, 66 (60%) provided consent for follow-up in year 2.

The median time between baseline and same academic year follow-up examinations was 90 days (range, 29-203). The median time between baseline and year 2 follow-up examinations was 435 days (range, 308-537).

Of the baseline study population of 206 students (119 females [58%]) initially prescribed glasses, 58% were in grade 2; mean age was  $8.5 \pm 0.7$  years. The majority (173/206 [84%]) were African American; 16 (8%) were of Hispanic ethnicity. The demographics of the students seen in year 2 follow-up did not differ from those seen in year 1 follow-up.

### Glasses Replacement in Year 1

All 206 students prescribed glasses received two pairs at baseline, one for school and one for home. Of these, 136 (66%) required replacements (Figure 2). Survival analysis showed that 25% students required replacements by 53 days (95% CI, 43-61) after they received the first set of glasses, and 50% students required replacements by 199 days (95% CI, 186-214). Fifty-two students (25%) required replacement twice, and 12 (6%) required replacement at least three times. Of the 197 students seen at follow-up visit in year 1, 11 (6%) reported that their school pair of glasses was missing, 22 (11%) reported their home pair missing, and 8 (4%) reported both missing.

### Student-reported Experience

At the year 1 follow-up examination, 172 students (87%) were observed wearing glasses, and 151 (77%) reported having both pairs of glasses as replacements were ongoing (Table 1). Sixty-three students (32%) reported wearing glasses full-time, and 122 (62%) reported wearing glasses part time. Research personnel observed 172 students (87%) wearing glasses. During year 1, 124 of 172 students (63%) reported wearing their glasses as prescribed (either part time or full time; see eSupplement 1, available at

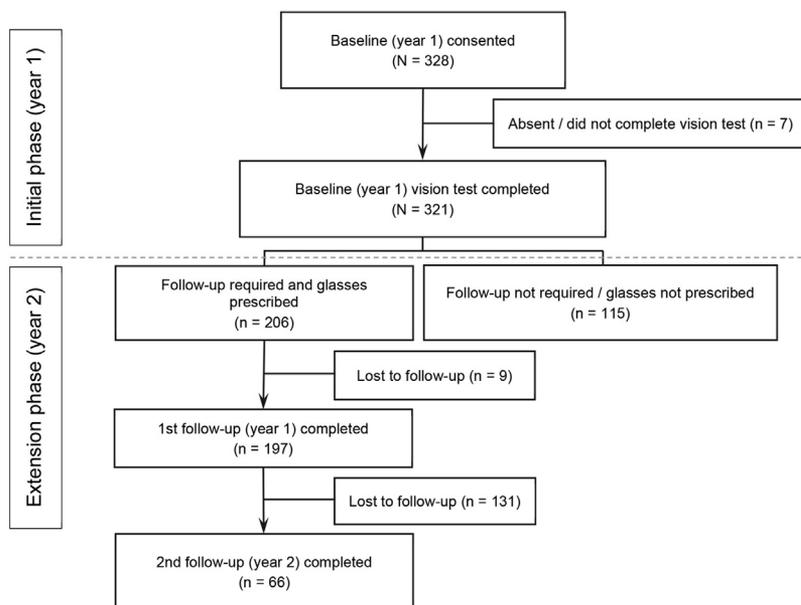


FIG 1. Flowchart of study.

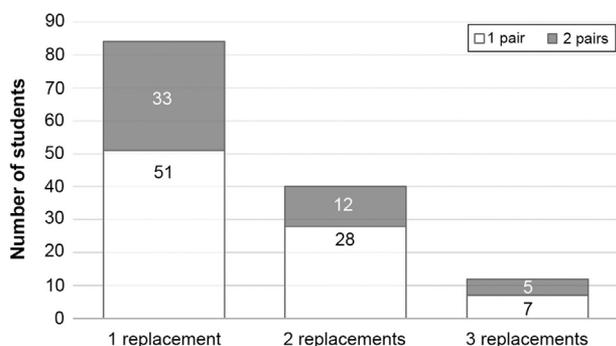


FIG 2. Replacement glasses: 2014-16.

jaapos.org). Similar trends persisted in year 2 (see eSupplement 2, available at jaapos.org). Of the 29 students prescribed full-time glasses, 13 (45%) were wearing their glasses part-time.

**Satisfaction with Glasses Wear**

During year 1, 175 students (89%) reported being happy with their glasses (Table 1). Nearly all, 169 (86%), liked how their glasses looked on them; 39 students (20%) reported being teased about their glasses. When asked about the impact of their glasses on vision, 135 students (69%) felt that their glasses helped “a lot.” For reading, 141 (72%) reported “a lot” of subjective improvement from the glasses. Fewer students felt that glasses had only a little effect on their vision (n = 53 [27%]) or reading ability (n = 43 [22%]). The proportions of students reporting their glasses helped “a lot” did not differ significantly between children prescribed glasses full time compared to part time. Similar proportions were observed during year 2 (eSupplement 3, available at jaapos.org).

At year 1 follow-up, only 134 of 197 students (68%) reported that their glasses continued to fit well, despite the fact that glasses were adjusted by the study team to ensure a good fit at interim visits. For students who felt that their glasses did not fit well, the most common complaint was that frames were too loose (n = 30 [15%]). Similar proportions were observed during year 2.

**Glasses Wear at Observations**

In year 1, students who reported being happy with their glasses were more likely to wear them compared with those unhappy with or unsure about their glasses (OR = 4.2; 95% CI, 1.2-14.2), although this association was not seen in year 2 (Table 2). In year 2, when questions about parental/teacher support for glasses use were asked, students who reported reminders to wear glasses by the teacher (OR = 4.2; 95% CI, 1.2-15.0) or by their parents (OR = 6.4; 95% CI, 1.5-28.4) were more likely to wear glasses than peers who were not reminded.

**Need for Replacement Glasses**

Students’ eyeglasses-wearing behavior and attitude toward the glasses were assessed for any association with requiring glasses replacement. No studied factors, including part-time/full-time glasses wear, glasses wear satisfaction, or self-reported frequency of glasses wear, were found to be associated (eSupplement 4, available at jaapos.org).

**Discussion**

Initial acceptance and observed use of school-delivered glasses among second- and third-grade children in 12 Baltimore City Public Schools was high (88%) during the same academic year and remained high in a smaller sample

Table 1. Year 1 data

Observed wearing of glasses (N = 197)	No. (%)
Observed wearing glasses by study team	172 (87)
Self-reported glasses wear	
Full time	63 (32)
Part time	122 (62)
Infrequently/never	6 (3)
Not sure	4 (2)
Refused	2 (1)
Students self-reporting still have both pairs	
Yes	152 (77)
No	43 (22)
Missing	2 (1)
Students' self-reported satisfaction on wearing glasses (N = 197)	
Happy with glasses	
Yes	175 (89)
No/unsure	17 (9)
Refused	5 (3)
Glasses look good	
Yes	169 (86)
No/unsure	25 (13)
Refused	3 (2)
Glasses help them see better	
Yes, a lot	135 (69)
Yes, a little	53 (27)
No	5 (3)
Refused	4 (2)
Glasses help them read better	
Yes, a lot	141 (72)
Yes, a little	43 (22)
No/unsure	10 (5)
Refused	3 (2)
Teased about glasses	
Yes	39 (20)
No/unsure	154 (78)
Refused	4 (2)
Glasses fit	
Just right	134 (68)
Too loose	30 (15)
Too tight	5 (3)
Uncomfortable or glasses broken	10 (5)
Refused	18 (9)

of children available for follow-up during the second year. This rate is higher than reported by other studies of school-age children (33%-80%).<sup>3,6,9,10</sup> However, the median time between distribution of glasses and follow-up was only 90 days in our study; had retention been assessed after a longer time period, the rate may have been lower. The high rate observed may also in part be due to frequent monitoring of students in the present study by the research team as well as reminders from the research team to school staff to encourage students' use of glasses.

The only factor that was significantly associated with glasses use in year 1 was self-reported happiness with the glasses. Other studies have found that higher refractive error has been associated with increased use of glasses in children.<sup>9,10</sup> However, in this study we found no difference in glasses wear for those prescribed part-time versus full-time glasses. While suggesting that factors other than uncorrected visual acuity may influence whether children will

continue to wear or not wear their glasses, this could not be fully assessed as we did not give glasses to emmetropic subjects as controls.

One study previously reported peer acceptance as an important contributor to glasses use in children and adolescents.<sup>6</sup> In the present study, about one-fifth of students reported negative feedback from peers about their glasses. Education of students by school staff about the importance of vision care and glasses usage as part of their curriculum may improve rates of wear, but further studies are needed to identify strategies that effectively reduce teasing by peers. Although our results were observed in elementary school children, teasing also potentially affects older children.

An additional factor that may influence wearing of glasses is poor fit, especially frames being or becoming too loose with wear. Improving the selection, quality, and fit of provided styles, providing repair kits to teachers or parents, and training school staff in rudimentary adjustments of fit may help decrease loss and breakage and improve adherence to recommended use.

Overall, our findings are consistent with prior reports citing glasses breakage and loss as the primary reason for children not wearing their prescribed glasses.<sup>7</sup> In our study, the majority of students lost at least one pair of glasses, in many cases soon after the glasses were dispensed. Almost half of the students who required replacements needed replacements two or three times: the 206 students enrolled in the program received 412 pairs of glasses initially, but also 266 replacements. This is a substantial burden that must be expected in similar school-based programs.

Managing and funding the repair of ill-fitting frames and replacement of lost glasses appears key to having a sustainable intervention for school-based delivery of eyeglasses to young children. This issue should be considered when embarking on school-based screening programs. In our study, all glasses were provided for free, which may have the unintended consequence of reducing student, parent, and teacher perception of the value of the glasses or concern about loss/breakage. Further research should investigate whether providing glasses for free versus requiring a small fee may impact valuation of glasses and affect rates of breakage and the need for replacement.<sup>13</sup>

An actionable finding was the increased likelihood of wearing glasses by children who had been encouraged by parents or teachers to wear their glasses. This points to a potentially useful approach to improve glasses wear but requires further investigation; we only inquired about this in the year 2 and cannot be certain of the generalizability of these findings.

Not all parents returned consent forms despite study participation being open to all second and third graders at participating schools, therefore selection bias may be present if motivated families or those concerned about vision problems were more likely to enroll.

Challenges to longitudinal follow-up included a rate of student transfers to different schools that was higher than expected, as well as the lower than expected return rate of consent forms for the extension study. Therefore, although

Table 2. Odds of students observed to be wearing glasses (2014-2016)

Determinants	Year 1 (2014-2015)		Year 2 (2015-2016)	
	Unadjusted model	Adjusted model <sup>a</sup>	Unadjusted model	Adjusted model <sup>a</sup>
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Prescribed glasses wear				
Part time	Reference	Reference	Reference	Reference
Full time	2.1 (0.48-9.6)	1.8 (0.39-8.3)	1.2 (0.23-6.4)	1.4 (0.24-7.7)
Glasses wearing satisfaction <sup>b</sup>				
Not happy/unsure	Reference	Reference	Reference	Reference
Happy	3.6 (1.2-11.5) <sup>d</sup>	4.2 (1.2-14.2) <sup>d</sup>	0.83 (0.16-4.4)	0.87 (0.16-4.8)
Being reminded by parent <sup>c</sup>				
No	N/A	N/A	Reference	Reference
Yes	N/A	N/A	3.7 (1.1-12.4) <sup>d</sup>	4.2 (1.2-15) <sup>d</sup>
Being reminded by teacher <sup>c</sup>				
No	N/A	N/A	Reference	Reference
Yes	N/A	N/A	6.2 (1.6-25) <sup>e</sup>	6.4 (1.5-28) <sup>d</sup>

OR, odds ratio; CI, confidence interval; N/A, not applicable.

<sup>a</sup>Models adjusted for age, sex, ethnicity/race.

<sup>b</sup>Self-reported glasses wear satisfaction; data obtained from first follow-up, with 5 of 197 students who completed first follow-up not answering (missing data).

<sup>c</sup>Glasses wear reminder not assessed during the first follow-up.

<sup>d</sup> $P < 0.05$ .

<sup>e</sup> $P \leq 0.01$ .

year 2 findings support the positive findings of year 1, they should be interpreted with caution. In addition, our high rates of wear may have been influenced by the fact that school visits announced by the study team could have affected student and teacher behavior and that median time to follow-up visit in the first year was only 90 days, with some as short as 29 days. Furthermore, information about glasses wearing habits were obtained by observing and interviewing students. Since students were only observed during school visits, it is difficult to know how closely these observations represented general patterns of wear both in school and at home. Similarly, we have no information about usage outside the classroom except from student self-reports, which may not reflect true glasses use. Future research in monitoring use with heat sensor technology could be considered to study this issue.

This study was not powered to examine if demographics differed between students who required replacement glasses versus those that did not. In addition, it was not designed to evaluate the benefit of dispensing one versus two pairs of glasses. Our surveys did not distinguish between the two pairs of glasses in terms of use, fit, and student satisfaction, but twice as many students in year 1 reported losing their home pair of glasses compared to those who reported loss of the school pair. Although this self-reported pattern is suggestive, direct observation by the research team could help determine whether there was a true difference between the two pairs. Lastly, we did not analyze data by individual school because of the small sample size for each. It is possible that among the twelve 12 schools in the study, there were differences in performance and teacher strategies used to promote eyewear.

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