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## Eye-related quality of life and functional vision in children wearing glasses

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### Abstract

**Purpose**—To evaluate eye-related quality of life (ER-QOL) and functional vision in children wearing glasses using the Pediatric Eye Questionnaire (PedEyeQ).

**Methods**—Children 5–17 years of age with normal visual acuity who wore glasses for correction of refractive error and with no other eye condition or treatment and control subjects who did not wear glasses, along with 1 parent for each child, were prospectively enrolled. Children completed the Child 5–11 or 12–17 PedEyeQ (four domains); parents completed the Proxy 5–11 or 12–17 questionnaires (perceived effect on child; five domains) and also the Parent questionnaire (effect on parent themselves; four domains). Each domain was Rasch-scored (converted to 0–100), and scores between groups were compared.

**Results**—A total of 40 subjects and 99 non-glasses-wearing controls, along with 1 parent for each child, were included. Children 5–11 and 12–17 years of age who wore glasses had lower PedEyeQ scores across all domains compared with controls (mean differences, –6 to –15;  $P = 0.04$  for each domain). Proxy scores were also lower for glasses wearers across age groups and domains (mean differences, –4 to –18;  $P = 0.02$ ), and Parent scores were lower for parents of children wearing glasses (mean differences, –6 to –18;  $P < 0.001$  for each domain).

**Conclusions**—In this study, glasses wearers had reduced ER-QOL and functional vision compared with control subjects. Parents of children wearing glasses also experience reduced quality of life.

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The Pediatric Eye Questionnaire (PedEyeQ) was developed to assess functional vision and eye-related quality of life (ER-QOL) in children with any eye condition and in their parents.

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<sup>1,2</sup> In a previous validation study, we reported reduced functional vision and ER-QOL using the PedEyeQ in children with bilateral visual impairment.<sup>3</sup> The present study evaluated a less severe but more common eye care scenario: glasses correction for refractive error. According to a national health survey conducted in 2016 by the Centers for Disease Control and Prevention,<sup>4</sup> approximately 30% of boys and 36% of girls aged 6–17 years were wearing refractive correction. Nevertheless, although glasses wear in children is encountered relatively frequently, the effects of glasses in child’s functional vision and ER-QOL has not been rigorously studied. In addition, because glasses wear for refractive error is frequently a part of the treatment plan for many different pediatric eye conditions, it would be helpful to understand the effects of glasses wear for refractive error vis-à-vis those for other treatments. The aim of the present study was to characterize and quantify the combined effects of glasses-wear and refractive error on functional vision and ER-QOL in children and their families using the PedEyeQ.<sup>1, 2</sup>

## Subjects and Methods

Institutional Review Board approval was obtained from institutional review boards at the Mayo Clinic, Rochester, Minnesota, and the University of Texas Southwestern Medical Center, Dallas, Texas. All procedures and data collection were conducted in a manner compliant with the US Health Insurance Portability and Accountability Act of 1996, and all research procedures adhered to the tenets of the Declaration of Helsinki. Subjects were prospectively enrolled at Mayo Clinic, Rochester, Minnesota, and at the Retina Foundation of the Southwest, Dallas, Texas.

We included developmentally normal 5- to 17-year-olds with normal visual acuity in each eye as assessed by using age-appropriate clinical tests (the testing method was not standardized but was typically HOTV<sup>5</sup> or E-ETDRS<sup>6</sup>). Because normal visual acuity in young children differs by age, we defined normal thresholds for each year of age based on previously published normal values.<sup>7,8</sup> Children wearing glasses for refractive error were identified in outpatient clinics or were referred by friends or colleagues or recruited through a flyer. Glasses were prescribed for full-time wear, and there were no exclusions based on the degree or type of refractive error. Children with no glasses or other refractive correction and normal visual acuity for age were enrolled as a control group. Thirty-six of these control subjects were reported in a previous validation study in children with visual impairment.<sup>3</sup> Control subjects were recruited in the same manner as study subjects. We chose a control population with normal visual acuity and no glasses or other refractive correction rather than alternative controls, such as children wearing contact lenses, because we wanted to identify the effects of glasses wear and refractive error compared with no refractive correction rather than the effects of two different types of refractive correction. In both groups, all children had no other current or previous eye condition/treatment.

## The Pediatric Eye Questionnaire (PedEyeQ)

The PedEyeQ consists of Child, Proxy, and Parent components<sup>1</sup> (full questionnaires with Rasch scoring freely available at [www.pedig.net](http://www.pedig.net)) and uses a three-point frequency scale for the responses: “never,” “sometimes,” and “all of the time.” The PedEyeQ was created from

specific concerns identified in patient and parent interviews across a large, diverse clinical population, which yielded a large number of candidate questionnaire items.<sup>2</sup> Subsequent administration and Rasch analysis of a subset of items in a second large clinical cohort resulted in the development of final of Child, Proxy, and Parent questionnaires, each with distinct domains.<sup>1</sup> Children completed the Child PedEyeQ, and a parent or legal guardian for each child completed the Proxy and Parent PedEyeQ. The majority of children/parents completed questionnaires electronically on an iPad, others completing on paper.

The Child PedEyeQ consists of 5–11 years and 12–17 years versions, each with four distinct, separately-scored domains: “Functional vision,” “Bothered by eyes / vision,” “Social,” and “Frustration / worry.”<sup>1</sup> The Proxy PedEyeQ consists of 0- to 4-, 5- to 11-, and 12- to 17-year-old versions. The Proxy 5–11 and 12–17 PedEyeQs used in the present study consist of five distinct domains, with “Eye care” added to the previous four.<sup>1</sup> In both the Child and Proxy components, there were differences in questions between age-specific versions.<sup>1</sup> The Parent PedEyeQ has four distinct domains: “Impact on parent / family,” “Worry regarding child’s eye condition,” “Worry regarding child’s self-perception and interactions,” and “Worry regarding child’s visual function.”<sup>1</sup>

## Analysis

For each subject, on each PedEyeQ domain, Rasch scores were calculated using previously published look-up tables ([www.pedig.net](http://www.pedig.net)) and then converted to 0 (worst) to 100 (best) for interpretation. Domain scores for 5–11 and 12–17 years were analyzed separately. Median scores were compared between glasses wearers and controls by age group using Wilcoxon rank-sum tests, because data were not normally distributed. For ease of interpretation of results, mean differences with a 95% confidence interval around the mean difference were also calculated (because there can be a statistically significant difference in median values, despite identical median values). Effect sizes were calculated based on the mean difference between groups divided by the standard deviation of controls. Effect sizes of 0.20 to 0.49 are considered small; 0.50–0.79, medium; and >0.80, large.<sup>9</sup> SAS software version 9.4 (SAS Institute, Cary, NC) was used for all statistical analyses.

## Results

A total of 26 children 5–11 years of age (median, 8) and 14 children 12–17 years of age (median, 13.5) were included (Table 1). Demographics are shown in Table 1. In 5- to 11-year-olds, median refractive error (spherical equivalent) was +1.00 D (range, –3.75 to +6.125) and median cylinder was 1.25 D (range, 0.00–4.25 D). In 12- to 17-year-olds, median refractive error by spherical equivalent was –1.94 D (range, –6.75 to –0.50 D), and median cylinder was 0.50 D (range, 0.00–2.00 D). We also included 74 children 5–11 years of age (median, 7) and 25 children 12–17 years old (median, 13) as controls. Demographics are shown in Table 1.

For 5- to 11-year-olds, median Child scores for glasses wearers were lower than those for controls on each domain ( $P = 0.04$  for each; Figure 1A; Table 2). For 12- to 17-year-olds, Child scores were significantly lower for glasses wearers than for controls for each domain ( $P = 0.003$  for each domain, Figure 1B; Table 2). The greatest difference was in the

Frustration/Worry domain (median, 83 vs 100; mean difference, -15; 95% CI -26 to -4 [ $P = 0.003$ ]; Figure 1B; Table 2). Effect sizes ranged from 0.39 to 0.62 in 5- to 11-year-olds and from 2.18 to 3.31 in 12- to 17-year olds (Table 2).

For both 5- to 11-year-olds (Figure 1C; Table 2) and 12- to 17-year-olds (Figure 1D; Table 2), Proxy scores were significantly lower for glasses wearers on each domain ( $P = 0.02$  for each). Effect sizes ranged from 2.63 to 9.07 for 5- to 11-year-olds and 2.19 to 10.40 for 12- to 17-year olds (Table 2).

Parent scores were also lower for parents of glasses wearers across all four domains ( $P < 0.001$  for each; Figure 1E; Table 2). Effect sizes ranged from 3.32 to 6.63 (Table 2).

## Discussion

ER-QOL and functional vision scores in 5- to 11-year-olds and 12- to 17-year-olds wearing glasses for correction of refractive error were lower than those of controls by both child self-report (Child PedEyeQ) and by parent report (Proxy PedEyeQ). In addition, we found lower ER-QOL in parents of glasses wearers. Although spectacle correction of refractive error might be considered a mild treatment, our study highlights a small but significant effect on both children and their parents.

The effects on children of wearing glasses has not been well studied. Some investigators<sup>10,11</sup> have reported improved vision-related quality of life in children wearing contact lenses compared with glasses, but we are unaware of any studies comparing children with normal vision who wear glasses to children with normal vision who do not. Other studies have reported increased bullying,<sup>12</sup> decreased satisfaction with physical appearance,<sup>13</sup> lower attractiveness, and poorer school performance, conduct, and sociability<sup>14</sup> associated with glasses wear, which, although not direct measures of ER-QOL, may be expected to affect a child's ER-QOL. In contrast, Walline and colleagues<sup>15</sup> reported that children wearing glasses were perceived by other children to be smarter and more honest than children not wearing glasses. In the present study, we used the recently developed PedEyeQ<sup>1</sup> to assess everyday effects and found that on average children wearing glasses had lower ER-QOL and functional vision than controls when measured by Child self-report and Proxy report.

We also found that the parents of glasses wearers were affected by their children's glasses. These findings are analogous to those of a previous study<sup>16</sup> in which the Intermittent Exotropia Questionnaire was administered to nonstrabismic children with visual acuity of at least 20/40 who were either wearing glasses for correction of refractive error ( $n = 20$ ) or who had no refractive error and no glasses ( $n = 29$ ). In this previous study,<sup>16</sup> scores on the Parent component of the Intermittent Exotropia Questionnaire were significantly lower for parents of children wearing glasses than for parents of children who did not wear glasses. It is possible that some parental worry is out of proportion to the state of a child wearing glasses for refractive error. It is possible that the effect on parents may be ameliorated by educational interventions.

Overall, the magnitude of mean differences between glasses wearers and controls was less (range of mean differences, -6 to -15) than those found in a previous study of children with

visual impairment (range of mean differences,  $-10$  to  $-46$ ).<sup>3</sup> This difference in magnitude of effect for children with visual impairment versus children with glasses correction of refractive error serves to confirm known-group validity of the PedEyeQ, with expected lower effect in glasses wearers and greater effect in visual impairment.

Our finding of reduced ER-QOL and functional vision in glasses wearers has implications when evaluating the effect of other pediatric eye conditions. When glasses wear is prescribed as part of a child's treatment plan, care should be taken to acknowledge that a component of any ER-QOL and/or functional vision effect may in fact be attributable to glasses wear. Nevertheless, the magnitude of effect from glasses wear for a given child and/or a given eye condition remains unknown. We caution against applying the magnitude of effect found in the present study as a threshold for effect in any eye condition. Indeed, we speculate that the relative effect of glasses wear may be lower in a child with severe eye disease and higher in a child with mild disease.

The present study is not without limitations. The effects of underlying refractive error are difficult to distinguish from that of glasses wear to correct the refractive error, but the purpose of the present study was to evaluate the combined effect of refractive error and glasses wear in children. In future studies, it would be helpful to evaluate the effects of uncorrected refractive error followed by a reassessment of the combined effects of refractive error and glasses once they are prescribed. By including only children who had normal visual acuity in glasses, we aimed primarily to identify the effects of glasses wear itself. That said, we did not obtain a measure of adherence with glasses wear, and it is possible that some findings (eg, reduced functional vision) were related to the child's experience when not wearing their glasses. Knowledge of glasses adherence may help with interpretation of ER-QOL and functional vision effects. In addition, we used a control group with normal visual acuity and no refractive correction, but additional questions remain regarding how glasses wear compares with other types of refractive correction (eg, contact lenses) in children with refractive error. Also, the relative effects of different types of refractive error and uncorrected or suboptimally corrected refractive error on a child's ER-QOL and functional vision remains unclear. We enrolled only a relatively small number of children and heterogeneity regarding race/ethnicity was limited; our results may not be generalizable to all children wearing glasses.

Children wearing glasses for refractive error have reduced ER-QOL and functional vision compared with normal controls, as reported by the child themselves and by proxy reporters. Eye care providers should weigh the benefits and possible adverse effects when correcting very low levels of refractive error and when there is questionable benefit to vision.

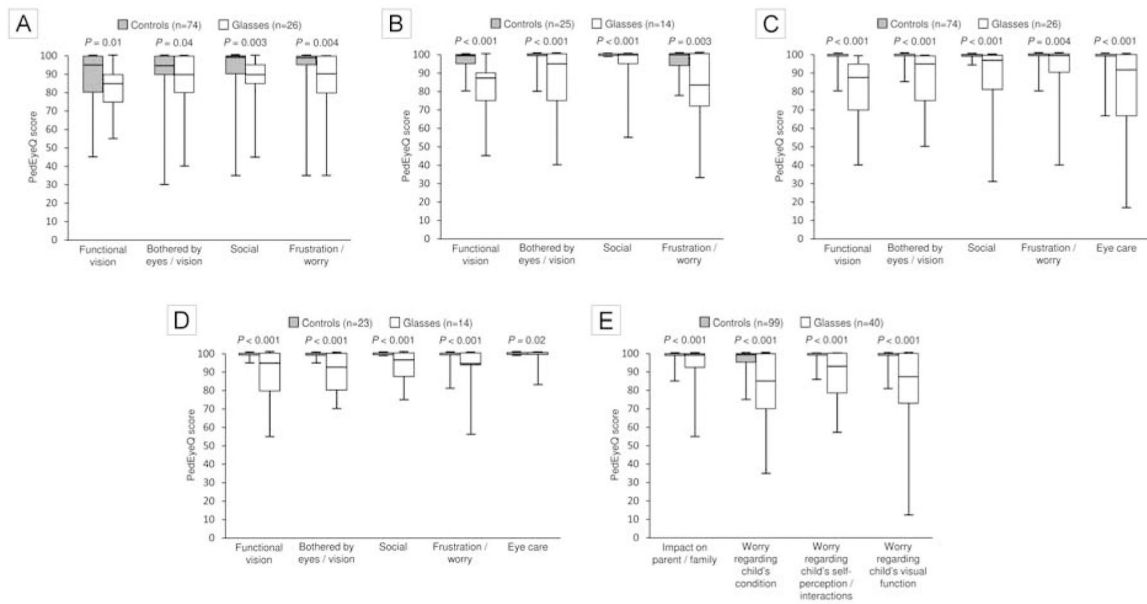
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**FIG 1.**

A, Child PedEyeQ domain scores in 5- to 11-year olds (“Functional vision,” “Bothered by eyes / vision,” “Social,” and “Frustration /worry”) comparing children wearing glasses for refractive error and controls not wearing glasses; scores lower across all domains ( $P = 0.04$ ). B, Child PedEyeQ domain scores in 12- to 17-year-olds (same domains) comparing glasses wearers and controls; scores were significantly lower for children wearing glasses for each domain ( $P < 0.003$ ). C, Proxy PedEyeQ domain scores for 5- to 11-year-olds (same domains, with addition of “Eye care”) comparing glasses wearers and controls. Scores were significantly lower for children wearing glasses across domains ( $P = 0.004$ ). D, Proxy PedEyeQ domain scores for 12- to 17-year-olds (same domains as for younger children) comparing glasses wearers and controls. Scores were significantly lower for all domains ( $P = 0.02$ ). E, Parent PedEyeQ domain scores (“Impact on parent/family,” “Worry regarding child’s eye condition,” “Worry regarding child’s self-perception / interactions,” and “Worry regarding child’s visual function”) comparing parents of glasses wearers and parents of controls. Scores were significantly lower for parents of children wearing glasses across all domains ( $P < 0.001$ ). Boxes represent 1st quartile, median, and 3rd quartile values; whiskers represent extreme values.

**Table 1.**

Demographics of 40 children wearing glasses for correction of refractive error, 99 children enrolled as normal controls, and their parents

Study parameter	Refractive error		Normal controls	
	5–11 years (n = 26), no. (%)	12–17 years (n = 14), no. (%)	5–11 years (n = 74), no. (%)	12–17 years (n = 25), no. (%)
Sex of child				
Female	14 (54)	7 (50)	37 (50)	10 (40)
Race				
White (including Hispanic / Latino)	19 (73)	12 (86)	54 (73)	16 (64)
Asian	6 (23)	0 (0)	10 (14)	3 (12)
More than 1 race	1 (4)	1 (7)	9 (12)	2 (8)
Black/African American	0 (0)	1 (7)	1 (1)	4 (16)
American Indian / Alaskan Native	0 (0)	0 (0)	0 (0)	0 (0)
Native Hawaiian / Other Pacific Islander	0 (0)	0 (0)	0 (0)	0 (0)
Other	0 (0)	0 (0)	0 (0)	0 (0)
Ethnicity				
Not Hispanic / Latino and not Middle Eastern/North African and not Indian Subcontinent	18 (69)	11 (79)	56 (76)	19 (76)
Hispanic/Latino	2 (8)	3 (21)	7 (9)	1 (4)
Indian Subcontinental	4 (15)	0 (0)	1 (1)	0 (0)
Middle Eastern / North African	0 (0)	0 (0)	2 (3)	2 (8)
More than one	2 (8)	0 (0)	9 (11)	3 (12)
Parent / legal guardian completing questionnaires				
Mother	22 (85)	12 (86)	65 (88)	23 (92)
Father	4 (15)	2 (14)	9 (12)	2 (8)
Legal guardian	0 (0)	0 (0)	0 (0)	0 (0)
Parent / legal guardian age				
21–30	0 (0)	0 (0)	6 (8)	0 (0)
31–40	14 (54)	2 (14)	40 (54)	9 (36)
41–50	11 (42)	10 (71)	28 (38)	15 (60)
51–60	1 (4)	2 (14)	0 (0)	1 (4)
Parent / legal guardian highest level of education				
Attended high school	0 (0)	0 (0)	2 (3)	1 (4)
High school graduate	3 (12)	0 (0)	2 (3)	1 (4)
Attended college	3 (12)	1 (7)	14 (19)	2 (8)
College graduate	9 (35)	3 (21)	37 (50)	15 (60)
Postgraduate / professional degree	11 (42)	10 (71)	18 (24)	6 (24)
Not reported	0 (0)	0 (0)	1 (1)	0 (0)
Housing				
Own	23 (88)	11 (79)	58 (78)	20 (80)



Study parameter	Refractive error		Normal controls	
	5–11 years (n = 26), no. (%)	12–17 years (n = 14), no. (%)	5–11 years (n = 74), no. (%)	12–17 years (n = 25), no. (%)
Rent	2 (8)	3 (21)	15 (20)	5 (20)
Other	1 (4)	0 (0)	1 (1)	0 (0)

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**Table 2.**

PedEyeQ domain scores for children wearing glasses for correction of refractive error, for normal controls, and for their parents

PedEyeQ domains (by age group for Child and Proxy)	Median (range) PedEyeQ scores		<i>P</i> value for difference, median scores	Mean difference with 95% CI	Effect size
	Glasses	Controls			
Child 5–11 years	N = 26	N = 74			
Functional vision	85 (55–100)	95 (45–100)	0.01	–6 (–12 to 0)	0.48
Bothered by eyes/vision	90 (40–100)	95 (30–100)	0.04	–8 (–15 to 0)	0.62
Social	90 (45–100)	100 (35–100)	0.003	–6 (–11 to 0)	0.44
Frustration/worry	90 (35–100)	100 (35–100)	0.004	–6 (–12 to 1)	0.39
Child 12–17 years	N=14	N=25			
Functional vision	87 (45–100)	100 (80–100)	<0.001	–15 (–23 to –6)	2.63
Bothered by eyes/vision	95 (40–100)	100 (80–100)	<0.001	–15 (–27 to –2)	3.30
Social	100 (55–100)	100 (100–100)	<0.001	–6 (–14 to 1)	N/A <sup>b</sup>
Frustration/worry	83 (33–100)	100 (78–100)	0.003	–15 (–26 to –4)	2.18
Proxy 5–11 years	N = 26	N = 74			
Functional vision	87 (40–100)	100 (80–100)	<0.001	–18 (–25 to –11)	5.02
Bothered by eyes/vision	95 (50–100)	100 (85–100)	<0.001	–12 (–19 to –5)	5.25
Social	97 (31–100)	100 (94–100)	<0.001	–13 (–21 to –5)	9.07
Frustration/worry	100 (40–100)	100 (80–100)	0.004	–8 (–16 to –1)	2.63
Eye-care	92 (17–100)	100 (67–100)	<0.001	–16 (–25 to –7)	3.77
Proxy 12–17 years	N=14	N = 23 <sup>a</sup>			
Functional vision	95 (55–100)	100 (95–100)	<0.001	–11 (–19 to –3)	10.40
Bothered by eyes/vision	93 (70–100)	100 (95–100)	<0.001	–10 (–16 to –4)	7.23
Social	97 (75–100)	100 (100–100)	<0.001	–7 (–12 to –2)	N/A <sup>b</sup>
Frustration/worry	94 (56–100)	100 (81–100)	<0.001	–9 (–17 to 0)	2.19
Eye care	100 (83–100)	100 (100–100)	0.02	–4 (–8 to 1)	N/A <sup>b</sup>
Parent	N=40	N=99			
Impact on parent/family	100 (55–100)	100 (85–100)	<0.001	–6 (–10 to –2)	3.88
Worry regarding child's condition	85 (35–100)	100 (75–100)	<0.001	–17 (–23 to –11)	3.32
Worry regarding child's self-perception/interactions	93 (57–100)	100 (86–100)	<0.001	–11 (–16 to –7)	6.63
Worry regarding child's visual function	87 (12–100)	100 (75–100)	<0.001	–18 (–24 to –11)	4.12

CI, confidence interval; N/A, not available.

<sup>a</sup>Two parents in the normal control group did not complete the proxy questionnaires.

<sup>b</sup>Effect size could not be calculated owing to standard deviation of 0 points in normal controls.