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Vision Health Disparities in the United States by Race/Ethnicity, Education, and Economic Status: Findings from Two Nationally Representative Surveys

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Abstract

Purpose—To assess vision health disparities in the United States by race/ethnicity, education, and economic status.

Design—Cross-sectional, nationally representative samples

Methods—We used national survey data from the National Health and Nutrition Examination Survey (NHANES) and the National Health Interview Survey (NHIS). Main outcome measures included, from NHANES, age-related eye diseases (i.e., age-related macular degeneration [AMD], cataract, diabetic retinopathy [DR], glaucoma) and from NHIS, eye care use (i.e., eye doctor visits and cannot afford eyeglasses when needed) among those with self-reported visual impairment.

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Contributions of Authors: design of the study (Zhang, Cotch, Ryskulova, Saaddine); and conduct of the study (Zhang, Cotch, Ryskulova, Primo, Saaddine); collection, management, analysis (Zhang, Nair, Chou), and interpretation of the data (Zhang, Cotch, Ryskulova, Primo, Nair, Chou, Geiss, Barker, Elliott, Crews, Saaddine); and preparation, review, or approval of the manuscript (Zhang, Cotch, Ryskulova, Primo, Nair, Chou, Geiss, Barker, Elliott, Crews, Saaddine).
Drs. Zhang, Chou, and Nair had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

The NHANES and NHIS surveys are publicly available data and their protocols were approved by a human subjects review board, and written informed consent was obtained from all participants.

The estimates were age- and sex-standardized to the 2000 US census population. Linear trends in the estimates were assessed by weighted least squares regression.

Results—Non-Hispanic whites had a higher prevalence of AMD and cataract surgery than non-Hispanic blacks, but a lower prevalence of DR and glaucoma (all $P < 0.001$ in NHANES 2005–2008). From 1999 to 2008, individuals with less education (i.e., < high school vs. > high school) and lower income (poverty income ratio [PIR] < 1.00 vs. ≥4.00) were consistently less likely to have had an eye care visit in the past 12 months compared with their counterparts (all $P < 0.05$). During this period, inability to afford needed eyeglasses increased among non-Hispanic whites and Hispanics (trend $P = 0.004$ and $P = 0.007$; respectively), those with high school education (trend $P = 0.036$), and those with PIR 1.00–1.99 (trend $P < 0.001$).

Conclusions—Observed vision health disparities suggest a need for educational and innovative interventions among socioeconomically disadvantaged groups.

Keywords

vision; eye; health disparity; surveillance

INTRODUCTION

Vision loss is a serious public health challenge today, and global efforts to reduce avoidable blindness by 2020 are underway.[1,2] In the United States, age-related eye diseases (i.e., age-related macular degeneration [AMD], cataract, diabetic retinopathy [DR], glaucoma) and other eye conditions are common causes of vision loss.[3–7] More than 3.3 million Americans 40 years or older are either legally blind (0.9 million, 0.8%) or have low vision (i.e., less than 20/40 best corrected vision in the better-seeing eye; 2.4 million, 2.0%) caused mostly by age-related eye diseases.[8] By 2020, the number of people with eye diseases and associated vision loss could increase by 50% or more because of the aging of the U.S. population. [3–7]

Blindness and low vision often affect people's ability to read, walk, drive, or conduct other daily activities.[9,10] Poor vision also results in an increased risk for falls and injuries[11,12], social isolation, depression,[13,14] loss of productivity,[15,16] and, ultimately, an increased risk for morbidity or premature death.[17–20] Moreover, many eye diseases are asymptomatic in the early stages, when treatment may forestall or delay disease onset and prevent vision loss. Given the rapidly aging US population, the growing obesity epidemic, and the increasing prevalence of diabetes, evidence is mounting that vision loss will become an even greater problem for the United States in the future.

Vision objectives are included in *Healthy People 2010* and *Healthy People 2020*, a national disease prevention initiative that identifies opportunities to improve the health of all Americans.[21,22] One of the overarching goals of *Healthy People 2010 /2020* is to eliminate health disparities, including differences that occur by gender, race/ethnicity, education, income, disability, geographic location, or sexual orientation. Addressing vision health disparities would help enhance public health programs and close the gaps to improve the nation's vision and eye health.[23,24] A national and state surveillance system using national,

state, and local surveys; birth and death certificates; and Medicare, Medicaid, and managed care data helps the nation's policy makers analyze, interpret, and report on vision loss, risk factors, care practices, morbidity, and mortality.

This report describes the use of national data to assess the prevalence of major age-related eye diseases and eye care utilization; examines disparities by race/ethnicity, education, and economic status; explores the strengths and weaknesses of using existing national data sets to identify vision health disparities; and helps future surveillance activities to guide public health priorities and policies.

METHODS

Data Sources

National Health and Nutrition Examination Survey (NHANES)—The NHANES (www.cdc.gov/nchs/nhanes.htm) is a national representative survey conducted by the National Center for Health Statistics, the Centers for Disease Control and Prevention (CDC). The NHANES was conducted during 1960–1962 (NHES I), 1963–1965 (NHES II), 1966–1970 (NHES III), 1971–1974 (NHANES I), 1976–1980 (NHANES II), 1982–1984 (HHANES), and 1988–1994 (NHANES III). Since 1999, the NHANES has been conducted continuously. The NHANES survey protocols were approved by a human subjects review board, and written informed consent was obtained from all participants.

The NHANES data consist of samples of the US noninstitutionalized civilian population, which were obtained by using a stratified multistage probability design with planned oversampling of certain age and minority groups. Participants were interviewed at home to obtain sociodemographic, medical, and family information; those who reported to the Mobile Examination Center received a detailed medical examination. The NHANES III also included a retinal photography protocol, which was used to determine the presence and severity of AMD and DR. Beginning in 1999, visual acuity testing was included. The ophthalmic component of digital retinal images and frequency doubling technology (FDT) for participants aged 40 or older was added to the 2005–2008 NHANES. Details about the methodology of these two new technologies have been described elsewhere.[25,26]

National Health Interview Survey (NHIS)—Conducted annually since 1957 by the National Center for Health Statistics, the NHIS (http://www.cdc.gov/nchs/nhis.htm) uses a stratified, cross-sectional, multistage probability sample to derive estimates for the civilian, noninstitutionalized population. A major redesign occurs every 10–15 years. Collected through an in-person household interview, the NHIS gathers data on illnesses, injuries, activity limitation, chronic conditions, health insurance coverage, use of health care, and other health topics. Protocols were approved by a human subjects review board, and written informed consent was obtained from all participants. One adult and one child are randomly selected from each family for a detailed health profile. Basic health and demographic information are obtained by interviewing all family members. Self-reported visual function questions were added to NHIS starting in 1986. An eye care use question was added starting in 1997. In 2002 and 2008, additional questions were included in NHIS as a vision health

supplement to assess and monitor progress of the *Healthy People 2010* and *2020* vision objectives.

Measurements

We used data from NHANES III (1988–1994, n = 5,704) and NHANES 2005–2008 (n = 8,208) to assess eye disease disparity among US adults aged 40 years or older. The NHANES III response rate for the interview sample aged 40 years or older was 79% and 67% for the examined sample. The NHANES 2005–2008 response rate for the interview sample aged 40 years or older was 71% and 69% for the examined sample. As defined previously by the University of Wisconsin's Ocular Epidemiologic Reading Center, Madison,[26] participants with diabetes (defined as self-report of a previous diagnosis of the disease by a clinician excluding gestational diabetes mellitus or hemoglobin A1c of 6.5% or greater) were considered to have DR (NHANES III and NHANES 2005–2008) if retinal images revealed the presence of one or more retinal microaneurysms or retinal blot hemorrhages with or without more severe lesions. By the Wisconsin Reading Center definition,[27] participants were considered to have AMD on the basis of the drusen size, type, and area; increased retinal pigment; retinal pigment epithelial depigmentation; pure geographic atrophy; and signs of exudative macular degeneration found in their retinal image. One eye was photographed in NHANES III and both in NHANES 2005–2008. To be comparable to estimates from NHANES III, we estimated the prevalences of DR and AMD in NHANES 2005–2008 by using the right eye if the last digit of the participant identification number was even and the left eye if it was odd. Cataract and glaucoma were defined on the basis of the participant self-report in NHANES III and NHANES 2005–2008. As a proxy, the presence of cataract was declared if the participant answered affirmatively to the question, "Have you ever had a cataract operation?" Likewise, we define glaucoma as answering yes to the question, "Have you ever been told by an eye doctor that you have glaucoma, sometimes called high pressure in your eyes?"

We used 10 consecutive years (1999–2008) of NHIS data to evaluate eye care use by race/ethnicity, education, and economic status among US civilian, noninstitutionalized population aged 18 years or older. The final response rate for the adult sample person component of the NHIS ranged from 62.6% in 2008 to 74.3% in 2002. Eye care use variables included respondent self-report of having visited an eye doctor in the past 12 months and being unable to afford eyeglasses when needed. These measures were chosen because eye doctor visits capture health care use, whereas inability to afford eyeglasses addresses financial barriers and the effect of reduced visual acuity caused by uncorrected refractive error on vision-related quality of life.[24] The analyses of annual eye care use indicators were restricted to those who reported visual impairment (n = 29,175) because annual eye care visit for those only need new eyeglasses prescription but no vision function loss (i.e., without visual impairment) is not considered cost-effective.[28] Respondents were classified as having visual impairment if they answered yes to the question, "Do you have any trouble seeing, even when wearing glasses or contact lenses?" We categorized adults who reported experiencing any trouble seeing despite wearing contact lens or glasses as having visual impairment.

In this study, we specifically focused on racial/ethnic and socioeconomic (educational attainment, income level) disparities in the major eye diseases and eye care use. Because of the survey design, we divided racial/ethnic status into non-Hispanic white, non-Hispanic black, and Mexican American in NHANES and non-Hispanic white, non-Hispanic black, and Hispanic in NHIS. Educational attainment was categorized as less than high school, high school graduate, and more than high school. Income status was measured by using the poverty to income ratio (PIR), an index of total income assessed in relation to federal poverty thresholds that vary by family size and composition.[29] A PIR score of 1.00 is defined as the official federal poverty threshold level. We categorized PIR as less than 1.00, 1.00 to 1.99, 2.00 to 3.99 and 4.00 or more.

Statistical Analysis

The data were analyzed by using SAS 9.1.3 (SAS Institute, Cary, NC) and SUDAAN 9.0 (Research Triangle Institute, Research Triangle Park, NC). All analyses accounted for the complex multistage sampling, clustering, and stratification design implemented by the NHANES and NHIS. Taylor linearization was used to estimate variances.[30] All prevalence estimates were age- and sex-standardized to the 2000 US census population.[31] Estimates with a relative standard error more than 30% were considered not reliable and therefore not reported. Linear trends in the prevalence estimates were assessed by weighted least squares regression. *P*-values less than 0.05 were considered statistically significant.

RESULTS

Prevalence of Eye Diseases by Race/Ethnicity, Educational Attainment, and Economic Status

The observed racial/ethnic differences of DR among non-Hispanic whites and non-Hispanic blacks remained during the decade (Table 1). The prevalence of DR was significantly higher among non-Hispanic blacks than among non-Hispanic whites in NHANES III and NHANES 2005–2008 (4.9% vs. 1.9%, 8.7% vs. 3.2%; both $P < 0.001$). Some significant differences in age- and sex-standardized prevalence of AMD or cataract surgery by race/ethnicity were also present. For example, the prevalence of AMD was higher among non-Hispanic whites than among non-Hispanic blacks in NHANES III and NHANES 2005–2008 (12.9% vs. 9.9%, 8.3% vs. 3.1%; $P = 0.017$ and $P < 0.001$, respectively). In addition, non-Hispanic whites reported a higher prevalence of cataract surgery than non-Hispanic blacks in NHANES III and NHANES 2005–2008 (19.3% vs. 16.4%, 18.4% vs. 13.5%; $P = 0.018$ and $P < 0.001$, respectively). Non-Hispanic blacks had a significantly higher age- and sex-standardized prevalence of glaucoma in NHANES 2005–2008 compared to non-Hispanic white (11.5% vs. 6.9%; $P < 0.001$) and Mexican American (11.5% vs. 6.5%; $P = 0.006$) participants.

In both NHANES III and NHANES 2005–2008, the age- and sex-standardized prevalence of DR was significantly higher among those with less than a high school education than among those with more than a high school education in NHANES III and NHANES 2005–2008 (2.8% vs. 1.1%, 6.9% vs. 2.7%; both $P = 0.001$). No significant difference by educational

attainment was observed in the prevalence of AMD, glaucoma, or cataract surgery for either time.

Although no significant differences for income were observed in NHANES III, the age- and sex-standardized prevalence of DR in NHANES 2005–2008 was significantly higher among individuals at the lowest income level (PIR < 1.00) compared to those at the highest income levels (PIR ≥4.00) (5.1% vs. 2.2%; $P = 0.030$). The age- and sex-standardized prevalence of AMD in NHANES III was also higher among those at the lowest income level than those at the highest income levels (17.9% vs. 11.5%; $P = 0.030$), although the difference was not significant in NHANES 2005–2008 (10.4% vs. 6.8%; $P = 0.057$). No significant difference in the prevalence of glaucoma or cataract surgery by income level was observed in NHANES III or NHANES 2005–2008.

Eye Care Use by Race/Ethnicity, Educational Attainment, and Economic Status

Among adults with reported visual impairment, no increasing or decreasing trend of visiting an eye doctor in the past 12 months was found by race/ethnicity, education attainment, or income status from 1999 to 2008 (Table 2). For several years, we observed some racial/ethnic differences in eye doctor visits. For example, in 2008, non-Hispanic whites were more likely to visit an eye doctor than Hispanics (52.6% vs. 36.9%; $P < 0.001$). Moreover, from 1999 to 2008, individuals with less than a high school education were consistently less likely to have had an eye care visit in the past 12 months than those with more than a high school education (all $P < 0.01$). During this period (except year 1999), individuals with PIR of less than 1.00 were consistently less likely to have an eye care visit than those with PIR of 4.00 or more (all $P < 0.05$).

From 1999 to 2008, the inability to afford eyeglasses increased among non-Hispanic whites and Hispanics (trend $P = 0.004$ and $P = 0.007$; respectively), those with high school education (trend $P = 0.036$), and those with income PIR 1.00–1.99 (trend $P = 0.001$) (Table 3). We also observed some significant racial/ethnic differences in the inability to afford eyeglasses in several years. For example, in 2008, Hispanics were more likely to report being unable to afford eyeglasses when needed than non-Hispanic whites and non-Hispanic blacks (26.7% vs. 16.0% and 15.3%; both $P = 0.020$). Individuals with less than a high school education were more likely to report being unable to afford eyeglasses when needed than those with more than a high school education in most years (all $P < 0.01$) except in year 2002 ($P = 0.075$) and year 2007 ($P = 0.069$). From 1999 to 2008, impoverished individuals (PIR < 1.00) were consistently more likely to report being unable to afford eyeglasses when needed compared to those at the highest income level (all $P < 0.001$).

DISCUSSION

Vision Health Disparities

We report observed disparities by race/ethnicity, education, and economic status in the prevalence of the major eye diseases and the use of eye care services. We also found that these disparities existed previously and have persisted over a decade.

Our survey-based evidence of racial/ethnic differences for the effects of major eye diseases is consistent with previous literature.[27,32–34] We found that the prevalence of DR and glaucoma among Americans 40 years of age or older is greater in non-Hispanic blacks than in non-Hispanic whites. We also found that non-Hispanic whites had a higher prevalence of AMD and cataract surgery than non-Hispanic blacks. Previous meta-analyses of findings from individual population-based studies within geographically circumscribed settings also reported similar findings.[3–6] Furthermore, we found that DR prevalence was higher among the less educated and the impoverished, which underscores a critical need for services, particularly regular eye examinations.

Affordability, continuity, and regular sources of care, as well as physician advice, have been shown to be strongly associated with receipt of needed eye care services.[35,36] Reviewing NHIS data from 1999 to 2008, we found that individuals with less education and lower income were both less likely to visit an eye doctor within the past year, and less able to afford eyeglasses when needed. A previous study similarly found that those with more education are more likely to see an eye care professional compared to those less educated.[37] More than 50% of Medicare beneficiaries have not visited an eye care provider or received an annual eye examination.[38] Lack of awareness about vision health is a major problem, especially among low income, minority, and uninsured families who are at highest risk of not accessing vision screening programs.[39] Furthermore, increasing trends of inability to afford eyeglasses among those with a high school education and those with PIR of 1.00–1.99 suggest that public health interventions to improve vision and eye health should focus more on those at the relatively lower end (i.e., ≤ high school or PIR < 2.00 vs. > high school education or PIR ≥ 2.00) of the socioeconomic spectrum.

Strength and Weakness of Current National Data

NHANES and NHIS data are widely used as major data sources to assess *Healthy People 2010* and *Healthy People 2020* vision health goals and objectives. They can provide national population-based estimates of age-related eye diseases and eye care use. Although all eye disease prevalence estimates in *Healthy People 2010*/2020 come from the NHIS self-reported vision supplement questions, our estimates from clinical measures (DR and AMD) increased the reliability of the diagnosis and provided similar findings on vision health disparities by race/ethnicity, education, and economic status. Compared with single eye protocol used in NHANES III, the protocol begun in the 2005 NHANES of digital fundus images of two photos for each eye has improved the ability to detect disease. Previous reports using data on both eyes from participants in NHANES 2005–2008 reflect more realistic estimates of the true eye disease prevalence. They indicate racial/ethnic disparities in DR[26] and AMD[27] and are consistent with what we report by using data from only one eye per participant. Combined with other population-based studies and state or local health surveys, an integrated national vision health surveillance system can provide baseline and trend data for vision health disparities and assist policy decision making.

Our study has several limitations. National surveys such as NHANES and NHIS do not include residents in long-term care facilities (e.g., nursing homes), persons on active duty with the Armed Forces, prisoners, and US nationals living in foreign countries. A previous

study has shown a higher prevalence of eye disease in nursing home residents than in community-dwelling older adults.[40] In addition, much of the available data is based on self-reports. More research on the reliability and validity of self-reported measures and ways to improve their collection is needed. The self-reported data used in this analysis are subject to many potential sources of bias, including recall bias, social desirability bias, and access to health care biases. The type and magnitude of these biases are difficult to evaluate. Thus, it is likely that our estimates of the rates of glaucoma, cataract, and use of eye care are negatively biased. Glaucoma is known to be persistently under-reported and under-diagnosed. Using self-reported cataract extraction surgery as a proxy for the presence of cataract provides a rough estimate of clinically significant cataract but underestimates true disease burden among those with cataract who were undiagnosed or have not had their cataracts removed. By using the new clinical retinal imaging measures in the ophthalmology component of NHANES for AMD and DR, we were able to pick up individuals with AMD and DR who might otherwise not have known of their condition because of lack of access to and use of the health care system. Also, we estimated utilization among those with self-reported visual impairment yet those who don't know they have impairment were missed.

Assessment of disease incidence is crucial to understanding the population effects of disease and the effectiveness of preventive efforts. However, national surveys rarely provide incidence information. NHANES and NHIS do not have more comprehensive examination or questionnaire data on eye diseases and use of eye care services due to the high cost attached to these surveys. In addition, because they are cross-sectional, causal inference cannot be obtained or inferred from national surveys. Finally, due to logistic constraints, national surveys often have only small sample sizes for certain ethnic groups (e.g., Asian and Pacific Islanders and American Indians). National surveys frequently require that component protocols be targeted to specific diseases or conditions. Thus, a comprehensive picture of vision health with trends over time and across all ethnic groups within the United States is not currently feasible.

Public Health Implications

One of the core elements of a coordinated public health approach to improve the nation's vision health is implementing a national vision health surveillance and evaluation system.[41] A national surveillance system assesses and monitors long-term outcomes of improved prevention and control of eye diseases and vision loss, increased access to eye care, better quality of life for the visually impaired, and enhanced vision health promotion throughout all life stages for all Americans. Surveillance data are used in many different contexts to estimate disease burden, recognize trends, detect gaps in coverage, and identify high-risk groups. Thereafter, strategies are developed and subsequently evaluated to effectively allocate limited health care resources to reduce disparities. This is the model used for establishing and assessing progress on national vision health priorities in *Healthy People 2010* and *Healthy People 2020*.

National data (e.g., NHANES and NHIS) have shown that vision health disparities exist. We need to first identify the underlying reasons for such disparities. Whenever possible, the efficacy, cost effectiveness, and appropriate methodologies of screening should be

established and implemented among the subpopulations most in need.[42] Periodic, national, point-prevalence data are needed with objective measurements of visual acuity and cause-specific disease. As technologies and treatments develop and demographics and the environment change, we need timely data and fast and efficient methods to detect new trends. In addition, people with eye disease likely have other health issues, particularly those of advancing age. A national surveillance system could ultimately improve the translation of vision research into a coordinated and personalized approach to monitor quality of care and advance public health prevention.

If vision data elements could be standardized and used across different surveys, more comprehensive analyses would be possible, and we would be better able to understand how to transfer knowledge about appropriate clinical care to the community to address disparities. For example, although an efficacious and cost-effective intervention is available for detecting diabetic retinopathy,[43,44] challenges remain for getting those at risk screened and seen by a health care professional. There is also a need to assess whether there are socioeconomic gradients in the quality and outcome of eye care in the U.S. An integrated surveillance system could identify and monitor the process of translating such public health interventions for communities to reduce existing visual health disparities. These efforts could help to improve the overall health for all Americans.

In conclusion, there are vision health disparities among the major eye diseases and for vision health care in the United States. Disparities by race/ethnicity, education, and economic status show that the greatest need is for innovative interventions to reduce unnecessary vision loss among socioeconomically disadvantaged groups.

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Biography

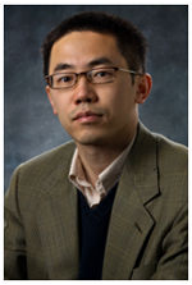

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Table 1

Age, Sex-Standardized Prevalence of Age-Related Eye Diseases by Race/Ethnicity among Adults Aged 40 Years or Older, National Health and Nutrition Examination Survey (NHANES) III and NHANES 2005–2008 [a]

	Diabetic Retinopathy				Age-Related Macular Degeneration				Glaucoma				Cataract Surgery			
	NHANES III		NHANES 2005–2008		NHANES III		NHANES 2005–2008		NHANES III [b]		NHANES 2005–2008		NHANES III		NHANES 2005–2008	
	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI	%	95%CI
Non-Hispanic white	1.9	(1.3–2.6)	3.2	(2.5–4.2)	12.9	(11.5–14.4)	8.3	(7.0–9.8)	N/A	N/A	6.9	(5.9–8.0)	19.3	(17.6–21.1)	18.4	(16.8–20.1)
Non-Hispanic black	4.9	(3.9–6.0)	8.7	(6.6–11.5)	9.9	(8.1–11.9)	3.1	(1.9–4.9)	N/A	N/A	11.5	(9.6–13.8)	16.4	(14.5–18.4)	13.5	(11.3–16.1)
Mexican American	6.8	(4.6–10.0)	5.0	(3.1–7.8)	10.4	(7.9–13.6)	9.8	(6.5–14.3)	N/A	N/A	6.5	(4.5–9.3)	20.5	(18.6–22.6)	16.4	(13.2–20.2)
P, White vs. Black		<0.001		<0.001		0.017		<0.001		N/A		<0.001		0.018		<0.001
P, White vs. Mexican		0.001		0.136		0.072		0.449		N/A		0.757		0.283		0.274
P, Black vs. Mexican		0.17		0.068		0.756		0.003		N/A		0.006		0.002		0.182
<HIGH SCHOOL	2.8	(2.2–3.6)	6.9	(5.1–9.2)	12.8	(11.2–14.6)	6.7	(5.1–9.1)	N/A	N/A	8.2	(6.7–9.8)	19.5	(17.8–21.4)	19.1	(16.3–22.3)
HIGH SCHOOL	3.0	(2.0–4.4)	3.5	(2.3–5.2)	11.7	(9.8–14.0)	7.9	(5.8–10.5)	N/A	N/A	7.0	(5.0–9.7)	17.8	(14.7–21.3)	17.1	(14.7–19.9)
>HIGH SCHOOL	1.1	(0.6–2.0)	2.7	(2.1–3.6)	13.6	(11.5–16.0)	8.3	(6.7–10.2)	N/A	N/A	7.1	(5.7–8.7)	20.0	(17.6–22.7)	17.5	(15.7–19.4)
P, <HS vs. >HS		0.001		0.001		0.490		0.210		N/A		0.397		0.763		0.309
PIR <1.00	2.4	(1.6–3.5)	5.1	(3.4–7.8)	17.9	(13.8–23.0)	10.4	(7.6–14.1)	N/A	N/A	7.4	(5.9–9.1)	17.2	(14.2–20.6)	16.7	(13.7–20.3)
1.00–1.99	2.6	(1.7–3.8)	4.8	(3.3–6.9)	12.1	(10.2–14.2)	7.1	(5.1–9.8)	N/A	N/A	8.3	(7.0–9.8)	21.1	(19.1–23.4)	21.3	(19.0–23.6)
2.00–3.99	2.2	(1.3–3.6)	3.8	(2.5–5.7)	13	(10.9–15.5)	8.3	(6.9–10.1)	N/A	N/A	7.8	(5.6–10.8)	17.5	(15.1–20.1)	18.5	(16.4–20.8)
> = 4.00	1.9	(1.1–3.2)	2.2	(1.4–3.5)	11.5	(9.6–13.7)	6.8	(5.0–9.2)	N/A	N/A	6.1	(4.4–8.4)	19.7	(17.3–22.3)	14.0	(11.4–17.0)
PIR < 1.00 vs. > = 4.00		0.405		0.030		0.030		0.057		N/A		0.394		0.23		0.116

Abbreviations: PIR, Poverty Income Ratio. PIR is an index of total income assessed in relation to federal poverty thresholds that vary by family size and composition. A PIR score of 1.00 is defined as the official federal poverty threshold level.

[a] n = 5,704 in NHANES III (1988–94); n = 8,202 in NHANES 2005–2008.

[b] Data related to glaucoma were not available from NHANES III.

Table 2

Age, Sex-Standardized Prevalence of Self-Reported Annual Eye-care Visits among Adults Aged 18 Years or Older with Self-Reported Visual Impairment, by Race/Ethnicity, Education, and Income, National Health Interview Survey, 1999–2008 [a]

	1999 %, 95%CI	2000 %, 95%CI	2001 %, 95%CI	2002 %, 95%CI	2003 %, 95%CI	2004 %, 95%CI	2005 %, 95%CI	2006 %, 95%CI	2007 %, 95%CI	2008 %, 95%CI	Trend P value [b]
Race/Ethnicity											
Non-Hispanic white	51.1 (47.0 – 55.1)	53.5 (49.8 – 57.2)	51.4 (47.7 – 55.0)	54.2 (50.3 – 58.0)	52.7 (48.9 – 56.4)	55.0 (51.4 – 58.6)	54.5 (50.6 – 58.3)	50.9 (46.2 – 55.5)	51.7 (47.5 – 55.9)	52.6 (47.8 – 57.4)	0.807
Non-Hispanic black	47.8 (39.8 – 56.0)	52.7 (43.5 – 61.8)	48.1 (39.9 – 56.5)	46.5 (37.8 – 55.4)	43.4 (35.4 – 51.7)	44.6 (37.3 – 52.1)	43.0 (35.0 – 51.4)	44.8 (36.6 – 53.3)	48.4 (40.1 – 56.8)	47.2 (37.8 – 56.9)	0.272
Hispanic	39.5 (28.3 – 51.8)	43.6 (36.3 – 51.1)	44.5 (37.4 – 51.8)	35.8 (26.6 – 46.2)	42.7 (31.9 – 54.2)	50.2 (42.7 – 57.8)	43.1 (34.5 – 52.1)	45.3 (36.2 – 54.8)	43.5 (33.0 – 54.7)	36.9 (30.1 – 44.2)	0.630
p, white vs. black	0.483	0.878	0.485	0.127	0.047	0.014	0.016	0.199	0.493	0.308	
p, white vs. Hispanic	0.070	0.018	0.103	0.001	0.102	0.265	0.020	0.308	0.173	<0.001	
p, black vs. Hispanic	0.261	0.142	0.518	0.116	0.926	0.286	0.991	0.931	0.485	0.101	
Education											
< high school	38.3 (31.9 – 45.1)	43.5 (37.2 – 50.0)	43.7 (38.2 – 49.4)	38.2 (32.6 – 44.2)	37.2 (31.8 – 43.0)	42.5 (36.5 – 48.7)	39.7 (34.0 – 45.6)	42.6 (35.8 – 49.6)	38.5 (32.1 – 45.4)	35.4 (28.6 – 42.8)	0.330
High school	52.9 (46.7 – 59.1)	47.5 (41.9 – 53.2)	44.5 (39.3 – 49.9)	51.5 (45.3 – 57.7)	52.8 (47.3 – 58.2)	50.9 (44.9 – 56.8)	53.1 (47.7 – 58.5)	46.1 (40.2 – 52.0)	52.6 (46.5 – 58.6)	54.9 (48.2 – 61.5)	0.312
> high school	54.1 (49.0 – 59.0)	63.1 (59.3 – 66.8)	58.8 (54.1 – 63.4)	60.9 (56.0 – 65.7)	59.0 (54.5 – 63.4)	60.9 (56.3 – 65.3)	59.2 (54.3 – 64.0)	55.8 (49.4 – 62.0)	57.0 (51.2 – 62.6)	59.0 (53.8 – 64.0)	0.637
p, <HS vs. >HS	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	
PIR											
< 1.00	44.2 (35.9 – 52.8)	41.0 (32.7 – 49.9)	47.1 (40.6 – 53.6)	36.7 (28.3 – 46.0)	39.5 (32.0 – 47.6)	47.7 (40.4 – 55.2)	39.1 (30.8 – 48.1)	41.0 (32.5 – 50.1)	38.7 (30.6 – 47.5)	33.3 (23.6 – 44.7)	0.147
1.00 – 1.99	44.8 (37.9 – 51.9)	51.7 (45.6 – 57.7)	43.0 (37.1 – 49.2)	46.7 (40.1 – 53.5)	48.3 (42.2 – 54.5)	43.4 (36.8 – 50.3)	44.8 (38.1 – 51.8)	44.3 (37.1 – 51.7)	47.2 (39.5 – 55.1)	44.3 (37.1 – 51.9)	0.393
2.00 – 3.99	49.7 (43.6 – 55.8)	49.8 (44.6 – 55.0)	51.4 (45.9 – 56.8)	50.5 (44.9 – 56.0)	51.9 (46.2 – 57.6)	51.8 (45.3 – 58.2)	55.9 (49.8 – 61.7)	51.2 (42.9 – 59.4)	49.3 (42.6 – 56.0)	52.6 (44.5 – 60.6)	0.393
≥4.00	55.2 (46.9 – 63.2)	60.9 (55.5 – 66.1)	58.5 (52.8 – 64.0)	68.0 (61.8 – 73.6)	57.5 (51.2 – 63.6)	64.6 (57.5 – 71.1)	60.0 (53.2 – 66.4)	58.2 (49.0 – 66.9)	62.5 (55.4 – 69.0)	65.7 (57.9 – 72.7)	0.342
p, <1 vs. ≥4	0.070	<0.001	0.009	<0.001	0.002	0.001	<0.001	0.009	<0.001	<0.001	

Abbreviations: PIR, Poverty Income Ratio. PIR is an index of total income assessed in relation to federal poverty thresholds that vary by family size and composition. A PIR score of 1.00 is defined as the official federal poverty threshold level.

[a] n=29,175. We categorized adults who reported experiencing any trouble seeing despite wearing contact lens or glasses as having visual impairment.

^{b}Linear trend.

Table 3

Age, Sex-Standardized Prevalence of Being Unable to Afford Eyeglasses when Needed among Adults Aged 18 Years or Older with Self-Reported Visual Impairment, by Race/Ethnicity, Education, and Income, National Health Interview Survey, 1999–2008 [a]

	1999 %, 95%CI	2000 %, 95%CI	2001 %, 95%CI	2002 %, 95%CI	2003 %, 95%CI	2004 %, 95%CI	2005 %, 95%CI	2006 %, 95%CI	2007 %, 95%CI	2008 %, 95%CI	Trend P value [b]
Race/Ethnicity											
Non-Hispanic white	11.2 (9.5 – 13.1)	15.2 (13.1 – 17.6)	12.7 (10.8 – 14.9)	12.7 (10.9 – 14.8)	14.5 (12.3 – 16.9)	15.1 (12.8 – 17.7)	17.1 (14.6 – 19.8)	16.1 (12.5 – 20.5)	17.9 (15.1 – 21.1)	16.0 (13.3 – 19.2)	0.004
Non-Hispanic black	17.7 (12.6 – 24.3)	26.7 (21.1 – 33.2)	13.7 (9.1 – 20.2)	17.4 (11.9 – 24.7)	17.0 (12.1 – 23.3)	22.5 (17.1 – 29.2)	21.4 (15.6 – 28.5)	16.6 (12.1 – 22.4)	18.1 (12.9 – 24.9)	15.3 (11.1 – 20.7)	0.451
Hispanic	12.4 (8.9 – 17.0)	9.7 (7.1 – 13.0)	16.9 (11.8 – 23.6)	19.0 (12.1 – 28.7)	23.1 (17.0 – 30.6)	21.7 (17.3 – 26.8)	17.4 (13.4 – 22.3)	23.2 (15.8 – 32.7)	16.7 (10.8 – 25.0)	26.7 (19.1 – 36.1)	0.007
p, white vs. black	0.035	0.001	0.743	0.162	0.417	0.026	0.231	0.876	0.941	0.803	
p, white vs. Hispanic	0.588	0.003	0.194	0.145	0.019	0.016	0.898	0.124	0.775	0.020	
p, black vs. Hispanic	0.151	<0.001	0.447	0.759	0.171	0.833	0.317	0.182	0.764	0.020	
Education											
< high school	18.7 (14.2 – 24.2)	21.0 (16.5 – 26.4)	16.3 (12.8 – 20.5)	16.5 (12.6 – 21.3)	22.7 (18.4 – 27.6)	22.5 (18.5 – 27.0)	24.9 (20.3 – 30.2)	27.7 (20.7 – 35.9)	19.4 (14.9 – 24.9)	25.8 (19.6 – 33.2)	0.071
High school	11.0 (8.9 – 13.5)	15.4 (12.2 – 19.2)	16.4 (13.1 – 20.4)	14.0 (10.5 – 18.3)	14.2 (11.6 – 17.2)	13.8 (11.0 – 17.3)	15.2 (12.0 – 19.0)	13.9 (10.3 – 18.6)	20.3 (16.2 – 25.3)	17.4 (13.2 – 22.6)	0.036
> high school	10.7 (8.2 – 13.8)	12.5 (10.2 – 15.2)	9.8 (7.8 – 12.2)	11.8 (9.5 – 14.6)	12.0 (9.9 – 14.5)	15.1 (12.1 – 18.6)	14.8 (12.2 – 17.8)	13.3 (10.4 – 16.8)	13.9 (10.6 – 17.9)	12.6 (10.1 – 15.6)	0.058
p, <HS vs. >HS	0.007	0.003	0.003	0.075	<0.001	0.009	0.001	<0.001	0.069	<0.001	
PIR											
< 1.00	24.7 (18.4 – 32.4)	22.0 (17.3 – 27.6)	21.1 (16.1 – 27.2)	24.2 (18.3 – 31.2)	28.6 (22.6 – 35.5)	24.7 (19.0 – 31.5)	29.0 (23.2 – 35.6)	24.0 (17.4 – 32.1)	30.3 (23.1 – 38.7)	23.7 (17.8 – 30.8)	0.156
1.00 – 1.99	16.1 (12.7 – 20.4)	20.0 (16.1 – 24.6)	20.5 (16.4 – 25.3)	18.0 (13.6 – 23.3)	20.5 (16.1 – 25.7)	21.9 (17.5 – 27.0)	22.5 (18.0 – 27.7)	22.6 (16.9 – 29.5)	26.9 (21.0 – 33.7)	28.6 (22.7 – 35.3)	<0.001
2.00 – 3.99	9.5 (7.2 – 12.5)	15.4 (11.9 – 19.6)	11.5 (8.9 – 14.8)	10.8 (8.3 – 13.9)	13.6 (10.6 – 17.2)	16.4 (12.9 – 20.6)	15.5 (12.1 – 19.8)	14.5 (10.2 – 20.0)	13.4 (9.9 – 17.8)	13.3 (9.9 – 17.5)	0.094
≥4.00	6.3 (3.9 – 10.2)	8.5 (5.8 – 12.2)	5.0 (3.2 – 7.8)	7.6 (5.3 – 10.8)	5.5 (3.5 – 8.4)	8.1 (5.5 – 11.8)	8.9 (5.7 – 13.8)	9.1 (4.7 – 16.9)	4.8 (3.0 – 7.5)	5.4 (3.7 – 7.8)	0.381
p, <1 vs. ≥4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	

Abbreviations: PIR, Poverty Income Ratio. PIR is an index of total income assessed in relation to federal poverty thresholds that vary by family size and composition. A PIR score of 1.00 is defined as the official federal poverty threshold level.

[a] n=29,175. We categorized adults who reported experiencing any trouble seeing despite wearing contact lens or glasses as having visual impairment.

[b] Linear trend.