tvst

https://doi.org/10.1167/tvst.7.6.43

Article

Spectacle Wear in Toddlers: Frequency of Wear and Impact of Treatment on the Child and Family

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Received: 12 June 2018
Accepted: 19 October 2018
Published: 28 December 2018

Keywords: spectacles; children; treatment compliance

Citation: Harvey EM, Miller JM, Davis AL, Twelker JD, Dennis LK. Spectacle wear in toddlers: frequency of wear and impact of treatment on the child and family. Trans Vis Sci Tech. 2018;7(6):43, https://doi.org/10.1167/tvst.7.6.43

Purpose: We assessed the frequency of spectacle wear and impact of spectacle treatment in toddlers.

Methods: Children 12 to <36 months old with significant refractive error were provided spectacles. After 12 (±6) weeks, parents reported the frequency of spectacle wear and completed the Amblyopia Treatment Index (ATI, modified for spectacle treatment). Factor analysis assessed usefulness of ATI for spectacle treatment. Spectacle wear and ATI results were compared across age (1- vs. 2-year-olds) and sex.

Results: Participants were 91 children (60% male; mean age, 22.98 [SD 6.24] months, 41 1- and 50 2-year-olds) prescribed spectacles for astigmatism (92%), hyperopia (9%), or myopia (1%). Reported frequency of wear was low (<2 hours/day) in 41%, moderate in 23% (2 to <6 hours/day), and high (≥6 hours/day) in 36% and did not differ across age or sex. ATI factor analysis identified three subscales: adverse effects, treatment compliance, and perceived benefit. One-year-olds had poorer scores on adverse effects ($P = 0.026$) and treatment compliance scales ($P = 0.049$). Low frequency of spectacle wear was associated with poorer scores on treatment compliance ($P < 0.001$) and perceived benefit scales ($P = 0.004$).

Conclusions: Frequency of spectacle wear was not related to age or sex. Younger children may have more difficulty adjusting to treatment. Parents of children with low spectacle wear reported less perceived benefit of treatment.

Translational Relevance: Data on factors associated with frequency of spectacle wear in toddlers is valuable for parents and clinicians and may lead to methods to improve compliance and reduce the negative impact of treatment.

Introduction

In 2016, the American Academy of Pediatrics, American Academy of Ophthalmology (AAO), and American Association for Pediatric Ophthalmology and Strabismus (AAPOS) recommended instrument-based vision screening at well-child checks beginning at age 1 year and continuing until acuity can be assessed reliably.[1] Recent reports have indicated that introduction of instrument-based screening in the primary care office significantly increases the rate of successful vision screening in preschool children (3–5 years), compared to chart-based methods.[2,3] Routine instrument-based screening at well-child visits also is likely to result in an increase in screening, referral, and spectacle prescribing for refractive errors in very young children (<3 years), who in the past typically did not receive a vision screening until they were old enough to perform acuity testing using chart-based methods.

Despite recommendations for screening, referral, and treatment of refractive errors in young children,[1,4] little information exists in the literature on the impact of spectacle treatment and compliance with treatment in children younger than 3 years. One study surveyed parents of 133 children younger than 8 years who were recently prescribed spectacles, although

only 13 children were <3 years old.[5] Surveys were completed after approximately 5 weeks of spectacle wear. One and 2-year-olds had the lowest estimates of compliance, but compliance was not significantly related to the child's age or sex. Negative comments from others were rare for younger children (3- and 4-year-olds compared to 5- and 6-year-olds), but could not be reliably measured for children under 3 years. Evidence from studies of older children suggests there can be negative social and/or psychologic factors associated with spectacle wear.[6–8] Previous studies assessing factors associated with spectacle wear in children have focused primarily on school-age children.[9–14]

We conducted a study to assess frequency of spectacle wear and the impact of spectacle prescribing in young children (12 to <36 months old) identified as a result of photoscreening conducted at a well-child check. In addition, we assessed the internal validity and internal consistency reliability of the Amblyopia Treatment Index (ATI) for assessing the impact of spectacle prescribing on the child and family. Previous studies have used the ATI in older children receiving patching or atropine treatment for amblyopia.[15–17] It is not yet known if the ATI is useful for assessing the impact of spectacle treatment in these younger children.

Methods

Subjects

Participants were children 12 to <36 months old who failed an instrument-based vision screening (Spot Vision Screener; Welch Allyn, Inc., Skaneateles Falls, NY) conducted at a pediatric well-child check. Referring clinics were two large multi-physician practices with several clinics throughout the community (Tucson, AZ). Children were invited to receive a standard eye examination as part of a research study. Eye examinations were conducted from October 2016 through September 2017 at the University of Arizona Visual Development Lab or on-site at one of the referring pediatric clinics. Children who had significant refractive error (12–30-month-olds: >2.50 diopters [D] spherical equivalent [SE] anisometropia, >4.50 D SE hyperopia, >2.00 D astigmatism, >3.50 D SE myopia; 31–35-month-olds: > 2.00 D SE anisometropia, >4.00 D SE hyperopia, >2.00 D astigmatism, >3.00 D SE myopia)[18] were invited to participate in a 12-week spectacle study to assess frequency of spectacle wear and the impact of spectacle prescribing on the child and family.

Written informed consent was obtained from a parent or guardian before the initial eye examination, and again before enrollment in the spectacle study. This study complied with the Declaration of Helsinki, was approved by the institutional review board of The University of Arizona, and conformed to the requirements of the United States Health Insurance Portability and Privacy Act.

Procedures

Children received an eye examination that included cover–uncover and alternate cover testing, assessment of pupils and anterior segment, cycloplegic retinoscopy (conducted at least 30 minutes after instilling one drop of 0.5% proparacaine and one drop of 0.5% cyclopentolate), and fundus examination. A pediatric ophthalmologist (JMM) or optometrist (JDT, ALD) conducted the examinations. Children with refractive error meeting any of the study prescribing criteria (see above)[18] were given a prescription for spectacles with a recommendation for "full-time wear, except in the bathtub and bed." The full correction was prescribed with the exception that for children with bilateral hyperopia (right and left eye sphere $\geq +0.25$ D in plus cylinder notation), the sphere components of correction were symmetrically reduced to provide a stimulus for emmetropization and to avoid of overcorrection, as is commonly done in routine clinical practice. The amount of hyperopia undercorrection was determined by the examiner so that it would be consistent with their routine clinical practice. Children prescribed spectacles were invited to participate in a 12-week spectacle study.

Children who were enrolled in the spectacle trial were provided a pair of spectacles with flexible pediatric frames (Dilli Dalli; Clearvision Optical, Hauppauge, NY; Miraflex, Doral, FL). Parents were given a "tips sheet" of ideas to help their child adjust to wearing the spectacles. Tips focused on providing positive reinforcement for spectacle wear, trying to avoid making spectacle wear a source of conflict with the child, and making spectacle wear part of the child's daily routine. Once spectacles were dispensed, study staff attempted to contact parents weekly via phone, email, or text message (depending on parent preference) for a brief update on frequency of spectacle wear (specifically, asking days/week of wear and hours/day of wear over the past week). After 12 weeks, children were scheduled for a follow-up examination. The follow-up examination was identi-

Table 1. Summary of Refractive Error in 91 Children in the Study Sample

Refractive Error Prescribing Criteria Met	Eye	Refractive Error	Mean	SD	Minimum	Maximum
Astigmatism, $n = 82$	Right	Sphere	−1.44	1.61	−5.50	+2.00
		SE	−0.03	1.48	−3.50	+3.25
		Cylinder	2.82	0.71	+1.25	+5.00
	Left	Sphere	−1.38	1.63	−5.50	+2.25
		SE	−0.01	1.49	−3.50	+3.38
		Cylinder	2.74	0.68	+1.25	+5.00
Astigmatism + Hyperopia, $n = 2$	Right	Sphere	+3.50	0.00	+3.50	+3.50
		SE	+4.63	0.18	+4.50	+4.75
		Cylinder	+2.25	0.35	+2.00	+2.50
	Left	Sphere	+3.50	0.00	+3.50	+3.50
		SE	+4.69	0.09	+4.63	+4.75
		Cylinder	+2.38	0.18	+2.25	+2.50
Hyperopia, $n = 6$	Right	Sphere	+5.67	0.93	+4.50	+7.00
		SE	+6.06	1.12	+4.75	+8.00
		Cylinder	+0.79	0.68	+0.00	+2.00
	Left	Sphere	+5.50	1.05	+4.50	+7.00
		SE	+5.81	1.29	+4.50	+8.00
		Cylinder	+0.63	0.80	+0.00	+2.00
Myopia,[a] $n = 1$	Right	Sphere	−10.00			
		SE	−9.38			
		Cylinder	+1.25			
	Left	Sphere	−10.00			
		SE	−9.38			
		Cylinder	+1.25			

[a] SD, Minimum, and Maximum not reported as only one child met this criterion.

cal to the initial examination, with the addition of the ATI and a brief spectacle wear survey completed by the child's parent or guardian.[15–17] The spectacle wear survey included three items: "How many days per week does your child wear the eyeglasses (0–7)?," "How long does your child wear the eyeglasses each day (hours)?," and "Since your last visit, has your child been without eyeglasses due to loss or breakage?" The ATI was originally constructed to assess the impact of patching or atropine treatment for amblyopia in children. For this study, the wording of the items was revised to ask about the impact of spectacle treatment, rather than atropine or patching treatment (see Table 2 for ATI items). The surveys were completed by the child's parent or guardian, were self-administered, and were available in English and Spanish languages.

Data Analysis

The final sample included children 12 to <36 months old meeting at least one refractive error prescribing criterion in the absence of constant strabismus or other ocular abnormalities and with no previous spectacle wear. Preliminary analyses compared characteristics of children who were enrolled versus not enrolled in the spectacle trial to determine if there was bias in participation rates by sex, age, or type of refractive error.

Previous validation studies of the ATI identified three subscales: adverse effects, treatment compliance, and social stigma.[15–17] However, because these studies were conducted with older children (age ≥3 years) receiving patching or atropine treatment, an exploratory factor analysis (EFA) was conducted to determine underlying factors relevant to our younger population receiving spectacle treatment.

EFA was conducted using SPSS Software V24.0 (IBM Corp., Armonk NY). The ATI uses a 5-point Likert response scale, where 1 represents "strongly disagree" and 5 represents "strongly agree." Before statistical analysis of ATI responses, scores for items 1, 9, and 15 were reverse coded to be consistent with scores for the other ATI items in which a higher score

Table 2. Summary of Responses by Item for the ATI Revised for Spectacle Treatment Among 77 Children 12 to <36 Months Old

ATI Item	Strongly Disagree	Disagree	Neither Agree/Disagree	Agree	Strongly Agree	*N*
1. My child does not seem to mind wearing the eyeglasses once they are on.[a]	13.0%	10.4%	15.6%	29.9%	31.2%	77
2. I worry that by wearing the eyeglasses, my child may miss out on fun activities (such as games and parties).	54.5%	33.8%	6.5%	2.6%	2.6%	77
3. Wearing the eyeglasses negatively affects my child's learning.	54.5%	37.7%	6.5%	0.0%	1.3%	77
4. Wearing the eyeglasses makes it hard for my child to play outside, such as running, jumping, riding a bike/ tricycle.	50.6%	36.4%	9.1%	3.9%	0.0%	77
5. I have trouble putting on my child's eyeglasses.	41.9%	32.4%	8.1%	12.2%	5.4%	74
6. Wearing the eyeglasses is a source of tension or conflict in my relationship with my child.	52.7%	32.4%	8.1%	5.4%	1.4%	74
7. Wearing the eyeglasses makes it difficult for my child to draw, color, or write.	54.7%	42.7%	2.7%	0.0%	0.0%	75
8. I worry that my child will become injured when wearing the eyeglasses.	54.5%	35.1%	7.8%	2.6%	0.0%	77
9. My child can see well when wearing the eyeglasses.[a]	0.0%	3.9%	11.8%	27.6%	56.6%	76
10. My child complains when it is time to wear the eyeglasses.	23.4%	31.2%	15.6%	24.7%	5.2%	77
11. Wearing the eyeglasses makes my child's eye or eyelids red or irritated.	47.4%	47.4%	2.6%	1.3%	1.3%	76
12. I worry that my child does not wear the eyeglasses enough.	18.4%	17.1%	18.4%	30.3%	15.8%	76
13. My child is more clumsy and uncoordinated than usual when wearing the eyeglasses.	42.9%	39.0%	11.7%	2.6%	3.9%	77
14. I notice that other children stare at my child when the eyeglasses are on.	37.7%	42.9%	10.4%	6.5%	2.6%	77
15. I believe that wearing the eyeglasses will improve my child's vision.[a]	1.3%	1.3%	6.6%	31.6%	59.2%	76
16. Wearing the eyeglasses makes it difficult for my child to play with blocks or toys.	51.9%	40.3%	7.8%	0%	0%	77
17. I sometimes forget to put the eyeglasses on my child.	21.1%	28.9%	11.8%	31.6%	6.6%	76
18. I worry that wearing the eyeglasses will make my child feel different from other children.	45.5%	39.0%	13.0%	1.3%	1.3%	77
19. I have trouble keeping the eyeglasses on my child.	23.4%	20.8%	13.0%	24.7%	18.2%	77

[a] Items 1, 9, and 15 were reverse coded for analysis.

represents a more negative impact of spectacle treatment. Surveys in which more than two items were unanswered were excluded from analyses. For surveys missing one or two item responses, missing responses were imputed based on the mean response for completed items for the child, consistent with two previous studies assessing the ATI.[16,17] Using the Principal Axis Factoring method, results of EFA

using oblique (Direct Oblimin, which allows for some correlation between factors) and orthogonal (Varimax, which assumes factors are uncorrelated) rotation methods were compared. Ideally, factor loadings for each item should display high loadings on one factor, with loadings for other factors close to 0. The method yielding the simplest factor structure was selected for use in subsequent EFA iterations. Factors with eigenvalues >1 were retained and factor loadings of ≥0.4 were considered significant. Kaiser-Meyer-Olkin Measure of Sampling Adequacy was conducted to determine if the data were sufficient for EFA, and the Bartlett's test of sphericity was conducted to determine if there were patterned relationships between items.

In each subsequent EFA iteration, one item was removed, and results re-examined for model fit. Items were selected for removal if they did not load significantly on any factor, or significantly loaded on more than 1 factor. This process was repeated until a solution was achieved in which all remaining items loaded significantly and uniquely on one factor, with each factor including at least two items. Internal consistency reliability was assessed using Cronbach's standardized α, where we considered $\alpha \geq 0.80$ to be acceptable.[19]

Study staff made weekly attempts to contact parents for reports of spectacle wear. However, the weekly response rate varied widely across children and generally was poor. Therefore, the parent report obtained closest to the 12-week post-dispensing time point was selected as the representative measurement for each child. This time point coincided with the target follow-up examination time point, and through either parent contacts or surveys completed at the examination, we had data for most participants at or near 12 weeks. We chose a single measurement (rather than a mean of several reports) to represent wear rate so that data would be obtained at a similar time point (relative to dispensing) across participants and because there were concerns of differences in measurement reliability across participants if we had calculated an average over time, as some children had several estimates while others had few. Thus, the frequency of spectacle wear data included in analyses was the single report of wear obtained closest to 12 weeks (±6 weeks) of spectacle wear for each child (calculated from date of dispensing) obtained either through parent contact (text message, phone call, or email) or through parent report on a survey completed at the follow-up examination (whichever was closer to 12 weeks post-dispensing). An estimate of hours of wear per week (days × hours) was determined for each child. Any report of "all day" wear or ≥8 hours of wear per day was recorded as 8 hours, so the maximum number of hours per week was 56 (7 days × 8 hours) and the minimum was 0. Frequency of wear was categorized as low (0 to <14 hours/week [<2 hours/day]), moderate (14 to <42 hours/week [2 to <6 hours/day]), or high (≥42 hours/week [≥6 hours/day]). The ATI was completed at the follow-up examination, which we attempted to schedule at or soon after 12 weeks post-dispensing. ATI data were included in analyses even if it was completed outside the 12 ± 6 week post-dispensing window used for inclusion of compliance reports.

Multivariate Analysis of Variance (ANOVA) was conducted to determine factors associated with frequency of spectacle wear. The scores for each factor (identified in EFA) were dependent variables, and age (1- and 2-year-olds), child's sex (F, M), and frequency of spectacle wear based on parent report (low, moderate, high) were included as independent variables.

Results

Study Sample

A total of 322 children aged 12 to <36 months were referred for and completed an eye examination as part of the study. Based on results of cycloplegic eye examinations, 104 children were eligible for participation in the spectacle study (no ocular abnormalities, no previous eyeglass wear, and met at least one prescribing criterion). A parent/guardian of 91 children (88%, 41 1- and 50 2-year-olds) enrolled their child in the spectacle study, and the parent/guardian of 13 children either declined to enroll their child or did not respond to an invitation to participate. Children enrolled in the study had a mean age of 22.98 (standard deviation [SD] 6.24) months, were predominantly male (60%), and were prescribed spectacles for astigmatism ($n = 82$, 90%), hyperopia ($n = 6$, 7%), astigmatism and hyperopia ($n = 2$, 2%), or myopia ($n = 1$, 1%). No child met the criterion for anisometropia. A detailed summary of refractive errors is provided in Table 1.

Of the 91 children included, 20 had hyperopic sphere values (≥+0.25 D in both eyes) per cycloplegic refraction. Spectacle correction of hyperopia was reduced by 0 to 0.50 D for children with +0.25 to +0.75 D sphere ($n = 4$), 0.50 to 0.75 D for children with +1.00 to +1.75 D sphere ($n = 6$), 0.75 to 1.00 D

Table 3. Factor Loadings (Correlations Between Items and Factors) for Items Retained in Final Factor Analysis

ATI Item	Adverse Effects	Treatment Compliance	Perceived Benefit of Treatment
2. I worry that by wearing the eyeglasses, my child may miss out on fun activities (such as games and parties).	**0.801**	−0.118	−0.034
3. Wearing the eyeglasses negatively affects my child's learning.	**0.483**	0.197	−0.068
4. Wearing the eyeglasses makes it hard for my child to play outside, such as running, jumping, or riding a bike or tricycle.	**0.833**	0.006	−0.039
7. Wearing the eyeglasses makes it difficult for my child to draw, color, or write.	**0.643**	0.064	0.207
8. I worry that my child will become injured when wearing the eyeglasses.	**0.755**	0.072	0.228
18. I worry that wearing the eyeglasses will make my child feel different from other children.	**0.507**	0.052	0.236
1. My child does not seem to mind wearing the eyeglasses once they are on.	−0.134	**0.756**	0.217
10. My child complains when it is time to wear the eyeglasses.	0.064	**0.729**	0.076
12. I worry that my child does not wear the eyeglasses enough.	0.088	**0.783**	−0.168
17. I sometimes forget to put the eyeglasses on my child.	0.242	**0.442**	0.017
19. I have trouble keeping the eyeglasses on my child.	−0.046	**0.918**	−0.007
9. My child can see well when wearing the eyeglasses.	0.151	0.230	**0.647**
15. I believe that wearing the eyeglasses will improve my child's vision.	0.047	−0.027	**0.519**

Notes: Items 5, 6, 11, 13, 14, and 16 were removed from the model for the final EFA. Loadings ≥0.4 (noted in bold type) were considered significant.

for children with +2.00 to +2.75 D sphere ($n = 2$), and 1.00 to 2.00 D for children with ≥ +3.00 D sphere ($n = 8$). Children were provided full correction of astigmatism and myopia.

To determine if there was evidence of enrollment bias, we compared demographic and refractive error characteristics of 91 children enrolled in the study to 13 who were not enrolled. Children not enrolled were significantly younger on average (independent samples t-test: 19.29 [SD 5.56] vs. 22.98 [SD 6.24] months, $P = 0.046$), included a greater percentage of females (77% vs. 40%, Fisher's exact test $P = 0.016$) and, although not statistically significant, included a smaller percentage of children prescribed spectacles for astigmatism (77% vs. 90%, Fisher's exact test $P = 0.11$). Rates of hyperopia and myopia were not compared due to the small number of children with these refractive errors.

Preliminary Analysis: ATI Exploratory Factor Analysis

The ATI was completed by the parent/guardian of 77 children (85%). Missing ATI data were due to loss to follow-up ($n = 10$), primary caregiver not present at follow-up exam ($n = 1$), and >2 nonresponses on the ATI ($n = 3$, parents missed a full page of the survey). A summary of items and responses is provided in Table 2. The simplest factor solution was obtained with the Direct Oblimin rotation method. Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.871, indicating the data were sufficient for EFA, and the Bartlett's test of sphericity indicated that there were patterned relationships between items (χ^2 test, $P < 0.001$). The initial model which included all 19 ATI items, yielded four factors (although one factor only included one item), with 15 of 19 items loading significantly on one of the four factors at a level of 0.4 or higher.

In the final EFA, items 5, 6, 11, 13, and 14 were removed (they did not load significantly on any factor or significantly loaded on more than 1 factor), and a three-factor solution was obtained. Factor loadings for the retained items are summarized in Table 3. For this model, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was 0.857 indicating acceptable internal consistency reliability and the Bartlett's test

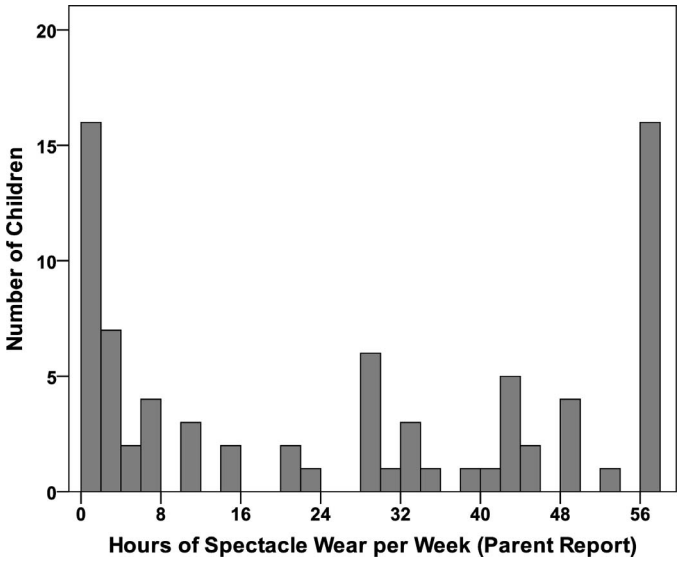

Figure 1. Estimated hours of spectacle wear per week as reported by parents of 78 children on whom wear data was obtained 12 (±6) weeks after dispensing.

of sphericity was significant (χ^2 test, $P < 0.001$) indicating that there were patterned relationships between items. Two factors had several items in common with factors identified in analyses of ATI data from older children prescribed different treatments, and, therefore, we used the same descriptive name for these factors: "Adverse Effects of Treatment" (items 2, 3, 4, 7, 8, 18) and "Treatment Compliance" (items 1, 10, 12, 17, 19). The third factor (items 9, 15) had no item overlap with the "Social Stigma" factor identified in previous ATI factor analyses. We refer to the third factor identified in our analysis as "Perceived Benefit of Treatment."

Results of internal consistency reliability analysis using Cronbach's standardized α were acceptable (≥0.80) when we evaluated all 19 items (0.901), only the 13 items in the final model (0.878), six items on the Adverse Effects scale (0.863), and the five items on the Treatment Compliance scale (0.875). However, when we evaluated the two items on the Perceived Benefit of Treatment Scale, the α (0.596) was below our reliability criterion of ≥0.80. It has been suggested that Cronbach α is not appropriate for two-item scales.[20] Therefore, we also assessed the items in the Perceived Benefit of Treatment scale using Spearman Brown reliability coefficient, which has been recommended for assessment of reliability in two-item scales.[20] However, the result was consistent with the result of Cronbach's α analysis (0.596).

Parent Report of Spectacle Wear

An estimate of hours of spectacle wear per week was obtained at 12 (±6) weeks post-dispensing (range 7.71–18.0, mean 13.12, SD 2.04) for 78 children (87%, 46 responded via email/text/call and 32 responded via survey). We were unable to obtain estimates of spectacle wear at 12 (±6) weeks post-dispensing for 13 children (seven 1-year-olds, six 2-year-olds; 10 males, three females). Parents of four of these children (31%) could not be reached for follow-up and provided no reports of spectacle wear. Parents of nine children provided at least one report of spectacle wear, but these reports were obtained before or after the 12 (± 6)–week post-dispensing follow-up window: six (46%) reported low wear, two (15%) reported moderate wear, and one (8%) reported high wear.

The distribution of reported hours of spectacle wear (Fig. 1) was U-shaped, with the majority of parents reporting either little or no wear (<2 hours/day) or full time wear (at least 6 hours/day). χ^2 analyses found no significant difference in frequency of wear (low, moderate, high) by sex ($P = 0.478$) or age (1- vs. 2-year-olds, $P = 0.994$; Table 4). ANOVA indicated that mean week of parent report across low (12.90 [SD 2.16] weeks), moderate (13.17 [SD 1.70]), and high (13.34 [SD 2.13]) wear groups did not significantly differ ($P = 0.701$). For children who met the spectacle prescribing criterion for astigmatism alone, the correlation between magnitude of astigmatism (more astigmatic eye) and hours of spectacle wear was not statistically significant ($n = 70$, Spearman $r = +0.11$, $P = 0.372$). Due to the small number of children with hyperopia and myopia in our sample, analyses assessing the association between magnitude of hyperopia and myopia and hours of wear were not conducted.

Treatment Impact

A total of 73 children had frequency of wear data at 12 weeks (±6 weeks) and ATI data (nine children were missing ATI and frequency of wear, five missing ATI only, four missing frequency of wear only [reports of wear obtained outside of the 12 ± 6-week window]). The ATI was completed at the follow-up exam, which we attempted to schedule at or near 12 weeks post-dispensing. In the sample of 73 children, the average time from dispensing to follow-up exam and ATI completion was 18 (SD 7.5) weeks. Two children (3%) completed the follow-up early (4 and 5 weeks after dispensing, per parent request), 58 (79%) completed the follow-up at 12 to 24 weeks after

Table 4. Frequency of Spectacle Wear by Sex and Age Among 78 Children for Whom We Obtained Estimates of Wear From a Parent or Guardian at 12 (± 6) Weeks Post-Dispensing

	Spectacle Wear (Hours/Day)			
	Low (<2)	Moderate (2 to <6)	High (≥6)	Total
Sex				
Female	16 (49%)	6 (18%)	11 (33%)	33 (100%)
Male	16 (36%)	12 (27%)	17 (38%)	45 (100%)
Age				
12 to <24 Months	14 (41%)	8 (24%)	12 (35%)	34 (100%)
24 to <36 Months	18 (41%)	10 (23%)	16 (36%)	44 (100%)
Total	32 (41%)	18 (23%)	28 (36%)	78 (100%)

dispensing, and 13 (18%) completed the follow-up at 25 to 39 weeks after dispensing (due to missed appointments and/or temporary loss to follow-up).

The mean score for the items associated with each factor (Treatment Compliance, Adverse Effects, Perceived Benefit) were calculated and included as dependent variables in a Multivariate ANOVA with frequency of spectacle wear, sex, and age and independent variables. The analysis identified significant main effects of child age on Adverse Effects ($P = 0.026$) and Treatment Compliance scales ($P = 0.049$), indicating that 12 to <24-month-old children had significantly poorer scores on both scales compared to children 24 to <36 months old (see Table 5). There also were significant main effects of frequency of wear on Treatment Compliance ($P < 0.001$) and Perceived Benefit scales ($P = 0.004$). Post hoc analyses with Bonferroni correction for multiple comparisons (six paired comparisons, $\alpha = 0.008$) indicated that children with low levels of spectacle wear had significantly poorer scores on the Treatment Compliance scale compared to children with moderate ($P = 0.001$) or high ($P < 0.001$) levels of spectacle wear. Children with low levels of spectacle wear also had significantly poorer Perceived Benefit scores compared to children with high levels of spectacle wear ($P = 0.005$, Table 5).

For children who met the spectacle prescribing criterion for astigmatism alone, there were no statistically significant correlations between magnitude of astigmatism (more astigmatic eye) and ATI scaled scores ($n = 69$; Adverse Effects scale, Spearman $r = -0.06$, $P = 0.61$; Treatment Compliance scale, $r = -0.049$, $P = 0.69$; Perceived Benefit scale, $r = -0.09$, $P = 0.479$). The association between magnitude of hyperopia and myopia and ATI scores could not be assessed due to the small number of children with hyperopia or myopia in our sample.

Table 5. Mean Scores on ATI Scales Among 73 Children for Whom a Parent Completed the ATI and Provided an Estimate of Spectacle Wear at 12 (±6) Weeks Post-Dispensing

	n	Adverse Effects, Mean (SD)	Treatment Compliance, Mean (SD)	Perceived Benefit of Treatment, Mean (SD)
Frequency of spectacle wear				
Low, <2 hrs/day	30	1.68 (0.52)	3.51 (0.77)	1.87 (0.71)
Moderate, 2–<6 hrs/day	15	1.67 (0.58)	2.44 (1.00)	1.53 (0.67)
High, ≥6 hrs/day	28	1.43 (0.64)	2.02 (0.84)	1.3 (0.58)
Age, months				
12 to <24 months	32	1.76 (0.62)	2.98 (1.03)	1.42 (0.63)
24 to <36 months	41	1.44 (0.53)	2.51 (1.08)	1.22 (0.55)
Overall sample	73	1.58 (0.59)	2.72 (1.08)	1.58 (0.69)

ATI scores range from 1 to 5, with 1 indicating less negative impact of treatment and 5 indicating more negative impact of treatment. Results are summarized by reported frequency of spectacle wear and child's age at dispensing.

Discussion

Despite recommendations for screening, referral, and treatment of refractive errors in young children,[1,4] little information exists in the literature on the impact of spectacle treatment and compliance with treatment in children <3 years old. Our results provide valuable data on spectacle treatment of refractive error in this understudied age group.

To our knowledge, our study is the first to evaluate the usefulness of the ATI for assessing the impact of spectacle treatment on younger children (<3 years) and their families. We conducted an EFA to determine the reliability, validity, and underlying factors measured with the ATI in our sample and identified three factors. Two factors had several items in common with factors identified in previous studies of older children prescribed patching or atropine treatments: "Adverse Effects of Treatment" (present analysis, items 2, 3, 4, 7, 8, 18; Holmes et al.,[16] 2, 3, 4, 7, 8, 9, 13, 16), and "Treatment Compliance" (present analysis, 1, 10, 12, 17, 19; Holmes et al.,[16] 1, 5, 6, 10, 12). Both factors had strong internal consistency reliability as measured by Cronbach's Standardized α. Our third factor, "Perceived Benefit of Treatment" had lower internal consistency reliability and had no item overlap with the third factor, "Social Stigma," identified in previous ATI factor analyses (present analysis, 9, 15; Holmes et al.,[16] 11, 14, 18). It is possible that "Social Stigma" is not a significant concern for parents of young children prescribed spectacles. Few parents responded that they "agree" or "strongly agree" with ATI items 14 (other children stare at my child; 9.1%) and 18 (worry that my child feels different; 2.6%; Table 2). Similarly, a previous study also found that negative comments on spectacle wear from others were rare for younger children.[5]

In our final EFA, items 5, 6, 11, 13, and 14 were removed. The two items with the lowest factor loadings (and, therefore, the first two items removed) were items 5 (trouble putting on my child's eyeglasses) and 11 (wearing the eyeglasses makes child's eyes/eyelids red or irritated). Although appropriate for assessing impact of patching or atropine treatment, these items are intuitively less relevant to spectacle treatment. We recommend their removal for future versions of the ATI when used with young children treated with spectacles. Items 6 (treatment is a source of tension), 13 (child clumsy on treatment), and 14 (other children stare at child), however, are intuitively relevant to spectacle treatment of young children. Therefore, we recommend they be included in subsequent versions until our findings are validated and replicated in a larger sample of young children prescribed spectacle treatment. Finally, as previously noted, the Perceived Benefit of Treatment scale was less reliable (Cronbach's Standardized $\alpha = 0.596$). It has been noted that value of Cronbach α tends to be lower when fewer items are included.[21] Results for this scale should be interpreted cautiously for this reason. Future revisions of the ATI for assessment of spectacle treatment may require the addition of more items to strengthen the reliably the perceived benefit of treatment scale, as our study suggests that it may provide useful information for children in this age range.

Data on frequency of spectacle wear indicated a wide range of hours of wear in our sample, with 38% of children wearing spectacles very frequently (≥6 hours/day) and 41% wearing them rarely (<2 hours/day). Spectacle wear did not vary by age or child's sex, although analysis of ATI data provided some clues to variables that may be associated with frequency of wear. Finally, it should be noted that for 13 children we were unable to obtain a report of frequency of spectacle wear at 12 weeks (± 6 weeks) after dispensing. Review of available wear data for these children (collected before or after the 12 ± 6-week post-dispensing window) indicated that most children had low levels of wear (46%) or had no parent reports of wear (31%, parents unable to be reached). This suggested that the results provided in Table 4 may overestimate wear for the overall sample of 91 children.

ATI results indicated parents generally had a positive experience with the spectacles. As shown in Table 2, responses for most items are skewed towards strongly disagree/disagree (reverse coded items skewed towards agree/strongly agree), indicating a more positive/less negative impact of treatment. This is further illustrated in Table 5 where the overall means reported for each scale are <3, again indicating a more positive/less negative impact of treatment. Comparing ATI scores across frequency of wear groups, it is interesting to note that the three groups did not differ on the adverse effects of treatment scale, but the children with low frequency of wear scored significantly higher on the perceived benefit of treatment scale (indicating a lower level of perceived treatment benefit) compared to children who wear their spectacles frequently. This suggests that low frequency of wear may be related to parental perception of the visual benefit of the spectacles,

rather than due to adverse effects the child may experience. We also found that younger children scored higher in terms of adverse effects and treatment compliance scales. The reason for the difference across age is not clear, but may be related to the child's behavior at different developmental stages or to differences in parental beliefs about spectacle wear as children grow older.

Finally, analyses assessing the correlation between magnitude of astigmatism and our dependent variables (frequency of spectacle wear, ATI scaled scores) did not yield any statistically significant correlations. These results suggested that magnitude of astigmatism does not influence spectacle wear or parent report of experiences with spectacle wear in children <3 years old.

Our study contributed uniquely to the literature and has several strengths, including a prospective design, validation of a widely used instrument to assess the impact of amblyopia treatment (ATI) in a clinical population not previously assessed with the instrument (toddlers receiving spectacle treatment), and an estimate of the frequency of spectacle wear and impact of spectacle treatment in children <3 years old. Our study also has some limitations. First, our sample size is lower than recommended for EFA. However, several analyses suggest that our sample and data were acceptable for an EFA: The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (which assesses the proportion of variance among items that might be common variance) indicated that the data were sufficient for EFA, the Bartlett's test of sphericity indicated that there were patterned relationships between items, and Cronbach's standardized α indicated that internal consistency reliability was acceptable. Despite these results, we are cautious in making recommendations for a revised version of the ATI for use in assessing younger children receiving spectacle treatment based solely on our analysis. Second, most children in our sample were prescribed spectacles for astigmatism. Different results may be observed in samples of children with other refractive errors. Third, spectacle wear was estimated based on a single parent report at or close to 12 weeks post-dispensing, and, therefore, may not be representative of frequency of wear over time. Finally, there were many unmeasured variables that could influence spectacle wear in young children (e.g., parental education, socioeconomic status, role models for spectacle wear within the family, child's personality and activity level, cultural beliefs and perceptions about spectacle wear in young children) that likely influenced frequency of spectacle wear and treatment impact. Due to these limitations, we recommend additional studies of larger samples of spectacle-treated children, including a wider age range and children with refractive errors other than astigmatism, to identify important differences in frequency of spectacle wear and the impact of spectacle treatment across age.

Acknowledgments

The authors thank the children and their families for their participation.

Supported by The Virginia G. Piper Charitable Trust. The Banner-University Pediatric Clinics (Kimberly Gerhart, MD, Chief of General Pediatrics) and El Rio Community Health Centers (Andrew Arthur MD, PhD, Medical Director of Pediatrics) assisted in recruitment of study participants.

Disclosure: **E.M. Harvey**, None; **J.M. Miller**, None; **A.L. Davis**, None; **D. Twelker**, None; **L.K. Dennis**, None

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