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Child Development and Refractive Errors in Preschool Children

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Abstract

Purpose—Many parents are concerned about their child's development. The purpose of this study is to determine if parental concerns about overall development are associated with significant refractive errors among urban preschool children.

Methods—A cross-sectional population-based study was conducted to evaluate the prevalence of ocular disorders in white and African American children 6 through 71 months of age in Baltimore, Maryland, United States. A comprehensive eye examination with cycloplegic refraction was performed. Parental concerns about development were measured with the Parents' Evaluation of Developmental Status screening tool. 2381 of 2546 eligible children (93.5%) completed the refraction and the parental interview.

Results—Parental concerns about development were present in 510 of the 2381 children evaluated (21.4%; 95% CI: 9.8% – 23.1%). The adjusted odds ratios [OR] of parental concerns with hyperopia ($\geq 3.00\text{D}$) was 1.26 (95% CI: 0.90 – 1.74), with myopia ($\geq 1.00\text{D}$) was 1.29 (95% CI: 0.83 – 2.03), with astigmatism ($\geq 1.50\text{D}$) was 1.44 (95% CI: 1.08 – 1.93) irrespective of the type of astigmatism, and with anisometropia $\geq 2.00\text{D}$ was 2.61 (95% CI: 1.07 – 6.34). The odds of parental concerns about development significantly increased in children older than 36 months with hyperopia $\geq 3.00\text{D}$, astigmatism $\geq 1.50\text{D}$, or anisometropia $\geq 2.00\text{D}$.

Conclusions—Parental concerns about general developmental problems were associated with some types of refractive error, astigmatism $\geq 1.50\text{D}$ and anisometropia $\geq 2.00\text{D}$ in children ages 6 to 71 months. Parental concerns were also more likely in children older than 36 months of age with hypermetropia, astigmatism or anisometropia. Parental concerns were not associated with myopia. Due to the potential consequences of uncorrected refractive errors, children whose parents have expressed concerns regarding development should be referred for an eye examination with cycloplegic refraction to rule out significant refractive errors.

Keywords

refractive error; myopia; hypermetropia; preschool children; parental concerns; child development; visual impairment

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Vision is important in development because it allows children to interact with their environment. Vision in preschool children is uniquely important because their visual system is still developing and they are at risk of developing amblyopia from some forms of uncorrected high ametropia or anisometropia.¹ Deprivation may lead to long term visual impairment.^{2, 3}

The presence of uncorrected refractive errors and an associated deficit in vision may be difficult to identify in young children. A vision deficit could be perceived by parents to be a problem with general development. Parents frequently discuss concerns about their child's development with the pediatrician.⁴⁻⁶ Such concerns, if carefully elicited, have been found predictive of developmental problems in children; with 80% sensitivity and 94% specificity.⁷ However, there is limited information evaluating the association between parental concerns about development and refractive errors in preschool children.

The Baltimore Pediatric Eye Disease Study (BPEDS) was a cross-sectional, population-based study to determine the prevalence of and risk factors for ocular disorders in urban preschool children. The purpose of this report is to examine whether parental concerns about development as assessed by the Parents' Evaluation of Developmental Status (PEDS) instrument were associated with significant refractive errors in preschool children.

Methods

BPEDS was designed to estimate and compare the prevalence of decreased vision, strabismus, amblyopia, and refractive error in a population-based sample of white and African American children 6 through 71 months of age living in Baltimore. Detailed methods and results have been published previously.⁸⁻¹⁰ All study activities were approved by the Committee on Human Research at the Johns Hopkins Bloomberg School of Public Health, the Battelle Centers for Public Health Research and Evaluation Institutional Review Board, and the Institutional Review Board of the Maryland Department of Health and Mental Hygiene.

The study enrolled subjects from 54 contiguous census tracts in northeastern and eastern Baltimore City and adjacent portions of Baltimore County, Maryland. In households with eligible children, an adult resident answered a questionnaire about basic demographic information, socioeconomic status of the household, and the eye health of each eligible child. Eligibility criteria were: (1) age 5 to 70 months on the day of the household screening, and (2) parent or legal guardian confirmation that the subject resided in one of the selected BPEDS census tracts.

Enrolled subjects were invited for comprehensive eye examinations at a centrally located clinic. The examinations were performed by study-certified ophthalmic technicians and pediatric-trained optometrists or ophthalmologists.⁸⁻¹⁰ At the clinic, the parent or guardian (hereafter called parent) participated in a detailed interview about their child/children that covered (1) health care coverage and use, (2) basic medical history, (3) ocular history, (4) pregnancy and neonatal history, (5) tobacco and alcohol use during pregnancy, (6) presence or absence of developmental delay, (7) motor milestones, (8) socioeconomic status, and (9) the PEDS.¹¹

Determination of Refractive Error

Cycloplegic autorefractometry was attempted on all children using the handheld Retinomax[®] autorefractor (RIGHT Medical Inc., Virginia Beach, VA). Cycloplegia was attained by administering 1 drop of 0.5% proparacaine, 1 drop of cyclopentolate (0.5% if the child was 1 year of age or younger and 1.0% if the child was older than 1 year), and 1 drop of 2.5%

phenylephrine. One additional drop of cyclopentolate was administered after waiting 5 minutes. The presence of cycloplegia was confirmed 30 minutes after the second drop with dynamic streak retinoscopy. A third drop of cyclopentolate was administered to those children with persistent accommodation as observed by the fluctuation of the retinoscopic reflex.

A Retinomax[®] confidence level of 8 or greater was required for the measurement to be accepted.¹² A maximum of 3 attempts were performed. If the confidence level could not be attained, a study-certified optometrist or ophthalmologist performed cycloplegic streak retinoscopy in a dim room with the child fixating on a distant target. For children with manifest strabismus, the fellow eye was occluded while performing the retinoscopy to prevent off-axis measurements. Children who were not cyclopleged were excluded from this analysis.

Based on a pre-analysis consensus of the investigators, cut-points for significant refractive error were defined as hyperopia $\geq 3.00\text{D}$, myopia $\geq 1.00\text{D}$ or astigmatism $\geq 1.50\text{D}$ in either eye, or anisometropia $\geq 2.00\text{D}$. In addition, other cut-points of hyperopia $\geq 1.00\text{D}$, hyperopia $\geq 4.00\text{D}$, myopia $\geq 3.00\text{D}$, astigmatism $\geq 3.00\text{D}$, and anisometropia $\geq 1.00\text{D}$ were also evaluated. The right eye and left eye spherical equivalent, right eye and left eye spherical powers, and the right eye and left eye cylinder powers were also treated as continuous variables during analysis.

Developmental Status Assessment

PEDS is a sensitive and well validated instrument for developmental screening, with good psychometric properties.^{4, 6} It has been proven useful regardless of socioeconomic status, educational level and other parental factors.⁴ It has a sensitivity of 74-79% for the detection of developmental problems in children from birth to 8 years, with a specificity of 70-80%.^{4, 5}

The PEDS 10-item questionnaire was administered during the BPEDS clinic interview. Parents responded to questions about their child's learning, development and behavior by answering "yes," "no," or "a little" to the questions (Table 1). Parents were asked to elaborate if they answered "yes" or "a little". Parental concerns were compiled and the subjects assigned to 5 levels (A, B, C, D, or E) of risk for developmental problems according to the PEDS scoring protocol.¹¹ For the purpose of this project, the 5 categories of a child's risk were collapsed into high and low risk groups. Children assigned to levels A or B were classified as having high risk for developmental problems. All other children were classified as having low risk for developmental problems (Table 2).

Statistical Analysis

All statistical analyses were carried out using the STATA 10 (StataCorp, College Station, TX).¹³ Demographic and health characteristics of the children in the high and low risk groups were compared using the 2 sample t-test for continuous variables, while non-continuous variables were compared using the chi square. Factors that were significantly different between the high and low risk groups were included in the multiple logistic regression analysis to determine their influence on any relationship between parental concerns about development and the presence of refractive errors. Crude odds ratios and 95% confidence intervals [CI] of the association between parental concerns and the preset cut-points for each refractive error were calculated. Multiple logistic regression was used to estimate the odds ratio [OR] after adjusting for age, sex, ethnicity, history of an eye problem, current eye health, primary caregiver's education, age of mother, age of father, smoking during pregnancy, and the relationship of the primary caregiver. A multiple logistic

regression was also used to calculate the OR of parental concerns when refractive error was treated as a continuous variable. The t-test was used to determine if refractive error means were different in the high and low risk groups. All reported p-values were 2 tailed. Analyses were repeated comparing children older than 36 months to children 36 months and younger.

Results

BPEDS identified 4132 preschool-aged children, 3990 eligible children (97%) were enrolled, and 2546 children (62%) were examined.⁸ The PEDS interviews were completed by 2499 children (60%). Of these children, 118 children were excluded because their refractive errors were measured without cycloplegia. The remaining 2381 children represent the cohort for this report.

There were 1158 males (48.6%) and 1223 females (51.4%). The mean age of the children included was 38.5 months (standard deviation [SD] 18.4), the median age was 39 months, the minimum age was 6 months and the maximum age was 71 months. 951 (40.0%) were white, 1197 (50.3%) were African Americans, and 203 (9.7%) were from other ethnic groups (Table 3). An eye problem had been previously diagnosed in 102 children, while parents of 3 children were uncertain. For 61 children the problem was a need for glasses. Only 43 children already had glasses, while 18 were without glasses.

On average, mothers were 30.6 years of age and fathers were 35.8 years of age at the time of the interview. Mothers were the respondents for 80.4%, biological fathers for 7.8%, and guardians for 11.8%. The average and the median years of education of the primary caregiver were 13.3 years and 10.5 years, respectively. The proportion of families with incomes greater than \$20,000 was 63.9%.

Demographic characteristics, including the child's age, sex, maternal and paternal age, history of eye problems, current eye health, existing developmental delay concerns (as reported by the caregiver), type of health insurance, household income, smoking during pregnancy and the primary caregiver's education were significantly associated with parental concerns determined from the PEDS (Table 3). However, only age, sex, maternal age, and smoking during pregnancy were associated with refractive errors.

The PEDS found 510 children (21.4%, standard error [SE] ± 0.008 , 95% CI: 19.8% – 23.1%) at high risk for developmental problems based on parental concerns. The mean age of the high risk group was 43.4 months (SD 16.2), the median age was 45 months, the minimum age was 7 months and the maximum age was 71 months. Of the 510 children in the high risk group, 199 were males (39.0%). At low risk were 1871 children (78.6%; SE ± 0.008 ; 95% CI: 76.9% – 80.2%). The mean age of the children in the low risk group was 37.1 months (SD 18.7), the median age was 37 months, the minimum age was 6 months and the maximum age was 71 months.

There were 1277 children older than 36 months with a mean age of 53.3 months (SD 9.4). Among these older children 329 were in the high risk group with the mean age of 53.5 months (SD 9.4). Males accounted for 124 (37.7%). The mean age of the 948 children in the low risk group was 53.2 months (SD 9.4). There were 1104 children 36 months of age or younger; the mean age was 21.4 months (SD 8.9). Among the younger children, 180 were in the high risk group; the mean age in the high risk group was 25.0 months (SD 7.3). Males accounted for 41.7%. 922 of the children 36 months or younger were in the low risk group; the mean age was 20.6 months (SD 9.1) (Table 3).

Based on the study's preselected cut-points for significant refractive errors, 232 children had hyperopia $\geq 3.00D$; 23.7% were in the high risk group for developmental problems

compared with 21.3%. For the 112 children with myopia $\geq 1.00D$, 25.0% were in the high risk group compared with 21.4%. For the 292 children with astigmatism $\geq 1.50D$, 26.7% were in the high risk group compared with 21.0%. 22 children had anisometropia $\geq 2.00D$, 40.9% were in the high risk group compared with 21.4% in those anisometropia $< 2.00D$. There was no evidence of an effect modification by sex in the associations of developmental concerns with refractive error, since the higher prevalence of developmental concerns in females was consistent for all refractive errors (Table 4).

After adjusting for age, sex, current health, previous diagnosis of an eye problem, primary caregiver's education, age of mother, age of father, smoking during pregnancy, and, the relationship of the primary caregiver, parents of children with hyperopia $\geq 3.00D$ or myopia $\geq 1.00D$ in either eye were not statistically more likely to have concerns about their child's development (Table 5). However, parents of children with significant astigmatism $\geq 1.50D$ were statistically more likely to have concerns about their child's development (OR = 1.44; 95% CI: 1.08 – 1.93). The association of parental concerns with significant astigmatism was irrespective of the type of astigmatism (with-the-rule, against-the-rule, or oblique). Parents of children with anisometropia $\geq 2.00D$ were also more likely to have developmental concerns (OR = 2.61; 95% CI: 1.07 – 6.34).

We identified no association between parental concerns when additional cut-points were considered (hyperopia $\geq 1.00D$, hyperopia $\geq 4.00D$, myopia $\geq 3.00D$, astigmatism $\geq 3.00D$, and anisometropia $\geq 1.00D$) (Table 5). The association between parental concerns and significant refractive error was stronger in children older than 36 months (Table 6). This was most evident for hyperopia, astigmatism and anisometropia.

In addition, when children assigned to PEDS levels A, B, and C were classified as the high risk group, only parents of children with astigmatism $\geq 1.50D$ had statistically significant concerns. The right eye spherical equivalent minimum, maximum, median and mean were -8.75, +10.875, 1.00 and 1.08 respectively. There was no association with increase in spherical equivalent and spherical power in either eye, but the spherical equivalent in both eyes was associated in children older than 36 months.

Conclusions

We found parental concerns about their child's development to be associated with some refractive errors in this urban population of preschool children. Parents of preschool children with astigmatism ($\geq 1.50D$) or anisometropia ($\geq 2.00D$) were more likely than other parents to have concerns about developmental problems. Myopia was not associated with parental concerns. Parents of children 36 through 71 months with hyperopia ≥ 3.00 , astigmatism $\geq 1.50D$, or anisometropia $\geq 2.00D$ were more likely to have concerns about development.

Parental concerns in our cohort were more prevalent in children older than 36 months compared with younger children. However, the PEDS instrument generally finds that parents of older children have more concerns.⁴ The odds of parental concerns may also be increased in older preschool children because problems may be more noticeable since their visual demands are more than likely different from younger children.

In addition, more parents of girls than boys had concerns that put them in the high risk group for developmental problem, and more girls had significant refractive errors (Tables 3 & 4). This gender bias is not consistent with PEDS validation data that show that boys are more often in the high risk groups.⁴⁻⁵ Our observation lends additional support to the association of developmental concerns and refractive error.

There was no difference in parental concerns by ethnicity. This is consistent with validation data of the PEDS instrument.⁴ Maternal and paternal ages were higher in the high risk group. These findings are also consistent with PEDS validation data.

Significant uncorrected refractive errors are risk factors for amblyopia.² Uncorrected refractive errors have also been associated with abnormal development,¹⁴⁻¹⁷ including reduced cognitive ability^{14, 15} and motor skill,^{15, 16} in infants and preschool-aged children. Deficits in these skills and difficulties could be perceived as developmental problems by parents.

When all the preschool children in this study were considered, there was no association found between parental concerns about developmental problems and hyperopia. However, when children older than 36 months were compared to younger children, parental concerns were significantly more likely in these older children if they had hyperopia $\geq 3.00D$. Some studies have shown that hyperopia is associated with visuo-motor and visuo-cognitive development in children.¹⁴⁻¹⁷ Roch-Levecq and her colleagues found that preschool children 3 to 5 years of age with uncorrected bilateral hyperopia $\geq 4.00D$ had significantly reduced visual-motor integration when compared with emmetropic children.¹⁴ Atkinson and colleagues performed a longitudinal study comparing infants with significant hyperopia ($\geq 3.50D$ in one meridian) with infants with normal refractive errors. They found that hyperopic children showed mild, but consistent delays in visuo-cognitive and visuo-motor development that continued to age 5 years^{15,16} and age 7 years.¹⁷ It is possible that the parental developmental concerns manifest when older hyperopic preschool children do not acquire or master visually based skills.

There was no association found between myopia ($\geq 1.00D$ or $\geq 3.00D$) and parental concerns about developmental problems in this population of preschool children. Perhaps the near working distance for children protects them.¹ Alternatively, parents may not perceive any developmental concerns because problems associated with uncorrected myopia common in school settings are not apparent in preschool children.

Astigmatism $\geq 1.50D$ was significantly associated with parental concerns about development in preschool children. This association was stronger in children older than 36 months when they were compared to younger children. Preschool children age 3 to 5 with uncorrected astigmatism $\geq 1.50D$ have been shown to have deficits in grating acuity, and could lead to amblyopia.^{18, 19} Children with astigmatism $\geq 2.00D$ in 3 year olds or $\geq 1.50D$ in 4 year olds have also been shown to have visual motor integration deficits.¹⁴ These deficits could be perceived as developmental problems.

Anisometropia $\geq 2.00D$ was associated with parental concerns about developmental problems in this population of preschool children, especially among children aged 36 through 71 months. Parental concerns may arise in children with anisometropia $\geq 2.00D$ because children with higher amounts may develop amblyopia which may lead to vision problems that parents perceive as developmental problems. There was no association between parental concerns and lesser anisometropia $\geq 1.00D$, possibly because the visual impairment in one eye is too mild to produce a developmental deficit.^{1, 20, 21}

Increased amounts of anisometropia have been found to be associated with reduced binocularity in children.²² Poor binocularity could be perceived as a developmental problem by the parents. It is also possible that anisometropia is a marker for some other factors that may put a child at higher risk for developmental delay, but we could not assess this in BPEDS.

When there is a parental concern about development, further screening, diagnostic tests and referrals are recommended to identify children with true developmental delays that need early intervention.^{4, 23} Pediatricians may consult neurologists, occupational therapists, physical therapists, social workers, psychologists, and speech therapists.^{4, 6} This report suggests that if there are parental concerns about development in a preschool child, an eye examination with cycloplegic refraction should be considered to detect significant refractive errors.

There are several strengths of this study. A comprehensive eye examination was performed and refractive errors were accurately determined with automated refraction under cycloplegia by study-trained testers. The PEDS tool has been previously validated and the full tool was included so parental concerns about development could be adequately examined. Examiners were masked to the PEDS results and parents were masked to their child's refractive error.

There are important limitations of the study. This study cannot prove a causal relationship between refractive error and parental concerns about developmental delay. The PEDS questions were included late in the interview and parent responses could have been influenced by earlier demographic and health questions. Due to the cross-sectional design, parental concerns were not re-evaluated after correction of refractive error, to determine if these changed. Only one developmental screening tool was used; no other tools or examinations were used to confirm the presence or absence of developmental problems. The response rate to examination was relatively low, at 64% of those eligible. It is not known how those who did not present for the eye examination might have been categorized by the PEDS, nor is it known whether the association between developmental risk and ocular outcomes would have been stronger or weaker in this group.

This study found that parental concerns about development are associated with significant refractive error in this preschool population aged 6 to 71 months, especially among those children aged 36 through 71 months. Parental concerns may be more significant in older children because visual and developmental demands are greater. Due to the potential consequences of uncorrected refractive errors, children whose parents have expressed concerns regarding development should be examined with cycloplegic refraction for refractive errors.

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Table 1

Parents' Evaluation of Developmental Status (PEDS) questions.

PEDS questions	
1	Please list any concerns about your child's learning, development, and behavior.
2	Do you have any concerns about how your child talks and makes speech sounds?
3	Do you have any concerns about how your child understands what you say?
4	Do you have any concerns about how your child uses his or her hands and fingers to do things?
5	Do you have any concerns about how your child uses his or her arms and legs?
6	Do you have any concerns about how your child behaves?
7	Do you have any concerns about how your child gets along with others?
8	Do you have any concerns about how your child is learning to do things for himself/herself?
9	Do you have any concerns about how your child is learning preschool or school skills?
10	Please list any other concerns.

Table 2

Risk for developmental problems and corresponding Parents' Evaluation of Developmental Status (PEDS) Levels.

Risk for developmental problems	PEDS level	Definition
High	A	High risk for developmental disabilities
	B	Moderate risk for developmental disabilities
Low	C	Low risk of developmental disability but some risk for behavioral/emotional problems
	D	Communication difficulties/barriers
	E	Low risk for developmental disabilities

Table 3

Demographic and health characteristics of the children in high and low risk for disability groups.

Child characteristics	N (%)	Parent Evaluation of Developmental Status**		p value
		High risk of developmental problems	Low risk of developmental problems	
Mean Age in months (SE)		43.4 ± 0.7	37.1 ± 0.4	
≤ 36 months	1104 (46.4)	25.0 ± 0.6	20.6 ± 0.3	<0.001
> 36 months	1277 (53.6)	53.3 ± 0.5	53.2 ± 0.3	
Males	1158 (48.6)	199 (39.0%)	959 (51.3%)	
Females	1223 (51.4)	311 (61.0%)	912 (48.7%)	<0.001
Ethnicity [†]				
White	951 (40.0)	209 (41.0%)	742 (39.7%)	
African American	1197 (50.3)	256 (50.3%)	941 (50.3%)	0.682
Other	203 (9.7)	42 (8.7%)	161 (10.0%)	
Mother's age (yrs)		33.1 ± 0.7	29.9 ± 0.2	<0.001
Father's age (yrs)		38.3 ± 0.8	35.1 ± 0.4	<0.001
Primary caregiver relationship to child [†]				
Biological Mother	2065 (86.9)	412 (80.94%)	1653 (88.40%)	
Biological Father	118 (5.0)	27 (5.30%)	91 (4.87%)	
Adoptive Parent	59 (2.5)	20 (3.93%)	39 (2.08%)	
Grandparent	81 (3.4)	24 (4.62%)	57 (3.05%)	<0.001
Other Relative	52 (2.2)	25 (5.21%)	27 (1.60%)	
History of eye problems [†]				
No	2257 (95.6)	469 (92.14%)	1788 (95.61%)	
Yes	100 (4.2)	37 (7.27%)	63 (3.37%)	0.002
Don't know	3 (0.2)	0 (0.00%)	3 (0.16%)	
Primary caregiver mean years of education (SE)		12.75 ± 0.19	13.47 ± 0.17	0.036

Child characteristics	N (%)	Parent Evaluation of Developmental Status ^{***}		p value
		High risk of developmental problems	Low risk of developmental problems	
Household income range [†]				
Above \$20,000	1525 (68.8)	299 (58.63%)	1226 (65.53%)	0.002
Below \$20,000	691 (31.2)	175 (34.31%)	516 (27.58%)	
Health insurance [‡]				
No	79 (3.4)	21 (4.13%)	58 (3.10%)	0.592
Yes	2279 (96.6)	486 (95.48%)	1793 (95.88%)	
Smoked during pregnancy [‡]				
No	1628 (79.7)	297 (58.24%)	1331 (71.14%)	<0.001
Yes	414 (20.3)	108 (21.18%)	306 (16.35%)	

Continuous variables are expressed as mean ± standard error. Categorical variables are expressed as proportion (%)

Based on the Parental Evaluation of Developmental Status (PEDS) questionnaire

[†] 28 missing ethnicity (2 high, 26 low); 4 missing primary caregiver relationship to child (1 high, 3 low); 165 missing household income range (36 high, 129 low); 21 missing health insurance (2 high, 19 low); 339 missing smoking (105 high, 234 low); 22 missing history of eye problem (3 high, 19 low)

Table 4

Prevalence of parental concerns about developmental problems** by refractive error for all children.

Refractive Error ^{††}	Children at high risk for developmental problems			Males at high risk for developmental problems			Females at high risk for developmental problems		
	Total	N	Prevalence	Males	N	Prevalence	Females	N	Prevalence
Hyperopia $\geq 3.00D$	232	55	23.7%	119	23	19.3%	113	32	28.3%
Myopia $\geq 1.00D$	112	28	25.0%	50	9	18.0%	64	19	29.7%
Astigmatism $\geq 1.50D$	292	78	26.7%	139	35	25.2%	153	43	28.1%
Anisometropia $\geq 2.00D$	22	9	40.9%	10	2	20.0%	12	7	58.3%

** Based on the Parental Evaluation of Developmental Status (PEDS) questionnaire.

^{††} Refractive error in the either eye.

D=diopter

Table 5

Association of significant refractive errors with parental report of concerns regarding developmental problems** in children 6-71 months.

Refractive errors ‡‡	Number of children	Children at risk for developmental problems**	Adjusted OR §§ of parental concerns in children 6-71 months (95% CI)
Hyperopia ≥ 1.00D*	1150	249	1.11 (0.91-1.36)
Hyperopia ≥ 3.00D*	232	55	1.26 (0.90-1.74)
Hyperopia ≥ 4.00D*	48	12	1.17 (0.59-2.32)
Myopia ≥ 1.00D*	112	28	1.29 (0.83-2.03)
Myopia ≥ 3.00D*	28	6	0.92 (0.36-2.35)
Astigmatism ≥ 1.50D*	292	78	1.44 (1.08-1.93) [†]
Astigmatism ≥ 3.00D*	19	5	0.98 (0.34-2.86)
Anisometropia ≥ 1.00D*	111	26	1.22 (0.77-1.94)
Anisometropia ≥ 2.00D*	22	9	2.61 (1.07-6.34) [†]

** Based on the Parental Evaluation of Developmental Status (PEDS) questionnaire.

‡‡ Refractive error in either eye.

* Reference groups are children 6 – 71 months with refractive errors less than these cut-points;

§§ Adjusted for age, sex, current health, history of an eye problem, primary caregiver's education, age of mother, age of father, smoking during pregnancy, and, the relationship of the primary caregiver.

D=diopter

[†] p value < 0.05

Table 6

Association of significant refractive errors with parental report of concerns regarding developmental problems^{**} in children 6-36 months and children 37-71 months.

Refractive errors ^{‡‡}	Adjusted OR of parental concerns in children 6-36 months (95% CI) ^{§§}	Adjusted OR of parental concerns in children 37-71 months (95% CI) ^{§§}
Hyperopia ≥ 1.00D	0.92 (0.66-1.27)	1.19 (0.92-1.54)
Hyperopia ≥ 3.00D	0.77 (0.41-1.42)	1.54 (1.03-2.30) [†]
Hyperopia ≥ 4.00D	0.93 (0.26-3.30)	1.52 (0.64-3.61)
Myopia ≥ 1.00D	1.79 (0.99-3.24)	0.89 (0.44-1.77)
Myopia ≥ 3.00D	1.44 (0.38-5.43)	0.67 (0.18-2.46)
Astigmatism ≥ 1.50D	0.96 (0.59-1.57)	1.81 (1.25-2.61) [†]
Astigmatism ≥ 3.00D	1.00 (0.11-9.20)	1.00 (0.30-3.35)
Anisometropia ≥ 1.00D	0.84 (0.34-2.03)	1.44 (0.83-2.51)
Anisometropia ≥ 2.00D	1.12 (0.24-5.26)	5.73 (1.44-22.67) [†]

^{**} Based on the Parental Evaluation of Developmental Status (PEDS) questionnaire.

^{‡‡} Refractive error in either eye.

^{§§} Adjusted for sex, current health, history of an eye problem, primary caregiver's education, age of mother, age of father, smoking during pregnancy, and, the relationship of the primary caregiver.

D=dioptr

[†] p value < 0.05