

Self-Reported Age-Related Eye Diseases and Visual Impairment in the United States: Results of the 2002 National Health Interview Survey

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Visual impairment is defined as low vision not correctable by glasses or contact lenses; it may have different causes. Visual impairment is recognized as a global public health problem.^{1,2} Worldwide, an estimated 37 million people were blind in 2002, and an additional 124 million were visually impaired.¹ The leading causes of blindness and visual impairment, determined on the basis of a composite analysis of several population-based studies conducted in developed and developing countries, are primarily age-related eye diseases: cataracts, glaucoma, macular degeneration, and diabetic retinopathy.^{1,2}

Healthy People 2010 established national vision objectives to improve visual health through prevention, early detection, treatment, and rehabilitation.^{3,4} When the *Healthy People 2010* vision objectives were published in 2000, all but 1 lacked national baseline data.³ Because of cost and logistical difficulty, nationwide studies concerning the prevalence of visual impairment and eye diseases in the United States have been limited. Most US data come from population-based studies of visual impairment in specific demographic groups^{5–7} or locations.^{8–10} Prevalence estimates may be obtained through self-reports in interview surveys or through surveys that include eye and vision examinations. The most recent national data on measured visual impairment are from the National Health and Nutrition Examination Survey (NHANES); these data were used to estimate that 6.4% of persons 12 years and older had visual acuity of 20/50 or worse in the better-seeing eye in 1999 to 2002.¹¹ NHANES 1999 to 2002 did not collect data on eye diseases.

For our study, we sought to (1) provide national data for adults on the prevalence of self-reported visual impairment, blindness, and 4 diagnosed eye conditions (cataract,

Objectives. We sought to establish national data on the prevalence of visual impairment, blindness, and selected eye conditions (cataract, diabetic retinopathy, glaucoma, and macular degeneration) and to characterize these conditions within sociodemographic subgroups.

Methods. Information on self-reported visual impairment and diagnosed eye diseases was collected from 31 044 adults. We calculated weighted prevalence estimates and odds ratios with logistic regression using SUDAAN.

Results. Among noninstitutionalized US adults 18 years and older, the estimated prevalence for visual impairment was 9.3% (19.1 million Americans), including 0.3% (0.7 million) with blindness. Lifetime prevalence of diagnosed diseases was as follows: cataract, 8.6% (17 million); glaucoma, 2.0% (4 million); macular degeneration, 1.1% (2 million); and diabetic retinopathy, 0.7% (1.3 million). The prevalence of diabetic retinopathy among persons with diagnosed diabetes was 9.9%.

Conclusions. We present the most recently available national data on self-reported visual impairment and selected eye diseases in the United States. The results of this study provide a baseline for future public health initiatives relating to visual impairment. (*Am J Public Health.* 2008;98:454–461. doi:10.2105/AJPH.2006.098202)

diabetic retinopathy, glaucoma, and macular degeneration) and (2) characterize these conditions within sociodemographic subgroups. Self-reported data from the 2002 National Health Interview Survey (NHIS) provide the most recent national estimates for these 4 eye conditions.

METHODS

Data Source

We used data from the 2002 NHIS sample adult component.¹² In 2002, a detailed NHIS Vision Health supplement collected data on 4 eye diseases for 31 044 persons who were 18 years and older, in addition to the regularly collected data on visual impairment and blindness.^{13,14}

The NHIS is a continuous household survey of the civilian noninstitutionalized population; it is conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention.¹² The NHIS uses multistage, stratified probability samples of

clusters of households. Black and Hispanic people are oversampled.¹² The NHIS obtains information on a variety of health measures and plays a pivotal role in tracking national health objectives. Data are collected by the US Census Bureau through in-person household interviews. The 2002 household response rate for the NHIS was 89.5%. A randomly selected adult from each interviewed family received the sample adult questionnaire, for which responses are self-reported. The final sample adult response rate was 74.3%, after taking into account household, family, and sample adult nonresponse. The main reason for nonresponse was refusal to participate. Sample weights used in all analyses included poststratification adjustments for design, ratio, nonresponse, and age–gender–race/ethnicity.¹²

People were classified as having visual impairment if they answered “yes” when asked the following question: “Do you have any trouble seeing even when wearing glasses or contact lenses?” Blindness was defined with

the following question: “Are you blind or unable to see at all?”¹³ Respondents were classified as having each of 4 eye diseases—cataract, diabetic retinopathy, glaucoma, and macular degeneration—on the basis of whether they had ever been told by a doctor or other health professional that they had any of these conditions and, if so, whether they had the condition during the past 12 months.¹³ Diagnosed diabetes was identified with the following question: “Have you ever been told by a physician that you have diabetes?”¹³ Excluded from analyses were 0.5% of adults who did not respond to the vision questions.

Estimates were made by age, gender, race/ethnicity, education, income, and diagnosed diabetes. Race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, and Hispanic. Prevalence of eye diseases for other single race and multiple race categories are not shown because of statistical unreliability. Prevalence of visual impairment for Asians, American Indians/Alaska Natives, and multiple race people was calculated by pooling data from the 2002 to 2005 NHIS, because those data were collected each year. Education was categorized as less than high school (no high school diploma or graduate equivalency diploma [GED]), high school graduate (received high school diploma or GED), some college or associate degree, and bachelor’s degree or higher. Because young adults may not have completed their education, we excluded persons younger than 25 years from analyses involving education.

Income was based on family income, family size, and the Census Bureau’s poverty thresholds and was categorized as less than 200% of the federal poverty level and 200% or more of the federal poverty level. Because 31% of the sample adults were missing exact family income, the National Center for Health Statistics imputed missing family income using sequential regression multivariate multiple-imputation methodology, which allows variability caused by imputation to be incorporated in variance estimates.^{15,16} The imputation methodology incorporated bounds on exact family income based on reported 2-category income (less than \$20 000 or at least \$20 000), which was available for most of those with missing exact income. Details of the imputation methodology and comparisons

TABLE 1—Prevalence of Visual Impairment and Blindness Among US Adults 18 Years and Older: National Health Interview Survey, 2002

	Visual Impairment, ^a % (95% CI)	Blindness, % (95% CI)
Total	9.3 (8.9, 9.7)	0.3 (0.3, 0.4)
Age group, y		
18–44	5.7 (5.2, 6.2)	0.2 (0.1, 0.2)
45–54	11.5 (10.5, 12.5)	0.3 (0.2, 0.5)
55–64	10.4 (9.3, 11.4)	0.3 (0.1, 0.5)
65–74	14.5 (13.0, 16.0)	0.5 (0.3, 0.8)
≥ 75	21.1 (19.4, 22.8)	1.5 (1.0, 2.0)
Gender ^b		
Men	7.8 (7.3, 8.4)	0.3 (0.2, 0.5)
Women	10.6 (10.0, 11.1)	0.3 (0.3, 0.4)
Race/Ethnicity ^b		
Non-Hispanic Black	11.7 (10.5, 13.0)	0.5 (0.2, 0.7)
Non-Hispanic White	9.1 (8.6, 9.6)	0.3 (0.3, 0.4)
Hispanic ^c	9.0 (7.9, 10.1)	0.4 (0.2, 0.7)
Income level ^b		
Below 200% of FPL	13.3 (12.5, 14.2)	0.7 (0.5, 0.9)
Above 200% of FPL	7.9 (7.4, 8.3)	0.2 (0.2, 0.3)
Education level ^b		
Less than high school	14.4 (13.2, 15.5)	0.6 (0.4, 0.8)
High school graduate	10.2 (9.4, 11.0)	0.4 (0.2, 0.6)
Some college or associate’s degree	9.9 (9.1, 10.7)	0.3 (0.2, 0.4)
Bachelor’s degree or higher	7.4 (6.6, 8.2)	0.3 (0.1, 0.4)
Diagnosed diabetes ^b		
Persons with diabetes	18.4 (15.4, 21.3)	0.9 ^d (0.3, 1.4)
Persons without diabetes	8.6 (8.2, 9.0)	0.3 (0.2, 0.4)
Total ^b	9.3 (8.9, 9.7)	0.4 (0.3, 0.4)

Note. CI = confidence interval; FPL = federal poverty level.

^aIncludes blindness.

^bAdjusted for age.

^cPersons of Hispanic origin may be of any race.

^dEstimates are considered unreliable. Relative standard error is greater than 30%.

of estimates using multiple, single, and no imputation have been published previously.^{15,16}

Statistical Analysis

We calculated prevalence estimates, expressed both as percentages and population counts, using sample weights, which sum to the civilian noninstitutionalized US population.¹² All analysis was completed using the Descript and Logistic procedures in SUDAAN (Research Triangle Institute, Research Triangle Park, NC).¹⁷ We used Taylor series linearization for variance estimation and incorporated sample weights, clustering, and stratification. Differences between percentages were evaluated using a 2-sided *t* test at the .05 level of significance with no adjustments for multiple comparisons.

We used direct standardization to age-adjust percentages to the 2000 US standard population with the following age groups: 18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 64 years, and 65 years and older.¹⁸ For analyses by education, the age groups used were 25 to 34 years, 35 to 44 years, 45 to 64 years, and 65 years and older.

We used multivariable logistic regression to assess the association between sociodemographic variables, diagnosed diabetes, and the following outcome variables: visual impairment, cataract, glaucoma, and macular degeneration. Regression analyses were limited to participants who were 25 years and older so that education could be included. For each outcome variable, 2 models were used. Model 1 included all sociodemographic variables (age group, gender, race/ethnicity,

income, and education), and model 2 added diagnosed diabetes. Because diabetes is associated with visual impairment and eye diseases and is correlated with the sociodemographic variables, we completed the logistic regression analyses with and without adjusting for diagnosed diabetes. Odds ratios (ORs) for gender, age, race/ethnicity, income, and education were similar in both models; therefore, only model 2 results are shown. We performed the Wald F test to evaluate the influence of each predictor variable after adjusting for the other variables.

We also used logistic regression to assess the association between sociodemographic variables and diabetic retinopathy. That analysis was limited to adults with diagnosed diabetes because only people with diabetes can have diabetic retinopathy.

RESULTS

Visual Impairment and Blindness

In the United States in 2002, 19.1 million civilian, noninstitutionalized adults reported some visual impairment, including 0.7 million who reported being blind. The overall prevalence of visual impairment was 9.3% (Table 1). The prevalence increased significantly with age, from 5.7% among people aged 18 to 44 years to 21.1% among people 75 years and older. The prevalence of visual impairment was higher among women than among men.

There was a strong inverse relation between both education and income and visual impairment (Table 1). Visual impairment among those with low income was almost 2 times that of those with higher income. People with diagnosed diabetes were more than twice as likely to be visually impaired as those without diabetes. Non-Hispanic Blacks had a higher prevalence of visual impairment than did non-Hispanic Whites or Hispanics. In 2002 to 2005, the prevalence of visual impairment was also higher for American Indians/Alaska Natives and multiple race people than for non-Hispanic White or Hispanic people, whereas the prevalence for Asians was lower than for non-Hispanic Whites or Hispanics (Table 2).

In 2002, 30.6% of visually impaired people reported having 1 or more of 4 eye diseases in the past 12 months: the

prevalence of cataract among people with visual impairment was 19.4%, the prevalence of glaucoma was 6.1%, the prevalence of macular degeneration was 6.0%, and the prevalence of diabetic retinopathy was 3.4%.

The prevalence of blindness among US adults was 0.3% in 2002 and did not differ between men and women. The prevalence of blindness was significantly higher for respondents 75 years and older than for younger people and was inversely related to education and income.

Selected Eye Diseases

Among adults 18 years and older, the lifetime prevalences for self-reported diagnosed eye conditions were as follows: cataract, 8.6%; glaucoma, 2.0%; and macular degeneration, 1.1% (Table 3). Prevalence rates for having these diseases in the past 12 months were lower for cataract (5.1%) and similar to the lifetime prevalence estimated for glaucoma and macular degeneration (1.8% and 1.0%, respectively), as expected. Among those who reported having these diseases in the past 12 months, the percentage reporting visual impairment was 30.1% for those with cataract, 33.1% for those with glaucoma, and 50.6% for those with macular degeneration.

Lifetime prevalence of diagnosed cataract, glaucoma, and macular degeneration increased with age. Cataract was the most frequently reported eye condition in older people, reported by 53.4% of those 75 years

and older. The prevalence of diagnosed glaucoma for non-Hispanic Black adults was more than twice that of non-Hispanic White and Hispanic adults. Diagnosed macular degeneration was 2 times as prevalent among non-Hispanic Whites as among non-Hispanic Blacks. Non-Hispanic White adults also were more likely to be diagnosed with cataract than were non-Hispanic Black or Hispanic adults.

Education and income were inversely associated with the prevalence of cataract and glaucoma. For people with diagnosed diabetes, prevalences of cataract (13.9%) and glaucoma (3.9%) were higher than for people without diabetes (8.3% and 1.8%, respectively).

Diabetes Mellitus and Diabetic Retinopathy

We estimated the prevalence of diabetic retinopathy for all adults and for those with diagnosed diabetes only, because only people with diabetes are at risk for diabetic retinopathy. The estimated prevalence of diagnosed diabetes among adults was 6.5%, or 13.4 million people; the estimated prevalence of diabetic retinopathy among adults was 0.7%, or 1.3 million people; and the prevalence of diabetic retinopathy among those with diagnosed diabetes was 9.9% (Table 4). Of those with diabetic retinopathy, 52.1% reported visual impairment.

The prevalence of diabetic retinopathy among the general population increased with age through ages 65 to 74 years, but among persons with diagnosed diabetes, there was

TABLE 2—Prevalence of Visual Impairment and Blindness Among US Adults 18 years and Older, by Race/Ethnicity: National Health Interview Survey, 2002–2005

Race/Ethnicity ^a	Visual Impairment, % (95% CI)	Blindness, % (95% CI)
American Indian/Alaska Native	13.5 (10.6, 16.4)	0.3 ^c (0.0, 0.7)
Asian	6.5 (5.4, 7.5)	0.2 ^c (0.0, 0.4)
Non-Hispanic Black	11.2 (10.6, 11.9)	0.5 (0.2, 0.6)
Non-Hispanic White	9.2 (8.9, 9.5)	0.4 (0.3, 0.4)
Hispanic ^b	9.3 (8.7, 9.9)	0.5 (0.4, 0.7)
Multiple race	16.9 (14.0, 19.7)	0.6 ^c (0.0, 1.3)

Note. CI = confidence interval.

^aAdjusted for age.

^bPersons of Hispanic origin may be of any race/ethnicity.

^cEstimates are considered unreliable. Relative standard error is greater than 30%.

TABLE 3—Prevalence of Ever Being Diagnosed With Cataract, Glaucoma, and Macular Degeneration Among US Adults 18 Years and Older: National Health Interview Survey, 2002

	Cataract, % (95% CI)	Glaucoma, % (95% CI)	Macular Degeneration, % (95% CI)
Total	8.6 (8.2, 9.0)	2.0 (1.8, 2.2)	1.1 (1.0, 1.3)
Age group, y			
18–44	0.5 (0.4, 0.7)	0.4 (0.2, 0.5)	0.2 (0.1, 0.2)
45–54	2.7 (2.2, 3.2)	1.3 (1.0, 1.7)	0.4 (0.2, 0.6)
55–64	9.3 (8.2, 10.3)	2.5 (2.0, 3.1)	0.9 (0.6, 1.1)
65–74	31.0 (29.0, 32.9)	5.7 (4.7, 6.6)	2.8 (2.1, 3.5)
≥ 75	53.4 (51.2, 55.5)	10.3 (9.1, 11.6)	8.7 (7.5, 9.8)
Gender ^a			
Men	7.8 (7.3, 8.3)	1.9 (1.6, 2.1)	1.0 (0.8, 1.2)
Women	9.8 (9.4, 10.2)	2.2 (2.0, 2.5)	1.3 (1.1, 1.5)
Race/Ethnicity ^a			
Non-Hispanic Black	7.5 (6.7, 8.4)	4.0 (3.3, 4.7)	0.5 (0.2, 0.7)
Non-Hispanic White	9.3 (9.0, 9.7)	1.9 (1.7, 2.0)	1.3 (1.2, 1.5)
Hispanic ^b	6.0 (5.1, 6.9)	1.9 (1.4, 2.3)	0.6 ^c (0.3, 0.9)
Income level ^a			
Below 200% of FPL	10.2 (9.6, 10.7)	2.5 (2.2, 2.9)	1.2 (0.9, 1.4)
Above 200% of FPL	8.4 (8.0, 8.8)	1.9 (1.7, 2.1)	1.2 (1.1, 1.4)
Education level ^a			
Less than high school	11.6 (10.8, 12.5)	2.9 (2.4, 3.4)	1.2 (0.9, 1.4)
High school graduate	10.2 (9.5, 10.8)	2.3 (2.0, 2.7)	1.4 (1.1, 1.7)
Some college or associate's degree	10.6 (9.9, 11.3)	2.1 (1.8, 2.5)	1.5 (1.2, 1.9)
Bachelor's degree or higher	9.1 (8.3, 9.8)	2.0 (1.6, 2.5)	1.5 (1.1, 1.9)
Diagnosed diabetes ^a			
Persons with diabetes	13.9 (12.5, 15.3)	3.9 (2.8, 5.1)	1.4 (1.0, 1.9)
Persons without diabetes	8.3 (8.0, 8.6)	1.8 (1.7, 2.0)	1.2 (1.1, 1.3)
Total ^a	8.9 (8.6, 9.3)	2.1 (1.9, 2.2)	1.2 (1.1, 1.3)

Note. CI = confidence interval; FPL = federal poverty level.

^aAdjusted for age.

^bPersons of Hispanic origin may be of any race/ethnicity.

^cEstimates are considered unreliable. Relative standard error is greater than 30%.

little difference in the prevalence of retinopathy between age groups. No statistically significant differences were observed between genders for diabetic retinopathy, either in the general population or among people with diabetes. Although rates of diagnosed diabetes and diabetic retinopathy among the total population were significantly higher among Hispanics and non-Hispanic Blacks than among non-Hispanic Whites, the prevalence of diabetic retinopathy among those with diagnosed diabetes did not differ significantly among these racial/ethnic groups.

Logistic Regression Results

In multivariate logistic regression models, age was the most important predictor of visual

impairment and eye diseases. The adjusted odds of visual impairment and cataract was 1.3 to 1.4 times higher for women than for men. After adjusting for other variables, the odds of visual impairment did not differ between non-Hispanic Whites and non-Hispanic Blacks; Hispanics were at reduced odds of visual impairment compared with non-Hispanic Whites. Race/ethnicity was found to independently influence the likelihood of eye conditions. The adjusted odds of glaucoma for non-Hispanic Blacks was 2.3 times that for non-Hispanic Whites, whereas non-Hispanic Whites were at significantly higher risk of being diagnosed with macular degeneration and cataract than non-Hispanic Black and Hispanic respondents.

After adjusting for other variables, income and education remained significantly associated with visual impairment. Both income below 200% of the federal poverty level and less than a high school education were associated with elevated odds of visual impairment. Income was not, however, significantly associated with macular degeneration or glaucoma. Higher levels of education did not appear to significantly reduce the risk of being diagnosed with cataract, glaucoma, and macular degeneration, after adjusting for other variables.

Diagnosed diabetes was a significant predictor of visual impairment, cataract, and glaucoma. The adjusted odds of people with diagnosed diabetes reporting these eye conditions were approximately twice as high as for persons without a history of diabetes (Table 5). Among people with diagnosed diabetes, no significant associations were found between the sociodemographic variables and diabetic retinopathy.

DISCUSSION

To fully describe the impact of visual impairment and eye diseases on the US population, data on the nature and extent of these eye conditions are essential. Although the ideal methodology to obtain these data would be to conduct a detailed personal interview and visual examination that included a comprehensive evaluation of visual acuity, the optic nerve, and visual field on a demographically representative sample of the total US population, this is neither a logistically feasible nor a financially viable option.

The NHANES I, Hispanic HANES, and NHANES 1999 to 2002 collected data on visual acuity impairment and refractive errors through self-reported history questions and vision examinations that included measurement of visual acuity and eyeglass prescription.^{11,19–21} Based on the NHANES 1999 to 2002 data, approximately 6.4% of respondents 12 years and older had distance visual acuity of 20/50 or worse in the better-seeing eye and were considered visually impaired.¹¹ The lower prevalence of visual impairment in NHANES may be explained in part by the difference in the study samples.

TABLE 4—Prevalence of Ever Being Diagnosed With Diabetes and Diabetic Retinopathy Among US Adults 18 Years and Older: National Health Interview Survey, 2002

	Diabetes Mellitus, % (95% CI)	Diabetic Retinopathy, % (95% CI)	Diabetic Retinopathy Among Adults With Diabetes, % (95% CI)
Total	6.5 (6.2, 6.8)	0.7 (0.5, 0.9)	9.9 (8.5, 11.4)
Age group, y			
18–44	1.9 (1.7, 2.2)	0.2 (0.1, 0.2)	8.0 (5.0, 11.1)
45–54	7.4 (6.6, 8.2)	0.8 (0.5, 1.1)	9.8 (6.0, 13.6)
55–64	12.6 (11.4, 13.9)	1.3 (0.9, 1.6)	9.5 (6.7, 12.2)
65–74	17.3 (15.8, 18.7)	2.4 (1.7, 3.1)	12.4 (9.1, 15.8)
≥ 75	14.9 (13.4, 16.4)	1.5 (1.1, 2.0)	9.2 (6.3, 12.2)
Gender ^a			
Men	7.3 (6.8, 7.8)	0.7 (0.6, 0.9)	8.0 (5.4, 10.5)
Women	6.1 (5.7, 6.5)	0.7 (0.6, 0.9)	8.1 (6.4, 9.9)
Race/Ethnicity ^a			
Non-Hispanic Black	10.1 (9.1, 11.1)	1.2 (0.8, 1.6)	8.6 (5.5, 11.7)
Non-Hispanic White	5.8 (5.4, 6.1)	0.6 (0.5, 0.7)	7.3 (5.4, 9.2)
Hispanic ^b	9.3 (8.2, 10.4)	1.3 (0.8, 1.8)	10.6 (6.2, 14.9)
Income level ^a			
Below 200% of FPL	9.0 (8.2, 9.7)	1.1 (0.9, 1.4)	9.0 (6.5, 11.5)
Above 200% of FPL	5.7 (5.4, 6.1)	0.6 (0.5, 0.7)	7.3 (5.4, 9.2)
Education level ^a			
Less than high school	11.3 (10.2, 12.3)	1.5 (1.1, 1.9)	10.4 (6.5, 14.2)
High school graduate	7.8 (7.2, 8.5)	0.7 (0.5, 1.0)	7.1 (4.5, 9.7)
Some college or associate's degree	7.2 (6.5, 7.9)	0.9 (0.6, 1.1)	10.0 (7.0, 13.0)
Bachelor's degree or higher	4.8 (4.2, 5.4)	0.5 (0.3, 0.7)	10.7 (5.0, 16.4)
Total ^a	6.6 (6.3, 6.9)	0.7 (0.6, 0.8)	8.0 (6.5, 9.4)

Note. CI = confidence interval; FPL = federal poverty level.

^aAdjusted for age.

^bPersons of Hispanic origin may be of any race/ethnicity.

The NHIS respondents were interviewed in their homes and the NHANES visual acuity examination required the participants to go to mobile examination centers, so the NHANES study sample might have been influenced by nonparticipation of persons with severe forms of visual impairment who found it difficult to travel to mobile examination centers. In addition, visual acuity was not tested in participants who were too cognitively or physically impaired to take the vision examination.¹¹

During the 1988 to 1994 NHANES III vision examination, fundus photos of 1 eye of adult respondents 40 years and older were taken to estimate prevalence rates of diabetic retinopathy and macular degeneration in the US population 40 years and older.^{7,21–23} In

1988 to 1994, the prevalence of age-related macular degeneration among respondents with gradable photographs was 0.5%.²² Participants with gradable photographs were more likely to be younger and male, have higher family income, report being in good-to-excellent health, and report less trouble seeing. Prevalence of diabetic retinopathy was determined among people 40 years and older with type II diabetes and a gradable fundus photo; 20% had diabetic retinopathy.²³ The more recent NHANES 1999 to 2004 does not include questions about eye diseases or special eye examinations.^{11,19}

The most recent previously published data on the prevalence of eye diseases were obtained through a meta-analysis of population-based studies conducted in selected communities in

the United States, Europe, and Australia between 1985 and 2000.^{2,24–27} By applying these rates to 2000 US census data, the researchers estimated the prevalence of selected eye diseases in the United States among adults 40 years and older.

The 2002 NHIS provides the most recent national data on both self-reported visual impairment and diagnosed eye diseases. Data were collected for a nationally representative sample, allowing estimation of visual impairment and eye diseases for a wide variety of population subgroups. The large sample size facilitates investigation of the association between self-reported visual impairment and eye diseases and a wide range of self-reported sociodemographic and health characteristics.

The NHIS includes questions on visual impairment, but not eye diseases, every year. Prevalence estimates of visual impairment in 2003 to 2005, the most recent data available, do not differ significantly from the 2002 NHIS data we used.^{13,14,28,29}

Visual impairment was inversely associated with income and education, after adjusting for other variables. In the NHIS, visual impairment is defined as “trouble seeing even when wearing glasses or contact lenses.” This inverse association may be explained in part by a greater likelihood of persons with lower income and education to not have properly corrected vision because of financial or nonfinancial barriers to obtaining eye care or new glasses.

Our findings support previous research showing that age and race/ethnicity are strongly associated with eye diseases.^{22–27} After we adjusted for other variables, non-Hispanic Whites were at higher risk of cataract and macular degeneration and non-Hispanic Blacks were more likely to report glaucoma. Our results concerning the relation between race/ethnicity and eye diseases are consistent with previous studies,^{22,25,26} but the reason for these racial/ethnic differences is unknown. Diagnosed diabetes was strongly associated with visual impairment, cataract, and glaucoma. Our analysis did not control for having a recent eye examination, so the higher prevalence of diagnosed eye diseases among persons with diagnosed diabetes might be related in part to more frequent use of the health care system.

TABLE 5—Adjusted Odds Ratios (ORs) and 95% Confidence Intervals (CIs) for Prevalence of Visual Impairment and Ever Being Diagnosed With Selected Eye Diseases Among US Adults: National Health Interview Survey, 2002

	Visual Impairment		Cataract		Glaucoma		Macular Degeneration		Diabetic Retinopathy ^a	
	OR (95% CI)	P ^b	OR (95% CI)	P ^b	OR (95% CI)	P ^b	OR (95% CI)	P ^b	OR (95% CI)	P ^b
Age group, y										
18–44 (Ref)	1.00		1.00		1.00		1.00		1.00	
45–54	2.17* (1.90, 2.47)		4.78* (3.49, 6.54)		3.51* (2.23, 5.52)		2.14* (1.05, 4.39)		1.19 (0.64, 2.20)	
55–64	1.73* (1.49, 2.01)		17.04* (12.92, 22.48)		6.70* (4.34, 10.35)		4.60* (2.58, 8.22)		1.22 (0.71, 2.09)	
65–74	2.22* (1.89, 2.61)		71.86* (55.05, 93.80)		14.55* (9.73, 21.76)		15.97* (9.34, 27.31)		1.49 (0.86, 2.58)	
≥75	3.34* (2.87, 3.88)	<.001	186.53* (143.55, 242.38)	<.001	29.28* (19.64, 43.67)	<.001	51.30* (31.03, 84.82)	<.001	1.18 (0.68, 2.05)	.37
Gender										
Men (Ref)	1.00		1.00		1.00		1.00		1.00	
Women	1.31* (1.19, 1.45)		1.36* (1.22, 1.53)		1.20 (0.99, 1.45)		1.28 (0.99, 1.66)		1.14 (0.80, 1.62)	
Race/Ethnicity										
Non-Hispanic White (Ref)	1.00		1.00		1.00		1.00		1.00	
Non-Hispanic Black	1.09 (0.93, 1.27)		0.69* (0.58, 0.83)		2.27* (1.78, 2.90)		0.40* (0.23, 0.67)		1.08 (0.70, 1.67)	
Hispanic	0.69* (0.59, 0.81)		0.50* (0.40, 0.62)		0.95 (0.70, 1.30)		0.54* (0.30, 0.96)		1.30 (0.76, 2.21)	
Income level										
Below 200% of FPL	1.51* (1.34, 1.70)		1.17* (1.03, 1.33)		1.05 (0.83, 1.33)		0.89 (0.66, 1.22)		1.20 (0.84, 1.73)	
Above 200% of FPL (Ref)	1.00		1.00		1.00		1.00		1.00	
Education level										
Less than high school	1.74* (1.47, 2.05)		1.23* (1.03, 1.48)		1.08 (0.79, 1.49)		0.80 (0.54, 1.19)		1.03 (0.58, 1.83)	
High school graduate	1.29* (1.11, 1.49)		1.08 (0.92, 1.26)		1.01 (0.76, 1.35)		0.92 (0.65, 1.29)		0.64 (0.36, 1.14)	
Some college or associate's degree	1.23* (1.06, 1.42)		1.18 (1.00, 1.39)		0.91 (0.66, 1.24)		1.02 (0.70, 1.47)		0.96 (0.59, 1.66)	
Bachelor's degree or higher (Ref)	1.00	<.001	1.00	.06	1.00	.50	1.00	.22	1.00	.72
Diagnosed diabetes										
Persons with diabetes	2.20* (1.91, 2.54)		2.23* (1.90, 2.62)		1.93* (1.50, 2.47)		1.13 (0.81, 1.56)		NA	
Persons without diabetes (Ref)	1.00		1.00		1.00		1.00		NA	

Note. FPL = federal poverty level; NA = not applicable. ORs are adjusted for all other variables in the model.

^aLogistic regression analyses for diabetic retinopathy included only persons with diagnosed diabetes.

^bFor test of linear trend.

*P < .05 (2-tailed).

Among people with diagnosed diabetes, there were no significant associations between sociodemographic variables and diabetic retinopathy. However, in the overall population, diabetic retinopathy was associated with education and income, reflecting the greater likelihood of being diagnosed with diabetes among those with lower income and education. The prevalence of diabetic retinopathy increased with age and then declined beginning at age 75 years. The reduced prevalence of diabetic retinopathy in noninstitutionalized elderly individuals may be explained by reduced survival and increased nursing home use among older

people with diabetes.^{30–32} Diabetic retinopathy, as a complication of diabetes, characterizes more severe diabetes with its life-threatening consequences.^{31,33}

Age-related eye diseases result in substantial health care use and costs.^{2,25–27,34,35} The number of people with age-related eye diseases is projected to increase significantly,^{7,27,36,37} driven largely by people older than 65 years, the fastest-growing segment of the US population. This increase will have important implications for the health care system in the United States. Prevention strategies that may help to avoid the expected increase in visual impairment among the aging population include

regular eye examinations, enhanced glycemic and blood pressure control, and early diagnosis and treatment for eye diseases.^{24–26,38–40}

Limitations

Limitations of the study should be noted. First, NHIS vision data are based on self-reports. This may result in considerable underreporting; some population studies have found that approximately half of people with cataract, glaucoma, and macular degeneration were aware of their condition.^{2,26,41} Approximately 30% of people with diabetes have not been diagnosed, and such individuals may have diabetic retinopathy as well.^{42,43}

In addition, underreporting may differ among population subgroups.

The NHIS self-reported vision data were not validated against physician-confirmed diagnoses or vision examinations. Although the NHANES 1999 to 2002 included a visual acuity examination, the 2002 NHIS and 1999 to 2002 NHANES visual impairment estimates were not directly comparable because different definitions of visual impairment were used in these surveys. The NHIS question on visual impairment did not ask about visual acuity but rather the respondents' perception of the quality of their vision.

Second, because the NHIS visual impairment question asked about trouble seeing even when wearing glasses, the estimates of impairment do not include people with eye diseases who do not have trouble seeing as well as those who had their vision corrected. Also, questions pertaining to the specific type of eye disease (i.e., type of glaucoma or cataract) were not asked. Because diagnostic criteria, protocol, and definitions for the various causes of low vision and eye diseases differ among eye care professionals,^{2,26,27,44} the potential for misclassification is an issue even among respondents with recent eye examinations.

Third, the NHIS did not ask for the cause of visual impairment. Approximately 35% of those reporting visual impairment also reported ever being diagnosed with 1 of the 4 eye diseases included in the NHIS. The NHIS vision data do not include information on uncorrected refractive error or other eye conditions that can cause visual impairment.^{2,11,45}

Fourth, because the NHIS excludes institutionalized people, a population at high risk for illness and disability, the results underestimate the total prevalence of visual impairment and eye diseases. The 1999 National Nursing Home Survey reported that among approximately 4 million people in nursing homes, the prevalence of visual impairment was approximately 27%.³²

Fifth, the final response rate for sample adults was 74.3% in 2002, with a potential for bias caused by nonresponse. However, sample weights used in all analyses included nonresponse and poststratification adjustments. Exact family income was imputed for 31% of sample adults. However,

the imputation methodology incorporated a substantial amount of information, and the use of multiple imputation enabled uncertainty associated with imputation to be accounted for in variance estimation. Finally, blindness and eye disease prevalence estimates were unreliable for some small racial/ethnic groups.

Conclusions

Among the estimated 205 million US civilian, noninstitutionalized adults who were 18 years and older in 2002, approximately 19.1 million people were visually impaired, including 0.7 million persons who were blind. Approximately 17 million persons reported having ever been diagnosed with cataracts, 4.1 million had glaucoma, 2.1 million reported macular degeneration, and 1.3 million persons had diagnosed diabetic retinopathy.

The 2002 NHIS provides the most recent national data on both self-reported visual impairment and diagnosed eye diseases. The results of this study provide a baseline for future public health initiatives relating to visual impairment. ■

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Contributors

A. Ryskulova and K. Turczyn originated and designed the study. D.M. Makuc, R.J. Klein, M.F. Cotch, and R. Janiszewski provided critical reviews and recommendations on the study design and data analysis. A. Ryskulova carried out the data analyses and wrote the drafts of the article. All of the authors contributed to interpretation of results and to article revisions.

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Human Participant Protection

No protocol approval was needed for this study because the data are publicly available and do not contain identifiers.

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