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Prevalence of Amblyopia or Strabismus in Asian and Non-Hispanic White Preschool Children:

Multi-Ethnic Pediatric Eye Disease Study

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Abstract

Objective—To determine the age- and race-specific prevalence of amblyopia in Asian and non-Hispanic white children aged 30 to 72 months and of strabismus in children aged 6 to 72 months.

Design—Cross-sectional survey.

Participants—A population-based, multiethnic sample of children aged 6 to 72 months was identified in Los Angeles and Riverside counties in California to evaluate the prevalence of ocular conditions.

Methods—A comprehensive eye examination and in-clinic interview were conducted with 80% of eligible children. The examination included evaluation of ocular alignment, refractive error, and ocular structures in children aged 6 to 72 months, as well as a determination of optotype visual acuity (VA) in children aged 30 to 72 months.

Main Outcome Measures—The proportion of 6- to 72-month-old participants with strabismus and 30- to 72-month-olds with optotype VA deficits and amblyopia risk factors consistent with study definitions of amblyopia.

Results—Strabismus was found in 3.55% (95% confidence interval [CI], 2.68–4.60) of Asian children and 3.24% (95% CI, 2.40–4.26) of non-Hispanic white children, with a higher prevalence with each subsequent older age category from 6 to 72 months in both racial/ethnic groups

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($P=0.0003$ and 0.02 , respectively). Amblyopia was detected in 1.81% (95% CI, $1.06\text{--}2.89$) of Asian and non-Hispanic white children; the prevalence of amblyopia was higher for each subsequent older age category among non-Hispanic white children ($P=0.01$) but showed no significant trend among Asian children ($P=0.30$).

Conclusions—The prevalence of strabismus was similar in Asian and non-Hispanic white children and was found to be higher among older children from 6 to 72 months. The prevalence of amblyopia was the same in Asian and non-Hispanic white children; prevalence seemed to be higher among older non-Hispanic white children but was relatively stable by age in Asian children. These findings may help clinicians to better understand the patterns of strabismus and amblyopia and potentially inform planning for preschool vision screening programs.

Amblyopia and strabismus are developmental disorders of vision that typically begin in early childhood and subsequently result in vision loss and impaired binocular function that may persist through adulthood unless successfully treated. Although clinical screening methods for these disorders in children have improved over the past few decades, population-based data on the prevalence of amblyopia and strabismus in early childhood for children of different races/ethnicities have been lacking. Population-based prevalence estimates for children younger than 8 years have ranged from 0.3% to 4.4% ^{1–21} for strabismus and from 0.5% to 3.5% for amblyopia.^{4,6,7,11,13–15,17–19,21–26} Determining precise estimates has been problematic in that the diagnoses of amblyopia and strabismus often were determined from retrospective chart reviews, using children of various ages and applying varying disease definitions, without the benefit of standardized testing or comprehensive eye examinations.

We recently reported in the Multi-Ethnic Pediatric Eye Disease Study (MEPEDS) that amblyopia was present in 2.6% of Hispanic children and 1.5% of African-American children aged 30 to 72 months and that this prevalence did not vary by age.²⁷ In the Baltimore Pediatric Eye Disease Study (BPEDS), conducted with the same protocol as the MEPEDS, amblyopia was present in 1.8% of non-Hispanic white children and 0.8% of African-American children.²⁸ Strabismus was found in 2.4% of Hispanic children and 2.5% of African-American children among MEPEDS participants 6 to 72 months of age, with higher prevalence in older children, whereas in BPEDS, the prevalence of strabismus was 3.3% and 2.1% in non-Hispanic white and African-American children, respectively. In the Strabismus, Amblyopia, and Refractive Error in Singapore (STARS) study, the prevalence of strabismus in children aged 6 to 72 months was 0.80% (95% confidence interval [CI], $0.51\text{--}1.19$) and the prevalence of amblyopia in children aged 30 to 72 months was 1.19% (95% CI, $0.73\text{--}1.83$).²⁹ Overall, these studies have expanded our understanding of the pattern of amblyopia and strabismus in young children of differing ages and racial/ethnic backgrounds. In the current analysis, we report age- and race/ethnicity-specific prevalence data for amblyopia and strabismus for both non-Hispanic white and Asian children from the MEPEDS.

Methods

Study Design

The MEPEDS is a multiethnic, population-based study of preschool children in Los Angeles and Riverside Counties in California. The study design and sampling plan have been described elsewhere.³⁰ Briefly, the study was designed to establish the prevalence of common ocular conditions in a population-based sample of African-American, Asian, Hispanic, and non-Hispanic white children; to identify risk factors associated with these conditions; and to explore the relationship between physical and psychosocial functioning and the prevalence and severity of various ocular disorders.

Study Population

Eligible MEPEDS participants were children aged 6 to 72 months living in 1 of 100 selected census tracts in Los Angeles County in and around the cities of Alhambra, Inglewood, and Glendale, and in the city of Riverside in Riverside County, California. The overall participation rate for eligible children was 80%; specifically, 9172 children completed comprehensive eye examinations of 11 519 eligible children identified by a door-to-door census. The participation rates by city from which the children in the current analysis were recruited were Riverside (80%), Glendale (82%), and Alhambra, California (87%). Participants were recruited, and clinical examinations and parental interviews were completed from 2003 to 2011. All children aged 5 to 70 months on the day of the door-to-door household screening who were residents of one of the study-selected census tracts were eligible for participation. Informed consent was obtained from the parent or legal guardian (referred to as “parent” hereafter) of each eligible child and followed by a brief in-home interview that included basic demographic information and a medical history including self-reported eye conditions and stereopsis testing. Eligible children were then scheduled for a comprehensive eye examination and in-depth parental interview at the local MEPEDS clinic.

Eye Examination and Parental Interview

All children underwent a comprehensive eye examination, conducted by optometrists or ophthalmologists who were trained and certified using standardized study protocols. The examinations, described in detail previously,^{27,31} included monocular distance optotype visual acuity (VA) testing for children aged 30 months,^{32,33} evaluation of ocular alignment, anterior segment and dilated fundus evaluations, and measurement of refractive error under cycloplegic conditions.³⁴

The protocol for cycloplegia was 2 drops of 1% cyclopentolate (0.5% for <12-month-olds) administered 5 minutes apart followed by autorefraction using the Retinomax Autorefractor (Right Manufacturing, Virginia Beach, VA) at least 30 minutes after the last drop. When Retinomax confidence ratings were not 8 in both eyes despite 3 attempts, cycloplegic retinoscopy was performed. Noncycloplegic retinoscopy was performed if parents did not allow cycloplegic eye drops.

Assessment of Ocular Alignment and Definition of Strabismus

Ocular alignment was evaluated using the unilateral cover (cover-uncover) test, the simultaneous prism and cover test (SPCT), and the alternate cover and prism test at 6-m and 40-cm fixation distances using an accommodative target with and without optical correction (if worn). Transient misalignment after the alternate cover test (ACT) was designated as strabismus only when it was of sufficient duration to be confirmed by a repeat unilateral cover (cover-uncover) test. Strabismus magnitude was measured in prism diopters (Δ) using the SPCT and the ACT. Hirschberg testing at near was used when the SPCT could not be performed and Krimsky testing at near was used when the ACT could not be performed.

Strabismus was defined as constant or intermittent heterotropia of any magnitude at distance or near fixation. Children tested at only 1 fixation distance and found to be without strabismus were considered nonstrabismic. Strabismus was classified according to the horizontal direction (esotropia, exotropia) of the tropia or as vertical strabismus if there was no horizontal tropia.

Measurement of Visual Acuity and Definition of Amblyopia

Monocular distance VA was measured in children aged 30 months using single-surrounded HOTV optotypes on the electronic VA tester³⁵ according to the Amblyopia Treatment Study protocol,³⁶ using naming or matching of letters.^{32,33} Initial VA was tested with habitual correction, if worn. Visual acuity was considered subnormal and retested after cycloplegia with full correction when (1) VA was decreased in either eye ($<20/50$ for 30- to 47-month-olds or $<20/40$ for 48-month-olds); or (2) 2 of interocular difference (with $20/32$ in the worse-seeing eye) was present. By using the best VA measure from each eye, children with persistent subnormal VA (as defined earlier) in either eye and an amblyopia risk factor (defined later) were scheduled for return-visit VA retesting with best correction and without cycloplegia to determine whether the subnormal corrected VA was an artifact of testing after dilation. Spherical equivalent (SE) hyperopia on this visit was undercorrected by up to 1.50 diopters (D) to allow for incomplete relaxation of accommodation. Participants unable to perform VA testing at the initial visit were sent home with HOTV letters to practice and scheduled for a return visit. Final best-corrected VA for each eye was the best VA measured at any visit.

Unilateral amblyopia was defined as a 2-line interocular difference in best-corrected VA with $20/32$ in the worse eye and a corresponding unilateral amblyopia risk factor of (1) strabismus (upon examination or history of strabismus surgery); (2) anisometropia consistent with the eye with worse VA (SE anisohyperopia 1.00 D, SE anisomyopia 3.00 D, or anisoastigmatism 1.50 D); or (3) past or present obstruction of the visual axis (e.g., cataract, ptosis, corneal opacity). Bilateral amblyopia was defined as bilaterally decreased best-corrected VA ($<20/50$ for 30- to 47-month-olds or $<20/40$ for 48-month-olds) in the presence of bilateral isoametropia (SE hyperopia 4.00 D, SE myopia 6.00 D, astigmatism 2.50 D) or with evidence of visual axis obstruction (described earlier) of both eyes.

Parental Interview

Trained interviewers conducted standardized parental interviews of demographic, medical, and ocular history in the clinic or subsequently by telephone if the child was accompanied to the examination by a person other than a parent. The medical history portion included questions about whether a doctor had ever told the parent that the child had health conditions, such as mental retardation, cerebral palsy, Down syndrome, convulsions or seizures, and retinopathy of prematurity, and whether a doctor had ever diagnosed the child with strabismus or amblyopia. Further details of the interview have been described elsewhere.³⁰

Statistical Analysis

The prevalence of strabismus and amblyopia was calculated as the ratio of the number of participants with one or the other ocular condition over the total evaluated for the condition. Strabismus prevalence was evaluated in children aged 6 to 72 months, whereas the prevalence of amblyopia was evaluated in children aged 30 to 72 months because the diagnosis required optotype VA testing, which was performed only in children aged 30 months. The proportions of children with each ocular condition were compared by race/ethnicity, sex, and age; chi-square tests were used to evaluate statistically significant differences in proportions between subgroups. The associations of strabismus and amblyopia frequency by age categories were evaluated using a Cochran trend test. Ninety-five percent CIs were calculated for prevalence of strabismus and amblyopia overall and by race/ethnicity, age group, and prevalence of esotropia and exotropia. Analyses were conducted using SAS software version 9.1 (SAS Inc., Cary, NC) at the 0.05 significance level. *P* values refer to chi-square tests unless otherwise specified.

Results

Study Population

A total of 1514 non-Hispanic white children and 1522 Asian children were included in the analysis of strabismus, whereas 945 non-Hispanic white and 938 Asian children were included in the analysis of amblyopia (Table 1). Among the 1522 participating Asian children, 1016 (67%) were East Asian, 307 (20%) were South East Asian, and 199 (13%) did not specify further. Of the East Asian, 861 were Chinese, 52 were Japanese, and 103 were Korean; of the South East Asian, 67 were Indian, 150 were Filipino, 82 were Vietnamese, and 8 were Cambodian. Three Asian children were excluded from the strabismus analysis (n=1525 eligible) because of an inability to complete all testing. There were slightly more boys than girls enrolled in the study (53% non-Hispanic white; 51% Asian); however, these differences were not statistically significant for the children contributing data to the strabismus ($P=0.40$) or amblyopia ($P=0.60$) analyses.

Prevalence of Strabismus

We found a similar prevalence of strabismus among non-Hispanic white (3.24%; 95% CI, 2.40–4.26) and Asian (3.55%; 95% CI, 2.68–4.60) children ($P=0.64$) (Table 2). Although esotropia (2.31; 95% CI, 1.62–3.20) was more common than exotropia (0.73%; 95% CI,

0.36–1.29) among non-Hispanic white children, exotropia (2.10%; 95% CI, 1.44–2.96) was more prevalent than esotropia (1.38%; 95% CI, 0.86–2.10) among Asian children. Asian children had a significantly higher prevalence of exotropia than non-Hispanic white children in our sample ($P=0.002$). There were no differences in the prevalence of amblyopia for boys compared with girls for Asian or non-Hispanic white children. There were no differences in prevalence of strabismus (any, esotropia, or exotropia) for Asian or non-Hispanic white boys compared with Asian or non-Hispanic white girls, respectively (data not shown).

Esotropia was more often constant than exotropia at both distance and near fixation. At distance fixation (Table 2), 63% of esotropias (24/38, combining data from non-Hispanic white and Asian children) were constant rather than intermittent, whereas only 26% of exotropias (9/35) were constant. At near fixation, 55% of esotropias were constant (29/53), but only 33% of exotropias were constant (9/27).

The majority of horizontal strabismus at distance measured $\leq 30^\circ$ in magnitude. Specifically, at distance fixation, 24.5% ($n=12$) of children had a microtropia ($1-9^\circ$) and 36.7% ($n=18$) of children had tropias that measured $10-30^\circ$ among non-Hispanic white participants. The distribution was similar for Asian participants, with 24.1% of children classified as microtropic at distance and 40.7% with angles measuring $10-30^\circ$; the distribution of children by magnitude at distance was not significantly different by race/ethnicity ($P=0.97$) (Table 2). At near fixation, there were more Asian children with microtropias ($n=23$; 42.6%) than with larger angles. Most of the microtropias at near fixation were intermittent in Asian children (78%), with 9 of the 23 children classified with intermittent exotropia and 9 classified with intermittent esotropia; 3 of the children were classified with constant exotropia and 3 were classified with constant esotropia (data not shown). Among non-Hispanic white children, 2 of the 11 children with microtropias were classified with intermittent exotropia, 4 were classified with intermittent esotropia, 0 were classified with constant exotropia, and 5 were classified with constant esotropia. At distance fixation, 7 of the 13 Asian children with microtropias were classified with intermittent exotropia, 3 were classified with intermittent esotropia, 1 was classified with constant exotropia, and 2 were classified with constant esotropia; among non-Hispanic white children, 5 of the 12 tropias at distance were classified as intermittent esotropia, 1 was classified as intermittent exotropia, 1 was classified as constant exotropia, and 5 were classified as constant esotropia (data not shown). Among all Asian children with microtropia, only 2 were classified as having constant esotropia at both near and distance fixation and 0 were classified as having constant exotropia at both near and distance fixation. Among the non-Hispanic white children with microtropia, 2 were classified as having constant esotropia at both near and distance fixation, and 2 were classified as having constant exotropia at both near and distance fixation (data not shown).

When we examined the prevalence of strabismus by age and race/ethnicity, we found a pattern of greater strabismus prevalence with older age category among non-Hispanic white children (P for trend=0.02) (Table 3), with the prevalence ranging from 2.44% among 6- to 11-month-olds to 4.62% among 60- to 72-month-olds. This also was true among Asian participants, with strabismus prevalence ranging from 1.5% for 6- to 11-month-olds to 5.0% for 60- to 72-month-olds (P for trend=0.0003).

Prevalence of Amblyopia

The prevalence of amblyopia was the same (1.81%) in Asian and non-Hispanic white participants. Similar to our findings for strabismus, when the results were stratified by age (for amblyopia, into 4 groups from 30 to 72 months of age), amblyopia prevalence was higher with increasing age for Non-Hispanic white children (P for trend=0.01; Table 4). Although the opposite pattern (higher amblyopia prevalence with younger age category) seemed to be present for Asian children, the trend was not statistically significant (P for trend=0.30; Table 4). There were no differences in the prevalence of amblyopia for boys compared with girls for Asian or non-Hispanic white children.

The most common types of amblyopia among all children were anisometropic without strabismus (47.1%; 16/34) and strabismic amblyopia (44.1%; 15/34); combined strabismic/anisometropic amblyopia was less common (17.6%, 6/34). The prevalence of anisometropic amblyopia was 0.75% among non-Hispanic white children and 0.96% among Asian children; these small differences were not statistically significant. Bilateral ametropic amblyopia was rare, with only 2 cases (prevalence = 0.21%) among non-Hispanic white children and no cases among Asian children. In total, 71% (24/34) of amblyopia cases were attributable entirely or in part to abnormal refractive error (anisometropia or bilateral ametropia).

Discussion

In our population-based sample of 6- to 72-month-old children from Los Angeles and Riverside counties in California, the overall prevalence of strabismus was similar in non-Hispanic white children (3.24%) and Asian children (3.55%), with a pattern of higher prevalence among older compared with younger children. Esotropia was the predominant form of strabismus in the non-Hispanic white children, whereas exotropia was more common in Asian children. The prevalence of amblyopia in children aged 30 to 72 months was the same (1.81%; 95% CI, 1.06–2.89) for both non-Hispanic white and Asian children.

The prevalence of strabismus reported in this article for Asian (3.55%; 95% CI, 2.68–4.60) and non-Hispanic white children is higher than previously reported in the MEPEDS (3.24%; 95% CI, 2.40–4.26) for African-American (2.5%; 95% CI, 2.0–3.1) and Hispanic (2.4%; 95% CI, 1.9–3.0) children measured using the same standard protocols. However, the prevalence of strabismus for non-Hispanic white (3.3%; 95% CI, 2.3–4.6) and African-American (2.1%; 95% CI, 1.3–3.0) children in the BPEDS sample, measured with the same protocol in Baltimore, Maryland, was nearly identical to the prevalence found in the same racial/ethnic groups in the MEPEDS sample.²⁸ The prevalence of strabismus and amblyopia in our MEPEDS Asian participants (largely of Chinese descent) was higher than the strabismus prevalence of 0.80% (95% CI, 0.51–1.19) and amblyopia prevalence of 1.19% (95% CI, 0.73–1.83) previously reported in the STARS study of East Asian children of the same age.²⁹ Although the CIs for strabismus are mutually exclusive, the CIs for amblyopia in MEPEDS and STARS overlap. The lower rates of strabismus in STARS compared with MEPEDS, despite the fact that both are population-based studies of Asian children with similar protocols, suggest that environmental factors may be driving these differences.

Our finding of higher rates of exotropia than esotropia among Asian children is consistent with findings from the STARS study of East Asian children²⁹ and the Refractive Error Study in Children, a study of urban children from Southern China³⁷; several clinical studies of children from Hong Kong and Singapore (Chinese, Indian, Malay) also have described that exotropia is approximately twice as common in Asian children than non-Asian children from other countries.^{38–40} Exotropia also was more common than esotropia in our previous report for African-American and Hispanic children.²⁷ However, we found the reverse to be true for non-Hispanic white children, with esotropia being the more common form of strabismus. Although the BPEDS group found the occurrence of esotropia and exotropia to be approximately the same in their population-based sample of non-Hispanic white and African-American children,²⁸ other studies have reported esotropia to be more common than exotropia in non-Hispanic white children, including a population-based study of 6-year-old primarily white children in Australia⁴¹ and white children in Olmsted County, Minnesota.⁴² Esotropia has been shown to be a stronger risk factor for amblyopia than exotropia.⁴³ Thus, we might have expected to find a higher prevalence of amblyopia, especially strabismic or strabismic/anisometropic amblyopia, in non-Hispanic white children, who tended to have a higher prevalence of esotropia. However, our study did not observe such differences in amblyopia prevalence between Asian and non-Hispanic white children.

Similar to our previous publication, the current study found that the prevalence of strabismus was higher in older children and that this association with age was most apparent with esotropia in non-Hispanic white children and exotropia in Asian children because of the larger number of cases in each of these strata. The BPEDS also reported higher rates of strabismus in older children and very low rates of strabismus in both non-Hispanic white and African-American children younger than 1 year.²⁸ These data are consistent with previous studies that also have reported few cases of strabismus in children younger than 1 year of age at examination.^{1–3}

The overall prevalence of amblyopia diagnosed in our 30- to 72-month-old participants was the same (1.81%; 95% CI, 1.06–2.89) in Asian and Non-Hispanic white children. This is lower than the prevalence we reported previously for Hispanic children (2.6%) and higher than the prevalence reported previously for African-American children (1.5%) in MEPEDS.²⁷ Although our data for African-American and Hispanic children suggested that the prevalence of amblyopia was stable from age 3 to 6 years, we observed a substantial increase with increasing age in the prevalence of amblyopia, specifically anisometropic and combined anisometropic/strabismic amblyopia, in non-Hispanic white children aged 30 to 72 months. This was not seen among Asian children. In non-Hispanic white children in the youngest age category (30–35 months), we observed no cases of amblyopia. This could be in part because of the smaller sample size for this age group and in part because of poorer testability in these young children. The VA retest protocol was designed to eliminate false-positives (overdiagnosis of amblyopia), but false-negatives (missed diagnosis of amblyopia) could have theoretically occurred in some instances, because children with normal-for-age VA and no interocular difference were not retested even if they had an amblyogenic factor. Thus, it is possible that a retest might have revealed an interocular difference in VA if VA had been retested. However, the higher prevalence of amblyopia in Asian children aged 30 to

35 months (2.38%) suggests that the increasing prevalence with older age in non-Hispanic white children is not solely related to issues of VA testability in the youngest groups.

Among Asian children, the prevalence of amblyopia was highest in children aged 30 to 47 months and continued to decrease in children aged 48 to <60 months and 60 to <72 months. Although this trend was not statistically significant, this pattern could occur if (1) some older Asian children with amblyopia had already been diagnosed and treated or (2) a sampling error or random variation created the pattern because of small numbers of cases in age-specific strata.

The overall distribution by type of amblyopia was similar for non-Hispanic white and Asian children. Approximately 70% of the unilateral amblyopia cases in this sample are due entirely or in part to some form of anisometropia, indicating that the majority of cases are at least in part attributable to refractive error. The percentage is higher still if one considers that some cases of purely strabismic amblyopia from esotropia are cases of accommodative esotropia and thus ultimately due to underlying refractive error. This observation supports the screening of young children for high-risk refractive error for detection of children with amblyopia.

Bilateral ametropic amblyopia was rare in this sample, with only 2 cases diagnosed among all children. In our previous report of African American and Hispanic children, the prevalence of bilateral amblyopia also was low, 0.45%. A previous study of Australian children (~60% European white, 20% Asian) found a prevalence of 0.12% of bilateral amblyopia among a population with a modest history of amblyopia treatment (1.3%).^{44,45}

Study Limitations

Limitations of study design always need to be considered in the interpretation of the prevalence findings. Because VA was not assessed in children younger than 30 months, we cannot provide amblyopia prevalence estimates for children aged 6 to 29 months. As previously discussed, amblyopia prevalence may be underestimated in the youngest age group, and conversely, we may have a small number of false-positive amblyopia cases because some children who tested positive for amblyopia at the first visit did return for follow-up VA retesting. In addition, because of the low prevalence of amblyopia, the small number of amblyopia cases by age group limits our ability to make definitive conclusions about the pattern of amblyopia by age. Although MEPEDS is a population-based sample of Chinese American children in Southern California, the generalizability of the findings to all Chinese Americans or the comparability to Chinese in Singapore is uncertain. Finally, we recruited children of different racial/ethnic ancestry across each census area; however, specific census tracts were selected on the basis of the high number of children of specific racial/ethnic ancestry for study efficiency. Therefore, children from different racial/ethnic backgrounds were more likely to live in some census areas. Particular strengths of our study include that our data are derived from a large, population-based, multiethnic cohort of children with high response rates and that our prevalence data for non-Hispanic white children support the previous findings by the population-based BPEDS, which was conducted using the same clinical protocol as the MEPEDS. To our knowledge, the prevalence findings for Asian children are one of the first population-based reports of the

prevalence of amblyopia and strabismus in preschool-aged Asian children in the United States.

In conclusion, the prevalence of strabismus was similar in non-Hispanic white and Asian children and was found to be higher with increasing age from 6 to 72 months. The prevalence of amblyopia was the same in non-Hispanic white and Asian children; prevalence seemed to be higher among older non-Hispanic white children but seemed to be relatively stable by age in Asian children. These findings may help clinicians to better understand the patterns of strabismus and amblyopia and potentially inform planning for preschool vision-screening programs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Age and Sex Frequency Distributions of the Non-Hispanic White and Asian Children in the Multi-Ethnic Pediatric Eye Disease Study

Characteristic	Strabismus			Amblyopia		
	White, n (%)	Asian, n (%)	P Value	White, n (%)	Asian, n (%)	P Value
Total	1514	1522		945	938	
Age group (mos)			0.70			0.86
6–11	125 (8)	135 (9)		N/A	N/A	
12–23	230 (15)	243 (16)		N/A	N/A	
24–35 *	253 (17)	261 (17)		87 (9)	84 (9)	
36–47	305 (20)	274 (18)		264 (28)	254 (27)	
48–59	273 (18)	288 (19)		267 (28)	282 (30)	
60–72	328 (22)	321 (21)		327 (35)	318 (34)	
Sex			0.40			0.60
Male	795 (53)	776 (51)		492 (52)	477 (51)	
Female	719 (47)	746 (49)		453 (48)	461 (49)	

N/A = not applicable.

* A total of 30–35 mos for amblyopia columns.

Table 2

Strabismus Prevalence and Subtypes for Non-Hispanic White and Asian Children in the Multi-Ethnic Pediatric Eye Disease Study

Strabismus	Non-Hispanic White (n=1514)	Asian (n=1522)	P Value
	Prevalence (n) (95% CI)	Prevalence (n) (95% CI)	
Any strabismus *	3.24% (49) (2.40–4.26)	3.55% (54) (2.68–4.60)	0.64
Esotropia	2.31% (35) (1.62–3.20)	1.38% (21) (0.86–2.10)	0.06
Exotropia	0.73% (11) (0.36–1.29)	2.10% (32) (1.44–2.96)	0.002
Horizontal strabismus type at distance, n (%) *			
Intermittent exotropia	6 (12.2)	20 (37.0)	
Constant exotropia	2 (4.08)	7 (13.0)	
Intermittent esotropia	9 (18.4)	5 (9.26)	
Constant esotropia	16 (32.7)	8 (14.8)	
Strabismus identified only at near	12 (24.5)	14 (25.9)	
Horizontal strabismus type at near, n (%) †			
Intermittent exotropia	5 (10.2)	13 (24.1)	
Constant exotropia	4 (8.16)	5 (9.26)	
Intermittent esotropia	11 (22.5)	13 (24.1)	
Constant esotropia	21 (42.9)	8 (14.8)	
Strabismus only at distance	4 (8.16)	14 (25.9)	
Strabismus magnitude at distance, n (%) * (horizontal SPCT)			0.97
1–9 PD	12 (24.5)	13 (24.1)	
10–30 PD	18 (36.7)	22 (40.7)	
>30 PD	1 (2.04)	1 (1.85)	
Unable to measure	2 (4.08)	4 (7.41)	
Strabismus only at near	12 (24.5)	14 (25.9)	
Strabismus magnitude at near, n (%) † (horizontal SPCT)			0.008
1–9 PD	11 (22.5)	23 (42.6)	
10–30 PD	19 (38.8)	10 (18.5)	
>30 PD	7 (14.3)	2 (3.70)	
Unable to measure	4 (8.16)	4 (7.41)	
Strabismus only at distance	4 (8.16)	14 (25.9)	

CI = confidence interval; PD = prism diopters; SPCT = simultaneous prism and cover test.

* Four non-Hispanic white children had purely vertical strabismus at distance and are not tabulated for horizontal type/magnitude.

[†]Four non-Hispanic white children had purely vertical strabismus at near, and 1 Asian child had direction of strabismus undetermined at near; these were not tabulated for horizontal type/magnitude.

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Table 3

Prevalence of Strabismus and Type of Strabismus in Non-Hispanic White and Asian Children in the Multi-Ethnic Pediatric Eye Disease Study Stratified by Age (Months)

Age (mos)	Any Strabismus, Prevalence (n) (95% CI)		Any Exotropia Prevalence (n)		Any Esotropia, Prevalence (n)	
	NHW	Asian	NHW	Asian	NHW	Asian
6–11 (NHW: n=123; Asian: n=135)	2.44 (3) (0.51–6.96)	1.48 (2) (0.18–5.25)	0.81 (1)	1.48 (2)	1.63 (2)	0.00 (0)
12–23 (NHW: n=228; Asian: n=243)	1.75 (4) (0.48–4.43)	0.41 (1) (0.01–2.27)	0.44 (1)	0.41 (1)	0.88 (2)	0.00 (0)
24–35 (NHW: n=253; Asian: n=261)	1.58 (4) (0.43–4.00)	3.83 (10) (1.85–6.93)	0.40 (1)	2.68 (7)	1.19 (3)	1.15 (3)
36–47 (NHW: n=303; Asian: n=274)	3.96 (12) (2.06–6.82)	2.19 (6) (0.81–4.71)	0.66 (2)	1.82 (5)	3.30 (10)	0.36 (1)
48 to 59 (NHW: n=271; Asian: n=288)	4.06 (11) (2.04–7.15)	6.25 (18) (3.75–9.70)	1.48 (4)	3.13 (9)	2.58 (7)	3.13 (9)
60–72 (NHW: n=325; Asian: n=321)	4.62 (15) (2.61–7.50)	5.30 (17) (3.12–8.34)	0.62 (2)	2.50 (8)	3.38 (11)	2.50 (8)
Total (NHW: n=1502; Asian: n=1522)	3.26 (49) (2.42–4.29)	3.55 (54) (2.68–4.60)	0.73 (11) (0.37–1.31)	2.10 (32) (1.44–2.96)	2.33 (35) (1.63–3.22)	1.38 (21) (0.86–2.10)

CI = confidence interval; NHW = non-Hispanic white.

Table 4

Prevalence of Amblyopia and Type of Amblyopia in Non-Hispanic White and Asian Children in the Multi-Ethnic Pediatric Eye Disease Study Stratified by Age (Months)

Age (mos)	Any Amblyopia, Prevalence % (n) (95% CI)		Unilateral Amblyopia, Prevalence % (n)								Bilateral Amblyopia, Prevalence (n)	
	NHW	Asian	Anisometropic Amblyopia		Strabismic Amblyopia		Anisometropic and Strabismic Amblyopia		Deprivational Amblyopia		NHW	Asian
			NHW	Asian	NHW	Asian	NHW	Asian	NHW	Asian		
30–35 (NHW: n=87; Asian: n=84)	0.0 (0) (NA)	2.38 (2) (0.29–8.34)	0.00 (0)	1.19 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	1.19 (1)	0.00 (0)	0.00 (0)
36–47 (NHW: n=262; Asian: n=254)	0.76 (2) (0.09–2.73)	2.36 (6) (0.87–5.07)	0.38 (1)	1.57 (4)	0.38 (1)	0.79 (2)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
48–59 (NHW: n=265; Asian: n=282)	1.89 (5) (0.62–4.35)	1.77 (5) (0.58–4.09)	0.75 (2)	0.71 (2)	0.75 (2)	1.06 (3)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.38 (1)	0.00 (0)
60–72 (NHW: n=323; Asian: n=318)	3.10 (10) (1.49–5.62)	1.26 (4) (0.34–3.19)	1.24 (4)	0.63 (2)	1.24 (1)	0.00 (0)	1.24 (4)	0.63 (2)	0.00 (0)	0.00 (0)	1.31 (1)	0.00 (0)
Total (NHW: n=937; Asian: n=938)	1.81 (17) (1.06–2.89)	1.81 (17) (1.06–2.89)	0.75 (7)	0.96 (9)	0.43 (4)	0.53 (5)	0.43 (4)	0.21 (2)	0.00 (0)	0.11 (1)	0.21 (2)	0.00 (0)
<i>P</i> for trend	0.013	0.303										

CI = confidence interval; NHW = non-Hispanic white.