

The Prevalence of Age-Related Eye Diseases and Visual Impairment in Aging: Current Estimates

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Submitted: July 10, 2013

Accepted: July 15, 2013

Citation: Klein R, Klein BEK. The prevalence of age-related eye diseases and visual impairment in aging: current estimates. *Invest Ophthalmol Vis Sci*. 2013;54:ORSF5-ORSF13. DOI: 10.1167/iovs.13-12789

PURPOSE. To examine prevalence of five age-related eye conditions (age-related cataract, AMD, open-angle glaucoma, diabetic retinopathy [DR], and visual impairment) in the United States.

METHODS. Review of published scientific articles and unpublished research findings.

RESULTS. Cataract, AMD, open-angle glaucoma, DR, and visual impairment prevalences are high in four different studies of these conditions, especially in people over 75 years of age. There are disparities among racial/ethnic groups with higher age-specific prevalence of DR, open-angle glaucoma, and visual impairment in Hispanics and blacks compared with whites, higher prevalence of age-related cataract in whites compared with blacks, and higher prevalence of late AMD in whites compared with Hispanics and blacks. The estimates are based on old data and do not reflect recent changes in the distribution of age and race/ethnicity in the United States population. There are no epidemiologic estimates of prevalence for many visually-impairing conditions.

CONCLUSIONS. Ongoing prevalence surveys designed to provide reliable estimates of visual impairment, AMD, age-related cataract, open-angle glaucoma, and DR are needed. It is important to collect objective data on these and other conditions that affect vision and quality of life in order to plan for health care needs and identify areas for further research.

Keywords: age-related eye diseases, age-related macular degeneration, cataract, diabetic retinopathy, glaucoma, prevalence, review, visual impairment

Prevalence estimates indicate the burden of a condition (e.g., visual impairment) at a defined location at a point or period in time. Accurate prevalence estimates are needed to plan for availability of health care services, associated monetary costs, and quality of life connected with having the condition. Such data are also of importance in planning future studies, such as controlled clinical trials of prevention and treatment of the disease. Periodic estimates of prevalence enable the tracking of temporal trends; this is important especially in situations where new, costly interventions are being introduced. Prevalence estimates reflect disparities in vision loss and vision-threatening conditions among racial/ethnic groups as well as age, income and education groups, as well as between the sexes. In addition to these characteristics, nutritional and environmental exposures may affect prevalences or disparities among groups. Aside from true disparities, apparent differences may be related to differences in case definition. For eye conditions this may rely upon self-reported history of a condition, findings at a clinical exam, or imaging (e.g., digital fundus photography, film fundus photography, optical coherence tomography). Variations in diagnostic procedures to define conditions (phenotypes) may further confound the ability to estimate prevalence as well as to identify temporal trends and cohort effects.

Definitional differences of conditions frequently occur among different groups of investigators, even when attempts are made to use the same characteristics and standardized protocols to classify subjects. For example, estimates of the prevalence of AMD may vary depending on whether size, type, and/or area of drusen or presence of pigmentary abnormalities

are used to define its presence. This occurred among three population-based cohorts that used the Wisconsin Age-Related Maculopathy Grading System to classify and grade AMD lesions. Each group made modifications to the protocol. These modifications led to several systematic differences in grading fundus photographs that exaggerated differences in the prevalence of early AMD among the studies.¹ Harmonization was required to achieve a uniform definition of early AMD to facilitate meta-analyses. Similar problems affect other conditions (e.g., open-angle glaucoma and cataract) because definitions and methods used to assess the conditions vary among studies.

Despite these problems, estimates, even if imperfect, are needed to describe public health and clinical burden as well as to plan for future needs. We describe estimates of prevalence of age-related cataract, open-angle glaucoma, AMD, diabetic retinopathy (DR), and visual impairment using data from several sources. We also highlight current needs in an effort to obtain data that will be used to successfully prevent visual loss due to these conditions.

METHODS

Data are derived from the Eye Diseases Prevalence Research Group (EDPRG),²⁻⁸ the National Health and Nutrition Examination Survey (NHANES) III,⁹ the NHANES 1999 to 2008,¹⁰⁻¹³ and the National Health Interview Survey (NHIS).¹⁴ Other sources of data include local population-based studies (the Los Angeles Latino Eye Study [LALES]),¹⁵⁻¹⁸ Wisconsin Epidemiologic

TABLE 1. 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)
Sex*			
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*			
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†	6.0 (5.1, 6.9)	1.9 (1.4, 2.3)	0.6 (0.3, 0.9)‡
Income level*			
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*			
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*			
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*	8.9 (8.6, 9.3)	2.1 (1.9, 2.2)	1.2 (1.1, 1.3)

CI, confidence interval; FPL, federal poverty level. Reprinted with permission from Ryskulova A, Turczyn K, Makuc DM, Cotch MF, Klein RJ, Janiszewski R. Self-reported age-related eye diseases and visual impairment in the United States: results of the 2002 national health interview survey. *Am J Public Health*. 2008;98:454–461. Copyright 2008 the American Public Health Association.

* Adjusted for age.

† Persons of Hispanic origin may be of any race/ethnicity.

‡ Estimates are considered unreliable. Relative standard error is greater than 30%.

ic Study of Diabetic Retinopathy [WESDR],¹⁹ and the Beaver Dam Eye Study [BDES]).²⁰

The EDPRG was a collaborative effort that combined data from up to 10 different studies of mostly European-derived populations, but including cohorts with persons of African or Mexican heritage: the Baltimore Eye Survey, the Barbados Eye

Study, the BDES, the Blue Mountains Eye Study, Proyecto Vision Evaluation and Research, the Rotterdam Study, the Salisbury Eye Evaluation Project, the San Antonio Heart Study, the San Luis Valley Diabetes Study, and the Melbourne Visual Impairment Project.^{3–8} The number of studies contributing data depended upon each study's availability of information on a

TABLE 2. Estimated Prevalence and Number of People in the Year 2000 With Various Age-Related Eye Conditions From the Eye Diseases Prevalence Research Group^{4–6}

Age, y	Cataract		Open-Angle Glaucoma		Large Drusen ≥125-μm Diameter		Late AMD, Any		Neovascular AMD		Geographic Atrophy	
	Subjects No. ×1000	Prev %	Subjects No. ×1000	Prev %	Subjects No. ×1000	Prev %	Subjects No. ×1000	Prev %	Subjects No. ×1000	Prev %	Subjects No. ×1000	Prev %
40–49	1046	2.5	290	0.7	851	2.0	20	0.05	20	0.05	NA	NA
50–54	902	5.1	160	0.9	519	2.9	60	0.3	40	0.2	27	0.2
55–59	1221	9.1	158	1.2	534	4.0	53	0.4	36	0.3	25	0.2
60–64	1679	15.5	170	1.6	585	5.4	60	0.6	41	0.4	31	0.3
65–69	2382	25.0	199	2.1	709	7.4	87	0.9	60	0.6	46	0.5
70–74	3270	36.9	248	2.8	906	10.2	147	1.7	101	1.2	80	0.9
75–79	3703	49.9	282	3.8	1043	14.1	241	3.2	166	2.2	132	1.8
≥80	6272	68.3	711	7.7	2164	23.6	1081	11.8	751	8.9	632	0.9
Total	20476	17.2	2218	1.9	7311	6.1	1749	1.5	1215	1.0	973	0.8

NA, not applicable; Prev, prevalence.

TABLE 3. Prevalence of Blindness and Low Vision by Age and Race/Ethnicity*

Variable	Prevalence per 100 Individuals (95% CI)		
	White Persons	Black Persons	Hispanic Persons
Blindness by WHO definition†			
Age, y			
40–49	0.11 (0.08–0.14)	0.13 (0.07–0.23)	0.04 (0.02–0.08)
50–54	0.08 (0.07–0.09)	0.22 (0.14–0.35)	0.08 (0.05–0.14)
55–59	0.08 (0.07–0.09)	0.32 (0.22–0.46)	0.13 (0.08–0.20)
60–64	0.10 (0.80–0.11)	0.45 (0.32–0.64)	0.20 (0.14–0.29)
65–69	0.14 (0.12–0.17)	0.65 (0.46–0.91)	0.31 (0.21–0.45)
70–74	0.25 (0.22–0.30)	0.93 (0.63–1.36)	0.48 (0.32–0.73)
75–79	0.55 (0.48–0.62)	1.32 (0.84–2.07)	0.75 (0.46–1.22)
≥80	4.27 (3.42–5.31)	2.67 (1.42–4.98)	1.80 (0.91–3.53)
Blindness by US definition‡			
Age, y			
40–49	0.12 (0.08–0.17)	0.18 (0.13–0.24)	0.05 (0.03–0.08)
50–54	0.10 (0.08–0.13)	0.34 (0.26–0.43)	0.10 (0.08–0.15)
55–59	0.11 (0.09–0.14)	0.52 (0.42–0.65)	0.16 (0.12–0.22)
60–64	0.15 (0.11–0.19)	0.81 (0.67–0.98)	0.26 (0.20–0.33)
65–69	0.23 (0.18–0.30)	1.25 (1.04–1.51)	0.41 (0.32–0.52)
70–74	0.43 (0.34–0.54)	1.93 (1.56–2.38)	0.64 (0.48–0.84)
75–79	0.93 (0.75–1.14)	2.96 (2.30–3.80)	0.99 (0.72–1.38)
≥80	6.82 (4.85–9.52)	6.85 (4.85–9.58)	2.42 (1.53–3.79)
Low vision§			
Age, y			
40–49	0.20 (0.15–0.25)	0.04 (0.02–0.07)	0.27 (0.19–0.38)
50–54	0.26 (0.22–0.30)	0.17 (0.12–0.23)	0.52 (0.42–0.64)
55–59	0.35 (0.30–0.40)	0.39 (0.29–0.54)	0.82 (0.68–1.00)
60–64	0.53 (0.46–0.62)	0.86 (0.62–1.18)	1.35 (1.10–1.64)
65–69	0.90 (0.78–1.04)	1.72 (1.27–2.33)	2.25 (1.85–2.72)
70–74	1.71 (1.50–1.95)	3.16 (2.41–4.13)	3.83 (3.22–4.56)
75–79	3.57 (3.13–4.08)	5.31 (3.99–7.04)	6.63 (5.56–7.87)
≥80	16.05 (12.95–19.73)	10.84 (5.89–19.11)	17.72 (13.02–23.66)

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* All estimates are based on the 2000 US Census population.

† Blindness as defined by the WHO standard is the best-corrected visual acuity of less than 6/120 (<20/400) in the better-seeing eye.

‡ Blindness as defined by the US definition is the best-corrected visual acuity of 6/60 or worse (<20/200) in the better-seeing eye.

§ Low vision is defined as the best-corrected visual acuity less than 6/12 (<20/40) in the better-seeing eye (excluding those who were categorized as being blind by the US definition).

given disease or visual function. The purpose of this collaborative effort was to estimate prevalence in the year 2000 of visual impairment and of five specific eye conditions (refractive error, cataract, open-angle glaucoma, DR, and AMD) in people 40 years of age or older and to project prevalence estimates to the year 2020.² The data in these studies were collected from as early as 1980 to as recently as 2000. An attempt was made to standardize diagnostic criteria among the studies. The EDPRG's findings were presented in an issue of the *Archives of Ophthalmology* in 2004 and included tables and figures showing the prevalence of the specific condition by age, sex, and race/ethnicity for each study and combined estimates of prevalence and total numbers of persons of each condition in the United States (US) by age, sex, and race/ethnicity. These papers, along with their tables and figures, are available electronically.^{3–8}

The NHANES was conducted by the National Center for Health Statistics at the Centers for Disease Control and Prevention.^{9,11,12,22,23} A stratified four-stage area probability sampling procedure was used to obtain a cross-sectional representative sample of the US civilian noninstitutionalized population aged 13 years and older for the NHANES III. It

provided estimates of the prevalence of AMD and DR based on gradings of fundus photographs between 1988 and 1994 (one 45° nonstereoscopic field centered on the optic nerve head). In the 2005 to 2008 survey, two 45° nonstereoscopic fields, one centered on the optic nerve head and the other on the fovea of both eyes, were taken of people 40 years of age and older. In the 1999 to 2004 and 2005 to 2008 NHANES, the best-corrected visual acuity was measured and prevalence estimates of visual impairment were reported.^{11,13,24,25}

The NHIS Vision Health supplement published in 2002 provides data based on self-reported diagnosed eye conditions (Table 1).¹⁴ The survey, involving 31,044 persons aged 18 years and older, was conducted by the US Census Bureau through in-person household interviews. The household response rate for the NHIS was 89.5%.

In the current paper, we include data from the LALES because of the limited amount of data on Hispanics, especially for cataract status.¹⁵ The study involved examination of 6357 Latinos 40 years and older living in six census tracts in Los Angeles, California. It included standard protocols to measure visual acuity and the grading of lens for identification of presence and severity of cataract at the slit lamp using the Lens

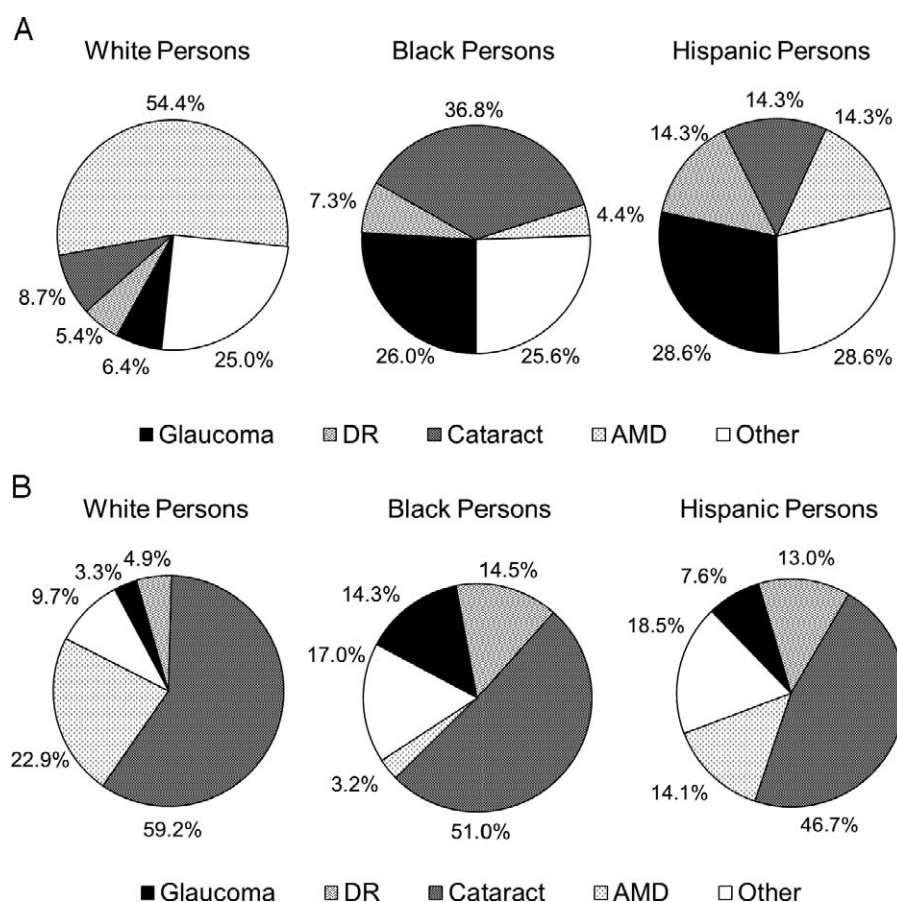


FIGURE. Causes of (A) blindness (best-corrected visual acuity < 6/60 [$<20/200$]) and (B) low vision (best-corrected visual acuity < 6/12 [$<20/40$] in the better seeing eye), excluding persons categorized as being blind (best-corrected visual acuity < 6/60 [$<20/200$]), by race/ethnicity. Reprinted with permission from Congdon N, O'Colmain B, Klaver CC, et al. Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol*. 2004;122:477–485. Copyright 2004 American Medical Association. All rights reserved.

Opacity Classification System II and fundus and optic disc photography; the Wisconsin Age-Related Maculopathy Grading System and the Airlie House classification scheme for DR were used in the grading of these photographs. The main outcomes included the prevalence and incidence of visual impairment, blindness, cataract, glaucoma, DR, and AMD. More detailed information is presented elsewhere.¹⁵

RESULTS

Estimated age-specific prevalence and number of people with the condition in the year 2000 from the EDPRG appear in Table 2.^{4–6} Estimates vary from a prevalence of 0.8% for geographic atrophy to 17.2% for cataract. Most estimates of eye disease prevalence increase with age. The heaviest burden of age-related eye disease was in those 80 years of age or older who had one-third of all cases of cataract, open-angle glaucoma, and early AMD and two-thirds of persons with late AMD.

Visual Impairment

In the EDPRG, the estimated number of persons with low vision (best-corrected visual acuity of <20/40 in the better seeing eye) and severe visual impairment (best-corrected visual acuity of <20/200 in the better seeing eye) for persons 40 years of age and older in the year 2000 was estimated to be 2,400,000 and 937,000, respectively.³ Visual impairment and severe visual impairment increased with age and age-specific

prevalence were higher in blacks and Hispanics than whites (Table 3). Specific causes of blindness and visual impairment in the EDPRG vary by race/ethnicity.³ Severe visual impairment was most commonly attributed to cataract in blacks (36.8%) and in Hispanics (28.6%), and to AMD in whites (54.4%, Figure). The second most common cause of blindness was glaucoma in blacks (26.0%), AMD, cataract, and DR (14.3% for each) in Hispanics, and cataract in non-Hispanic whites (8.7%).

In the NHIS there were 19.1 million civilian, noninstitutionalized adults who reported some visual impairment by answering affirmatively the question: “Do you have any trouble seeing even when wearing glasses or contact lenses?” of whom 0.7 million reported being blind by answering affirmatively the question: “Are you blind or unable to see at all?”¹⁴ Self-reported visual impairment was 9.3% and increased with age, from 5.7% among people 18 to 44 years of age to 21.1% among people 75 years of age or older. Visual impairment was more frequent among women than among men and was inversely associated with education and income (Table 4). The prevalence of visual impairment was higher in non-Hispanic blacks than in non-Hispanic whites and Hispanics. 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, glaucoma, AMD, and DR among people with visual impairment was 19.4%, 6.1%, 6.0%, and 3.4%, respectively. The prevalence of blindness among US adults was 0.3%, rose with age and was similar between men and women. The prevalence of blindness was higher in those aged 75 years

TABLE 4. Prevalence of Visual Impairment and Blindness Among US Adults 18 Years and Older: National Health Interview Survey, 2002

	Visual Impairment,* % (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)
Sex†		
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‡		
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‡	9.0 (7.9, 10.1)	0.4 (0.2, 0.7)
Income level‡		
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‡		
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‡		
Persons with diabetes	18.4 (15.4, 21.3)	0.9 (0.3, 1.4)§
Persons without diabetes	8.6 (8.2, 9.0)	0.3 (0.2, 0.4)
Total‡	9.3 (8.9, 9.7)	0.4 (0.3, 0.4)

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* Includes blindness.

† Adjusted for age.

‡ Persons of Hispanic origin may be of any race.

§ Estimates are considered unreliable. Relative standard error is greater than 30%.

and older than for younger people and was inversely related to education and income.¹⁴

Cataract

It was estimated by the EDPRG that there were 20.5 million persons older than 40 years of age in the United States with cataract (Table 2) and 6.1 million persons with aphakia/pseudophakia in the year 2000.⁵ The prevalence was 17.2% for cataract and 5.1% for aphakia/pseudophakia. The prevalence of cataract increased with age and for each specific age was higher in females than males and higher in whites than blacks (Table 5).⁵ Data were not available for cataract prevalence in Hispanics in the EDPRG. Data from the LALES, not included in the EDPRG, provided estimates of cataract prevalence based on slit-lamp evaluation using the Lens Opacity Classification System II (Table 6).^{15,16}

In the NHIS, the lifetime prevalence for self-reported diagnosed cataract was 8.6% (Table 1).¹⁴ Prevalence of diagnosed

TABLE 5. Prevalence of Cataract by Age, Sex, and Race/Ethnicity*

Sex/Age, y	Prevalence per 100 Individuals (95% CI)	
	White Persons	Black Persons
Females		
40–49	1.9 (1.2–2.8)	2.2 (1.4–3.5)
50–54	5.0 (4.0–6.2)	7.3 (5.7–9.3)
55–59	9.4 (7.7–11.5)	12.8 (10.2–16.0)
60–64	16.9 (14.1–20.0)	20.1 (16.4–24.2)
65–69	27.7 (24.1–31.6)	28.5 (24.3–33.1)
70–74	41.0 (36.9–45.1)	37.4 (32.6–42.5)
75–79	54.7 (50.2–59.1)	46.1 (40.1–52.2)
≥80	76.6 (71.2–81.2)	60.9 (51.0–69.9)
Males		
40–49	2.8 (2.1–3.7)	1.7 (1.1–2.5)
50–54	4.9 (4.2–5.7)	4.5 (3.6–5.6)
55–59	8.2 (7.0–9.5)	7.6 (6.2–9.3)
60–64	13.8 (12.1–15.7)	11.9 (9.9–14.2)
65–69	22.4 (20.1–24.8)	17.5 (15.0–20.3)
70–74	33.9 (31.2–36.8)	24.1 (21.0–27.5)
75–79	47.2 (43.9–50.4)	31.3 (27.1–36.0)
≥80	71.3 (67.0–75.2)	46.2 (37.9–54.6)

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* Significant lens opacity was defined as the presence of one or more of the following in either eye: posterior subcapsular cataract of 1.0 mm or more, cortical cataract occupying 25% or more of the lens visible through a dilated pupil, or nuclear cataract greater than or equal to the penultimate grade in the system used (i.e., grade ≥3 in the Wilmer Cataract Grading System and in the Lens Opacities Classification System II and grade ≥4 in the Wisconsin Cataract Grading System).

cataract increased with age, with the highest self-reported prevalence in persons 75 years and older (53%). Whites were more likely to report being diagnosed with cataract than black or Hispanic adults. These associations were similar to those reported in the EDPRG. There was no information on cataract prevalence in the NHANES because the study did not measure this endpoint.

Open-Angle Glaucoma

In the EDPRG, open-angle glaucoma was estimated to be present in 2,218,000 persons in the United States, a prevalence of 2%.⁶ Open-angle glaucoma increased with age and was highest in blacks and lowest in whites, with Hispanics between whites and blacks (Table 7). Age-specific prevalence was higher in younger women than in younger men and was similar between men and women after age 70 years. In the 2002 NHIS, in persons aged 18 years and older, the lifetime prevalence for self-reported diagnosed glaucoma was 2% (Table 1).¹⁴ Blacks were twice as likely as whites and Hispanics to have glaucoma, and more education and higher income were associated with lower prevalence of glaucoma. Data from the LALES for age-specific prevalence of glaucoma are presented in Table 6.^{15,17} The prevalence in Mexican Americans was higher than in whites.

Age-Related Macular Degeneration

For AMD, estimates in the EDPRG were made only for blacks and non-Hispanic whites.⁴ There was an estimated 1.75 million persons with advanced AMD in at least one eye and 7.3 million had large drusen, a measure used to define early AMD, in the

TABLE 6. Estimated Prevalence of Eye Conditions in the Los Angeles Latino Eye Study^{16–19}

Age, y	Cataract, %			Open-Angle Glaucoma, %	Large Drusen ≥125-μm Diameter, %	Late AMD, %	Any Visual Impairment, %
	PSC	NSC	Cortical				
40–49	0.6	0.6	2.0	1.3	8.5	0	0.9
50–59	1.4	2.2	8.0	2.9	13.6	0.2	0.9
60–69	5.7	15.1	27.8	7.4	19.3	0.3	3.6
70–79	10.4	44.5	43.6	14.7	26.3	1.5	10.6
≥80	28.4	76.9	60.2	21.8	45.3	8.5	27.8
Total	3.2	9.0	13.5	4.7	14.5	0.4	3.0

NSC, nuclear sclerotic cataract; PSC, posterior subcapsular cataract.

year 2000. The prevalence of advanced AMD was 1.5%, with neovascular AMD estimated to be present in 1%, while pure geographic atrophy was estimated to be present in 0.8% (Table 2).⁴ The prevalence of early AMD, defined by the presence of at least one large druse (≥125 μm in diameter) in at least one eye, was 6% (Table 2). In the LALES, for Mexican Americans, the age-specific prevalence increased with age for signs of both early and late AMD (Table 6).^{15,18} In the NHIS, the prevalence of AMD was 1% and rose with age (Table 1).¹⁴ Diagnosed AMD was twice as prevalent among whites as among blacks.

Overall, the prevalence of any AMD in the 2005 to 2008 NHANES was 6.5%.¹⁰ This was lower than the 9.4% prevalence reported in the 1988 to 1994 NHANES III.²⁶ This finding might be explained, in part, by possible methodological differences and differences in race/ethnicity distributions between the surveys. The lower overall prevalence of AMD in the more recent NHANES is consistent with a decreasing incidence of AMD in whites reported in the BDES and it has important public health care implications.²⁷ It suggests that there may be fewer people with early AMD than expected based on projections that assumed that the prevalence would not change.⁴

Diabetic Retinopathy

Diabetic retinopathy is an important cause of severe visual impairment in persons 25 to 64 years of age. Its prevalence has been changing as a result of marked improvements in management of blood sugar, dyslipidemia, and blood pressure, as well as the development of new technology and medications to monitor blood sugar and treat high lipid and blood pressure levels.²⁸

The EDPRG estimated DR to be present in 4 million persons, of whom 900,000 were estimated to have vision-threatening diabetic retinopathy (VTDR) defined as the presence of severe non-proliferative DR or worse, or presence of macular edema.⁷ The prevalence was 40% and 8% for any DR and VTDR, respectively. In the NHANES 2005 to 2008, the prevalence of VTDR varied from 9.3% in non-Hispanic blacks and 7.3% in Mexican Americans to 3.2% in non-Hispanic whites (Table 8)¹² and was lower than the EDPRG estimates. In the NHIS in 2000, the estimated prevalence of diagnosed diabetes among adults was 6.5%, or 13.4 million people; the estimated prevalence of DR among adults was 0.7%, or 1.3 million people; and the prevalence of DR among those with diagnosed diabetes was 9.9% (Table 9).¹⁴

TABLE 7. Prevalence of Open-Angle Glaucoma by Age, Sex, and Race/Ethnicity

Age, y	Prevalence per 100 Persons (95% CI)		
	White Subjects	Black Subjects	Hispanic Subjects
Women			
40–49	0.83 (0.65–1.06)	1.51 (0.94–2.41)	0.34 (0.15–0.72)
50–54	0.89 (0.78–1.02)	2.24 (1.59–3.14)	0.65 (0.37–1.15)
55–59	1.02 (0.89–1.16)	2.86 (2.16–3.78)	0.98 (0.61–1.58)
60–64	1.23 (1.07–1.41)	3.65 (2.83–4.69)	1.49 (0.97–2.28)
65–69	1.58 (1.37–1.82)	4.64 (3.54–6.05)	2.24 (1.43–3.49)
70–74	2.16 (1.87–2.49)	5.89 (4.28–8.05)	3.36 (2.00–5.60)
75–79	3.12 (2.68–3.63)	7.45 (5.06–10.84)	5.01 (2.68–9.15)
≥80	6.94 (5.40–8.88)	9.82 (6.08–15.48)	10.05 (4.35–21.52)
Men			
40–49	0.36 (0.27–0.47)	0.55 (0.31–0.95)	0.39 (0.18–0.85)
50–54	0.61 (0.50–0.74)	1.71 (1.25–2.32)	0.69 (0.39–1.25)
55–59	0.85 (0.72–1.00)	3.06 (2.30–4.04)	1.00 (0.61–1.64)
60–64	1.18 (1.02–1.37)	4.94 (3.69–6.59)	1.44 (0.92–2.24)
65–69	1.64 (1.40–1.91)	7.24 (5.40–9.63)	2.07 (1.32–3.23)
70–74	2.27 (1.90–2.72)	9.62 (7.29–12.59)	2.97 (1.79–4.89)
75–79	3.14 (2.53–3.90)	11.65 (8.81–15.25)	4.23 (2.32–7.60)
≥80	5.58 (4.15–7.47)	13.21 (7.85–21.38)	7.91 (3.53–16.77)

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TABLE 8. Estimated Prevalence of Diabetic Retinopathy and Vision-Threatening Diabetic Retinopathy in Individuals With Diabetes Aged 40 Years and Older and in the Adult US Population, by Age, Sex, and Race/Ethnicity: NHANES 2005 to 2008

Characteristic	No.*	No.†	Weighted Size, in Thousands‡	Diabetes Population		US Population	
				95% CI	P Value	95% CI	P Value
Crude prevalence of DR							
Total	1006	324	4202	28.5 (24.9–32.5)		3.8 (3.2–4.5)	
Age, y							
40–64	575	189	2588	28.0 (23.0–33.6)	0.64	3.1 (2.4–3.9)	<0.001
≥65	431	135	1613	29.5 (25.4–33.9)		6.1 (5.1–7.3)	
Sex							
Male	504	173	2257	31.6 (26.8–36.8)	0.04	4.3 (3.5–5.3)	0.046
Female	502	151	1944	25.7 (21.7–30.1)		3.3 (2.7–4.1)	
Race/ethnicity							
Non-Hispanic white	396	107	2507	26.4 (21.4–32.2)	0.008	2.9 (2.2–3.9)	<0.001
Non-Hispanic black	306	119	1006	38.8 (31.9–46.1)		9.6 (7.7–11.9)	
Mexican American	197	70	401	34.0 (26.7–42.1)		6.7 (5.4–8.4)	
Other	107	28	286	19.7 (12.5–29.7)		3.3 (2.3–4.7)	
Crude prevalence of vision-threatening DR							
Total	1006	62	655	4.4 (3.5–5.7)		0.6 (0.5–0.8)	
Age, y							
40–64	575	36	376	4.1 (2.8–5.8)	0.41	0.4 (0.3–0.7)	0.009
≥ 65	431	26	278	5.1 (3.5–7.3)		1.0 (0.7–1.5)	
Sex							
Male	504	24	298	4.2 (2.8–6.1)	0.67	0.6 (0.4–0.9)	0.81
Female	502	38	356	4.7 (3.2–6.9)		0.6 (0.4–0.9)	
Race/ethnicity							
Non-Hispanic white	396	13	304	3.2 (2.0–5.1)	0.006	0.4 (0.2–0.6)	<0.001
Non-Hispanic black	306	28	241	9.3 (5.9–14.4)		2.3 (1.5–3.6)	
Mexican American	197	16	85	7.3 (3.9–13.3)		1.4 (0.8–2.7)	
Other	107	5	22	1.6 (0.6–3.8)§		0.3 (0.1–0.6)	

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* Number of participants with diabetes in NHANES 2005–2008.

† Number of participants with diabetes who had DR or VTDR in NHANES 2005–2008.

‡ Weighted total number of US adult population who had DR or VTDR.

§ Estimate is considered unreliable because relative standard error is greater than 30%.

Prevalence of DR appears to be declining. In the 8 years between the beginning of the WESDR and the beginning of the BDES, the prevalence of any DR in persons with type 2 diabetes fell by 30% (from 50% in the WESDR in 1980–1982 to 35% in the BDES in 1988–1990) and prevalence of VTDR fell by 70% (from 10% in the WESDR in 1980–1982 to 3% in the BDES in 1988–1990).^{20,21}

DISCUSSION

We have presented national estimates of the prevalence of visual impairment, cataract, open-angle glaucoma, AMD, and DR showing that they increase with age, and may vary by race/ethnicity and sex. Differences among studies regarding the age-specific prevalences of these conditions may be due to methodological issues (e.g., ophthalmoscopy versus grading of fundus photos) and differences in the definitions used. The prevalence estimates are largely from data collected mostly in the 1980s and 1990s, 25 to 30 years ago. There are no national data estimates for most corneal diseases, conditions affecting the optic nerve, and less common retinal conditions.

The following needs were identified:

1. Ongoing surveillance, through national surveys (e.g., the NHANES); objectively measuring the presence and severity of common conditions (e.g., age-related cataract, AMD, DR, and open-angle glaucoma); and those conditions not routinely measured in population-based studies (e.g., Fuchs' dystrophy, ischemic optic neuropathy, macular hole, and dry eye);
2. Standardize protocols to be used in the field to assess each condition and establish consensus on how to define the conditions being studied;
3. Incorporate into classification schemes and validate new technologies (e.g., spectral domain optical coherence tomography) used to define the presence and severity of disease;
4. Identify cost-effective methods to measure phenotypes;
5. Incorporate economic analyses and quality of life measures in epidemiologic cohort studies;
6. Train clinicians in understanding and interpreting epidemiologic data; and
7. Educate the public and Congress on why collecting epidemiologic data is important.

TABLE 9. Prevalence of Ever Being Diagnosed With Diabetes and DR Among US Adults 18 Years and Older: National Health Interview Survey, 2002

	Diabetes Mellitus, % (95% CI)	DR, % (95% CI)	DR 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)
Sex*			
Male	7.3 (6.8, 7.8)	0.7 (0.6, 0.9)	8.0 (5.4, 10.5)
Female	6.1 (5.7, 6.5)	0.7 (0.6, 0.9)	8.1 (6.4, 9.9)
Race/ethnicity*			
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†	9.3 (8.2, 10.4)	1.3 (0.8, 1.8)	10.6 (6.2, 14.9)
Income level*			
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*			
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*	6.6 (6.3, 6.9)	0.7 (0.6, 0.8)	8.0 (6.5, 9.4)

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* Adjusted for age.

† Persons of Hispanic origin may be of any race/ethnicity.

Acknowledgments

Supported by National Institutes of Health Grants EY06594 and EY016379, as well as an unrestricted grant from Research to Prevent Blindness, New York, New York.

Disclosure: **R. Klein**, None; **B.E.K. Klein**, None

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