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## The prevalence and demographic associations of presenting near-vision impairment among adults living in the United States

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### Abstract

**Purpose**—Estimate prevalence of presenting near-vision impairment (PNVI) among people 50 years in the United States (US) and examine associations with socio-demographic characteristics.

**Design**—Cross-sectional study

**Methods**—11016 of 12781 (88.5%) US adults 50 years participated in the National Health and Nutrition Examination Survey (NHANES) between 1999–2008 with recorded near visual acuity. PNVI was defined as presenting near-vision worse than 20/40; functional near-vision impairment (FNVI) was defined as at least “moderate-difficulty” with either reading newsprint or near-work. Prevalence of PNVI and FNVI were estimated accounting for NHANES multistage probability sampling design. Multivariable regression models were used to determine socio-demographic characteristics associated with PNVI.

**Results**—13.6% of participants had PNVI with 25.9% reporting concurrent FNVI. Higher odds of PNVI was associated with non-White race, older-age, male-sex, less than high-school education, lack of private health-insurance, income <poverty level, lacking/not using near-vision correction at time of examination, and impaired distance-vision. While the majority of participants with PNVI (82.9%) had normal distance-vision or uncorrected refractive error, less than half (46.1%) used near-vision correction. Not using near correction was associated with non-White race, younger-age, male-sex and lack of access to healthcare.

**Conclusions**—Approximately 1 in 8 Americans 50 years have PNVI with 1 in 4 reporting concurrent FNVI. Demographic factors shown to be important in access to eye-care likely influence PNVI and utilization of near-vision correction in the US. As the majority of PNVI is

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likely correctable with spectacles, allocation of resources to provide corrective lenses to those in need likely has great public health implications.

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## Introduction

Near vision impairment (NVI) can adversely affect quality of life with studies demonstrating a correlation between poor near vision and difficulty with near tasks.<sup>1,2</sup> Prevalence of NVI increases with age<sup>3</sup>. Most NVI is due to optically correctable presbyopia as a result of progressive loss of accommodative amplitude in older adults. The prevalence of presbyopia has been estimated at nearly 80% by age 45–55 in North America<sup>3,4</sup> with an estimated 16% of these individuals without adequate correction.<sup>4</sup>

The vast majority of studies of vision impairment to date have focused on distance vision impairment and not NVI; near vision is not always assessed in population-based studies.<sup>5–8</sup> In addition, existing studies report findings in non-U.S. populations,<sup>1,2,9–12</sup> describe a non-nationally representative cohort,<sup>3</sup> or rely solely on patient report to identify NVI. Given the aging of the US population and increasing demand for adequate near vision for reading, smartphone, computer use, and other near tasks, an understanding of the prevalence of NVI is needed to help guide efforts to reduce this form of vision loss. We estimated the prevalence of presenting near vision impairment (PNVI) among people aged 50 years and older in the U.S. in a nationally representative sample and examined associations with socio-demographic characteristics.

## Methods

The National Health and Nutrition Examination Survey (NHANES) is a cross-sectional, ongoing survey of the health status of representative samples of the U.S. population that is performed by the National Center for Health Statistics, Center for Disease Control and Prevention in contiguous 2-year cycles. Participants undergo a home interview and a comprehensive physical examination in a Mobile Examination Center (MEC).

The 1999–2008 NHANES protocol was approved by the National Center for Health Statistics research ethics review board and written informed consent was obtained from all study participants. All data are de-identified and made publicly available by the National Center for Health Statistics.

Demographic data including age, sex, race/ethnicity, education, private health insurance status, access to health care and income were collected during the home interview. Private health insurance was defined as self-reported private insurance coverage. Access to health care was assessed by using the question “is there a place you usually go when you are sick or need advice about your health?” A response of “there is no place” was defined as no access to health care whereas a response of “yes” or “there is more than one place” was defined as having access to health care.

The vision examination component was conducted in the MEC. Distance visual acuity was measured for all participants aged 12 years. Presenting distance visual acuity (PDVA) was measured in each eye with the participant’s usual distance correction by using an

autorefractor containing built-in visual acuity charts (ARK-760, Nidek Co Ltd). PDVA was defined as the smallest line for which 4 or more characters were read correctly. Automated refraction of each eye was then performed and distance VA was re-measured for eyes with presenting PDVA of 20/30 or worse, aided by the autorefractor result to obtain corrected distance visual acuity (CDVA). Visual acuity of the better-seeing eye was used to categorize participants. Individuals whose PDVA was better than 20/40 were considered to have normal vision. Subjects were considered to have uncorrected refractive error (URE) if their PDVA was worse than or equal to 20/40 but improved to better than 20/40 post-refraction. Individuals with PDVA and CDVA worse than or equal to 20/40 were considered to have non-refractive distance visual impairment (DVI).

Presenting near vision (PNV) was measured for participants 50 years by using a near card with lines corresponding to 20/400 (line 1), 20/200, 20/63, 20/40, and 20/25 (line 5). The card was held at a comfortable reading distance (mean 16.6 inches, range 1–35 inches), measured in inches from the center of the near card to the examinee's brow, with both eyes open and the participant wearing his or her usual near correction, if available at the examination site. PNV was recorded as the smallest line on which 4 of 5 symbols were correctly read. Presenting near vision impairment (PNVI) was defined as near vision worse than 20/40 (i.e. could not read lines 4 and 5 on the near vision card). PNVI was further categorized into moderate and severe PNVI, where moderate PNVI was defined as PNV worse than 20/40 but better than 20/200 and severe PNVI was defined as PNV equal to or worse than 20/200. Self-reported use as well as the availability of near corrective lenses at the time of the examination were recorded for all participants.

Participants also rated their difficulty with near vision based on the answers to two questions, based on the National Eye Institute (NEI) Visual Functioning Questionnaire (VFQ-25)<sup>13</sup>, about near vision tasks: 1) reading newsprint or 2) doing work or hobbies requiring them to see well up close. Response options were “no”, “a little”, “moderate”, “extreme”, or “unable to do because of eyesight”. Functional near vision impairment (FNVI) was defined as a response of “moderate difficulty”, “extreme difficulty” or “unable to do because of eyesight” for either question. FNVI was also subdivided into moderate (“moderate difficulty” for either question) and severe categories (“extreme difficulty” or “unable to do because of eyesight” for either question).

All analyses were restricted to those aged 50 years or older. Given the NHANES complex probability sampling scheme, 10-year interview and exam weights computed by the National Center for Health Statistics were used to provide valid estimates for all analyses.<sup>14</sup> Stata version 12 (StataCorp, College Station, TX, USA) was used to calculate prevalence and 95% confidence interval estimates. Differences in prevalence were compared by using chi squared tests. Univariate and multivariable logistic regression models were used to determine demographic characteristics associated with PNVI and FNVI.  $P < 0.05$  was considered statistically significant.

## Results

A total of 12,781 individuals aged 50 years and older participated in NHANES 1999–2008. Of these, 1,765 (11.5%) were missing data for near visual acuity and 2,278 (13.8%) had missing data for either near visual acuity, distance visual acuity, or near vision functioning (Table 1). Those with missing data for any of the vision-related variables studied were significantly less likely to be of non-Hispanic White race/ethnicity, more likely to be older and female, to have less than high school education, to lack private health insurance and to be poor ( $p < 0.0001$  for all; Table 1). The only exception to this pattern was seen for near vision functioning, where men and women were equally likely to have missing data ( $p = 0.97$ ).

The overall prevalence of PNVI was 13.6% (95% CI, 12.6–14.7%) (Table 2). Prevalence of PNVI was higher among non-Hispanic Blacks (22.7%) and Mexican-Americans (26.6%), males (14.7%) and among those aged 80 years or older (30.1%), with less than high school education (27.4%), without private health insurance (21.5%), without access to healthcare (18.5%) and income below poverty level (28%) ( $P < 0.0001$  for all, Table 2). Compared with non-Hispanic Whites, the prevalence of PNVI was higher among non-Hispanic Blacks and Mexican Americans in all age groups for both males and females (Table 3). Additionally, prevalence of PNVI increased with increasing age among all race/ethnicity subgroups and for both sex groups ( $P < 0.0001$  for all, Table 3).

46.1% of individuals with PNVI used near vision spectacle correction at the time of the NHANES exam, and 33.1% reported using near vision correction but did not have corrective lenses at the time of the examination. 20.8% reported not using near correction. Among those with PNVI, use of near vision spectacles at time of examination increased with increasing age (OR 1.7, 95% CI 1.5–2.0, per 10 years older). The prevalence of PNVI was higher among those who reported using but did not have the corrective lenses at the time of the examination (50.7%, 95% CI 47.1–54.2) as well as among those who reported not using near corrective lenses (22.7%, 95% CI 19.5–26.3) compared to those that used them at time of examination (9.8%, 95% CI 8.9–10.8). This held true for all demographic subgroups (Table 2).

In multivariable analysis among those with PNVI, not using corrective near lenses was associated with non-White race/ethnicity (OR 1.8, 95% CI 1.4–2.3), younger age (OR 1.8, 95% CI 1.5–2.3), male sex (OR 1.6, 95% CI 1.1–2.4) and lack of access to health care (OR 2.5, 95% CI 1.4–4.7) but not education level, private health insurance, poverty or distance vision. Not having corrective lenses at the time of examination was associated with non-White race/ethnicity (OR 1.6, 95% CI 1.3–1.9), younger age (OR 1.9, 95% CI 1.6–2.2), male sex (OR 1.9, 95% CI 1.4–2.4) and less than high school education (OR 1.6, 95% CI 1.1–2.4). DVI was associated with lower odds of forgetting corrective near lenses at time of examination (OR 0.5 95% CI 0.3–0.7).

Among participants with PNVI, 13.9% also had URE and 17.1% also had DVI. Similarly 13.4% of participants with PNVI who used corrective near lenses at time of examination had URE. The prevalence of PNVI was higher among those with URE (25.8%, 95% CI 22.1–

30.0) and DVI (57.2%, 95% CI 51.7–62.5) than in those with normal distance vision (9.8%, 95% CI 8.9–10.8). This held true for all demographic subgroups (Table 2).

After multivariable adjustment, higher odds of PNVI was significantly associated with non-Hispanic Black and Mexican-American race/ethnicity, older age, male sex, less than high school education, lack of private health insurance, income less than 2 times poverty level, lacking or not using near vision correction at the time of examination, and impaired distance vision (URE and DVI). These associations held true for both moderate and severe levels of PNVI with the exception of severe PNVI where there was no significant difference in prevalence between men and women (Table 4). Additionally, all the above associations remained if subjects who forgot their near correction at the time of examination were assumed to not have PNVI (Table 5) with the exception of severe PNVI where there was no association with lack of private health insurance.

The overall prevalence of FNVI was 12.3% (95% CI, 11.4–13.2%) with 3.3% (95% CI 2.9–3.8%) of the total population having both PNVI and FNVI (Table 6). FNVI was present in 9.3% (95% CI 8.5–10.1%) of those without PNVI but was more prevalent among those with PNVI (25.9%, 95% CI 23.1–28.1%). This was true for all demographic subgroups (Table 6). The odds of FNVI was 3.4 (95% CI 3.0–4.0) times higher (2.3, 95% CI 1.9–2.8 after multivariable adjustment) in those with PNVI compare to those with normal near vision. Prevalence of FNVI was higher among non-Hispanic Blacks (15.9%) and Mexican-Americans (19.3%), females (13.1%) and among those aged 80 years or older (21.4%), with less than high school education (19.0%) and without private health insurance (17.5%) and income below poverty level (25.9%) ( $P < 0.0001$  for all, Table 6). In multivariable regression models (Table 7), higher odds of FNVI was associated with less than high school education, lack of private health insurance, income less than 2 times poverty level and impaired distance vision (both URE and DVI), while lower odds of FNVI was associated with older age (60 years and older vs those aged 50–59 years). These associations held true for both moderate and severe levels of FNVI with the exception of moderate FNVI, where there was no significant association with education and age greater than 80 years and severe FNVI where there was also no significant association with age greater than 80 years. Moderate FNVI was associated with lower odds of not using near vision correction while severe FNVI was associated with higher odds of not using near correction (Table 7).

## Discussion

We estimate that 1 in 8 individuals over the age of 50 in the U.S have PNVI. Non-White race/ethnicity, older age, male sex, lower educational level, lack of private health insurance and poverty were all significantly associated with higher risk of PNVI, suggesting access to eye care may play an important role in PNVI in the U.S.

The few studies of NVI conducted in developed countries report largely disparate prevalence rates due to varying definitions of NVI, protocols used, and differing population demographics.<sup>2,3,12</sup> Our estimated prevalence of PNVI in the US is much higher than that reported for the Finnish population<sup>2</sup> at 1.8% and the Australian population<sup>12</sup> at 2%. While the definition of presenting near vision impairment used for the Finnish study was somewhat

more conservative (20/80 or worse) than used in our study, the Australian study used N8 print size or approximately 20/50, similar to the cutoff used in the present study. Aside from demographic differences, these lower rates in Finland and Australia may reflect easier access to eye care in these countries. In the US, the Los Angeles Latino Eye Study (LALES) estimated unadjusted prevalence of presenting near vision impairment (20/40 or worse) from all causes at 24%<sup>3</sup>, which is comparable to our estimated rate of 26.6% for Mexican Americans. It is difficult to directly compare our results to those of other population-based studies conducted in the developing world.<sup>1,3,9-11</sup>

The prevalence of PNVI in the NHANES population was higher among individuals of non-White race/ethnicity and those with lower education, without private health insurance, without access to healthcare and income less than two times poverty level, suggesting poor access to eye care and lack of resources are significant contributing factors. Additionally, all above associations remained if subjects who forgot their glasses at time of examination assumed to not have PNVI. Though there are no previous reports with regards to near vision, studies of distance vision impairment have demonstrated similar associations.<sup>8,15</sup> Interestingly, the majority (83%) of participants with PNVI either had normal distance vision or URE. Though not a perfect surrogate, distance vision has been shown to correlate with near vision,<sup>2,12</sup> suggesting that the majority of PNVI in the US may indeed be corrected with spectacles as has been demonstrated in other studies.<sup>3</sup> Additionally, nearly 13% of participants with PNVI who used corrective near lenses at time of examination had URE suggesting a substantial portion of subjects with near correction may indeed be under corrected.

Over 50% of the US population over age 50 with PNVI did not use near correction or did not have near corrective lenses at the time of the exam. Not surprisingly, the rate of PNVI was much higher in these groups than those who used near corrective lenses. Not using near corrective lenses or not having them at the time of the exam was associated with younger age, male sex, lack of access to healthcare, and lower education. While this again implicates poor access to eye care as a potential cause of poor near vision, the association with younger age and male sex suggests lack of perceived impairment as a potential cause as well.

The prevalence of FNVI was approximately 3 fold higher in those with PNVI than without, indicating a substantial impact of PNVI on functioning. This is consistent with previous reports that have also shown an association between near vision and self-reported difficulty with near tasks.<sup>1,2</sup> However, it must be noted that a considerable portion of our population reported FNVI without presence of objective PNVI suggesting factors such as literacy (measured indirectly through education and poverty level) or other unmeasured variables may be playing a role. While similar to previous studies,<sup>2,3,12</sup> older age predicted higher odds of PNVI, the opposite was true for FNVI: we found lower odds of FNVI with older age. This suggests that PNVI in the younger population may have greater functional significance, as this group may be more likely to be engaging in near tasks. Alternatively the lower odds of FNVI in older age may be due to higher odds of near correction.

Our study is subject to a number of limitations. First, our results may have been influenced by nonparticipation. Though we adjusted for this by using sampling weights, missing data



was more likely in those of non-White race/ethnicity, older age, lower education level, and lacking private health insurance. As these same factors were associated with higher rates of PNVI in our study, the overall prevalence of PNVI was likely underestimated in the present study, but it is not clear if age and race-specific estimates were affected. Additionally, we included 1176 participants (8.7%) who reported using near correction but did not have them at time of examination. Not surprisingly, a large percentage of this group was found to have PNVI (50.7%). If these individuals are assumed to not have PNVI or are excluded from analysis the overall prevalence of PNVI decreases to 9.2% and 10.1% respectively. Though we feel it is important to include this group as habitual correction likely better reflects daily functioning at near, inclusion of these individuals increased the reported overall prevalence of PNVI. Additionally, NHANES measured near vision at the subject's preferred distance, which may have improved near acuity and underestimated PNVI. Again, we feel that this method of measurement likely better reflects current function and use of near corrective lenses. We were also unable to determine in this study what percentage of PNVI was correctable with spectacles, though analysis using distance vision status and experience from previous studies<sup>3</sup> suggest the majority may be correctable. Finally, intermediate visual acuity was not measured in this study. This has become increasingly relevant in the modern era as more near tasks involve use of computers<sup>16</sup> and is an interesting area for future research.

In conclusion, this is the first study to estimate the prevalence of PNVI in the United States. Our results suggest approximately 1 in 8 Americans over the age of 50 have some degree of PNVI with 1 in 4 of these reporting concurrent functional impairment. Additionally, demographic factors shown to be important in access to eye care likely influence PNVI. As most PNVI is correctable with simple reading glasses, allocation of resources to provide corrective lenses to those in need will likely have great public health and quality of life implications.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table 1**

Comparison of participants with missing and non-missing vision data, age 50+, NHANES 1999–2008.

	Near vision			Vision functioning, near tasks			Distance vision			Near vision, vision functioning, and distance vision		
	Complete, %	Missing, %	n	Complete, %	Missing, %	n	Complete, %	Missing, %	n	Complete, %	Missing, %	n
<b>Total % with missing data</b>	88.5	11.5	n=1765	98.0	2.0	n=441	87.2	12.8	n=10714	86.2	13.8	n=2278
<b>Race/ethnicity</b>												
Nonhispanic Black	9.0 <sup>b</sup>	11.0	9.0	20.3	8.8	12.1	8.7	12.7	8.7	12.1	8.7	12.7
Mexican-American	4.0	3.8	3.8	9.8	4.4	3.8	3.8	5.0	3.8	4.4	3.8	5.0
Nonhispanic White	79.1	72.9	78.8	58.0	79.4	71.2	79.7	70.1	79.7	71.2	79.7	70.1
Other <sup>c</sup>	7.9	12.3	8.4	12.0	7.9	12.3	7.8	12.2	7.8	12.3	7.8	12.2
		<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001		<i>P</i> <.0001		<i>P</i> <.0001
<b>Age</b>												
50–59	44.1	31.2	43.0	23.6	44.6	29.5	44.7	29.7	44.6	29.5	44.7	29.7
60–69	27.9	22.8	27.5	20.9	28.1	22.4	28.1	22.4	28.1	22.4	28.1	22.4
70–79	19.1	21.4	19.3	26.0	18.9	22.7	18.9	22.8	18.9	22.7	18.9	22.8
80+	8.9	24.5	10.3	29.5	8.5	25.5	8.3	25.1	8.3	25.5	8.3	25.1
		<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001		<i>P</i> <.0001		<i>P</i> <.0001
<b>Sex</b>												
Male	46.4	40.3	45.9	46.9	46.7	40.2	46.6	41.5	46.7	40.2	46.6	41.5
Female	53.4	59.7	54.29	53.1	53.3	59.8	53.4	58.5	53.3	59.8	53.4	58.5
		<i>P</i> <.0001			<i>P</i> =.97			<i>P</i> <.0001		<i>P</i> <.0001		<i>P</i> <.0001
<b>Education</b>												
<High School	22.4	32.5	22.8	59.9	21.5	34.2	21.5	36.2	21.5	34.2	21.5	36.2
High School	26.7	27.0	26.9	18.5	26.8	26.0	27.0	25.1	26.8	26.0	27.0	25.1
>High School	50.9	40.6	50.3	21.6	51.2	39.8	51.5	38.7	51.2	39.8	51.5	38.7
		<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001		<i>P</i> <.0001		<i>P</i> <.0001

	Near vision			Vision functioning, near tasks			Distance vision			Near vision, vision functioning, and distance vision		
	Complete, %	Missing, %	n	Complete, %	Missing, %	n	Complete, %	Missing, %	n	Complete, %	Missing, %	n
<b>Private health insurance<sup>d</sup></b>												
Any	67.6	52.9	1765	66.6	31.1	441	68.0	51.2	2067	68.5	49.7	2278
None	32.4	47.1		33.4	69.9		32.0	48.8		31.5	50.3	
		<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001	
<b>Access to health care<sup>e</sup></b>												
Yes	93.6	92.9		93.5	93.1		93.5	93.1		93.6	93.0	
No	6.4	7.2		6.5	6.9		6.5	6.9		6.5	7.0	
		<i>P</i> =0.44			<i>p</i> =0.86			<i>P</i> =0.60			<i>P</i> =0.54	
<b>Income<sup>f</sup></b>												
2x poverty level or above	69.52	56.5		68.6	36.4		70.1	54.2		70.4	52.9	
At and up to 2x poverty level	21.2	29.1		21.7	35.5		20.9	30.2		20.7	30.7	
Below poverty level	9.3	14.4		9.5	28.1		9.1	15.6		8.9	16.5	
		<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001			<i>P</i> <.0001	

<sup>a</sup>Unweighted n

<sup>b</sup>Percentages are computed using NHANES (National Health and Nutrition Examination Survey) interview weights. Interpretation of percentage for this cell: of those who have complete data, 9.0% are Nonhispanic Black

<sup>c</sup>Other race includes Asian or mixed race

<sup>d</sup>Defined as self-reported private health insurance coverage

<sup>e</sup>Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>f</sup>Defined using poverty income ratio, which accounts for family size

P values test global within group differences in percentage of missing data

**Table 2**  
Prevalence of presenting near vision impairment by refractive status, NHANES 1999–2008.

	Near vision correction				Distance vision			
	Overall, % (95% CI)	Near correction used for exam, % (95% CI)	Reports near correction use, not worn for exam, % (95% CI)	Does not report near correction use, % (95% CI)	Normal, % (95% CI)	Uncorrected refractive error, % (95% CI)	Visual impairment, % (95% CI)	
<b>Total with near vision impairment</b>		<b>n=8361 (78.7)<sup>a</sup></b>	<b>n=1172 (8.8)</b>	<b>n=1476 (12.5)</b>	<b>n=9067 (89.4)</b>	<b>n=985 (6.8)</b>	<b>n=651 (3.8)</b>	
	13.6 (12.6–14.7)	8.1 (7.3–9.0)	50.7 (47.1–54.2)	22.7 (19.5–26.3)	9.8 (8.9–10.8)	25.8 (22.1–30.0)	57.2 (51.7–62.5)	
<b>Race/ethnicity</b>								
Nonhispanic Black	n=2028	11.5 (9.6–13.6)	61.8 (55.3–67.9)	35.1 (29.6–41.1)	17.9 (16.2–19.9)	31.9 (25.4–39.2)	67.9 (55.9–77.9)	
Mexican-American	n=1869	26.6 (23.1–30.4)	10.3 (8.0–13.2)	66.7 (61.3–71.7)	42.5 (35.3–50.0)	42.2 (32.7–52.4)	61.5 (49.6–72.2)	
Nonhispanic White	n=6220	11.2 (10.1–12.4)	7.6 (6.7–8.5)	45.7 (40.5–51.1)	16.1 (12.7–20.1)	23.5 (19.1–28.6)	53.7 (47.5–59.8)	
	<i>P</i> <.0001	<i>P</i> =0.0001	<i>P</i> =0.02	<i>P</i> =0.0001	<i>P</i> <0.0001	<i>P</i> =0.0006	<i>P</i> =0.06	
<b>Age</b>								
50–59	n=3132	10.1 (8.9–11.4)	3.4 (2.6–4.4)	42.9 (38.0–48.0)	16.8 (13.2–21.1)	22.8 (16.4–30.8)	34.5 (17.6–56.5)	
60–69	n=3602	10.6 (9.3–12.02)	5.8 (4.8–6.9)	51.6 (45.1–58.1)	20.7 (15.6–27.0)	29.6 (22.1–38.3)	51.0 (37.4–64.6)	
70–79	n=2606	17.3 (15.5–19.3)	12.3 (10.6–14.2)	64.8 (56.3–72.5)	34.4 (27.1–42.5)	25.0 (19.8–31.0)	53.1 (43.5–62.4)	
80+	n=1676	30.1 (27.3–33.0)	23.4 (20.8–26.2)	79.4 (69.4–86.8)	60.8 (51.5–69.5)	27.3 (20.7–35.1)	66.3 (59.3–72.7)	
	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.5	<i>P</i> =0.009	
<b>Sex</b>								
Male	n=5509	14.7 (13.4–16.1)	7.8 (6.8–8.9)	51.5 (46.6–56.3)	23.2 (19.6–27.1)	29.8 (24.7–35.5)	57.1 (48.4–65.4)	
Female	n=5507	12.7 (11.6–13.9)	8.4 (7.5–9.4)	49.6 (44.1–55.1)	22.2 (17.9–27.2)	22.8 (17.4–29.3)	57.3 (50.7–63.6)	
	<i>P</i> =0.002	<i>P</i> =0.3	<i>P</i> =0.6	<i>P</i> =0.7	<i>P</i> <0.0001	<i>P</i> =0.1	<i>P</i> =0.97	
<b>Education</b>								
<High School	n=3911	27.4 (25.6–29.2)	16.0 (14.4–17.8)	71.2 (66.8–75.3)	45.8 (40.6–51.0)	40.4 (34.2–47.0)	64.2 (56.8–70.9)	
High School	n=2636	12.1 (10.6–13.8)	7.1 (6.0–8.2)	51.1 (44.4–57.8)	23.0 (16.8–30.6)	19.6 (14.8–25.4)	52.5 (43.4–61.5)	
>High School	n=4450	8.2 (7.2–9.3)	5.3 (4.4–6.4)	34.0 (27.6–41.0)	11.0 (8.1–14.8)	17.4 (12.2–24.1)	49.4 (38.3–60.6)	
	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.045	

	Near vision correction			Distance vision			Visual impairment, % (95% CI)
	Overall, % (95% CI)	Near correction used for exam, % (95% CI)	Reports near correction use, not worn for exam, % (95% CI)	Does not report near correction use, % (95% CI)	Normal, % (95% CI)	Uncorrected refractive error, % (95% CI)	
<b>Private health insurance<sup>c</sup></b>		n=8361 (78.7) <sup>d</sup>	n=1172 (8.8)	n=1476 (12.5)	n=9067 (89.4)	n=985 (6.8)	n=651 (3.8)
Any	n=6285	9.8 (8.8–10.8)	42.8 (37.8–47.9)	15.2 (12.1–18.8)	7.3 (6.5–8.2)	21.2 (16.3–27.1)	51.3 (44.4–58.2)
None	n=4731	21.5 (19.7–23.4)	61.3 (56.8–65.5)	35.9 (30.5–41.5)	15.7 (14.0–17.5)	31.2 (26.2–36.7)	63.3 (56.9–69.3)
		<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> =0.008	<i>P</i> =0.006
<b>Access to health care<sup>d</sup></b>							
Yes	n=10262	13.3 (12.3–14.4)	50.8 (47.1–54.5)	21.4 (18.3–24.8)	9.5 (8.6–10.4)	24.5 (20.7–28.6)	57.2 (51.6–62.6)
No	n=754	18.5 (14.4–23.4)	49.5 (32.4–66.7)	32.7 (23.6–43.5)	14.7 (11.1–19.2)	42.4 (27.8–58.5)	57.3 (35.6–76.5)
		<i>P</i> =0.009	<i>P</i> =0.2	<i>P</i> =0.01	<i>P</i> =0.003	<i>P</i> =0.02	<i>P</i> =0.99
<b>Income<sup>e</sup></b>							
2x poverty level or above	n=5649	9.3 (8.4–10.3)	42.3 (37.5–47.3)	14.6 (11.2–18.9)	7.2 (6.3–8.2)	22.2 (16.7–28.9)	47.5 (39.1–56.1)
At and up to 2x poverty level	n=2838	20.7 (18.6–23.0)	13.3 (11.3–15.6)	34.4 (28.2–41.2)	15.4 (13.3–17.7)	25.7 (20.5–31.8)	57.7 (48.7–66.3)
Below poverty level	n=1530	28.0 (24.7–31.6)	15.7 (12.6–19.3)	42.4 (35.2–49.9)	19.8 (16.6–23.5)	37.2 (27.9–47.5)	56.0 (50.5–61.3)
		<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> <.0001	<i>P</i> =0.02	<i>P</i> =0.005

<sup>a</sup> n denotes unweighted total number of participant in each category with weighted % in parentheses

<sup>b</sup> Prevalence percentage with 95% confidence intervals (CI), computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population. Interpretation of percentage for this cell: of those who are Nonhispanic Black, 22.7% have presenting near vision impairment (PNVI). PNVI defined as vision worse than 20/40 (cannot read 4th or 5th line of near vision chart) “Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

<sup>c</sup> Defined as self-reported private health insurance coverage

<sup>d</sup> Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>e</sup> Defined using poverty income ratio, which accounts for family size

P values test global within group differences in prevalence

NHANES = National Health and Nutrition Examination Survey

**Table 3**

Prevalence of presenting near vision impairment by age, sex and race/ethnicity, NHANES 1999–2008.

Overall	Nonhispanic Black % (95% CI)	Mexican-American % (95% CI)	Nonhispanic White % (95% CI)
50–59	18.0 (15.5–20.8)	22.9 (18.8–27.5)	7.3 (6.1–8.7)
60–69	22.1 19.1–23.4)	24.8 (21.6–28.3)	8.1 (6.7–9.8)
70–79	29.8 (25.5–34.4)	37.1 (30.1–44.8)	14.4 (12.4–16.7)
80+	42.2 (34.6–50.1)	43.5 (32.2–55.5)	27.3 (24.5–30.2)
	<i>P</i> <0.001	<i>P</i> <0.001	<i>P</i> <0.001
<b>Females</b>			
50–59	12.6 (9.6–16.3)	18.6 (15.3–22.4)	5.6 (4.1–7.6)
60–69	21.3 (17.6–25.6)	21.4 (17.3–26.2)	7.1 (5.4–9.2)
70–79	28.3 (22.0–35.6)	34.0 (26.1–42.9)	13.7 (11.4–16.5)
80+	40.7 (32.3–49.7)	46.1 (29.8–63.2)	24.8 (21.5–28.5)
	<i>P</i> <0.001	<i>P</i> <0.001	<i>P</i> <0.001
<b>Males</b>			
50–59	24.3 (20.3–28.8)	27.2 (20.7–34.7)	9.0 (7.2–11.2)
60–69	23.1 (18.8–28.0)	28.8 (24.2–33.9)	9.3 (7.4–11.5)
70–79	32.0 (25.4–39.3)	41.0 (32.5–50.1)	15.3 (12.3–19.0)
80+	45.6 (34.2–57.5)	40.2 (26.9–55.1)	31.3 (26.9–36.1)
	<i>P</i> =0.002	<i>P</i> =0.006	<i>P</i> <0.001

Prevalence percentage with 95% confidence intervals (CI) computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population.

Presenting near vision impairment defined as vision worse than 20/40 (cannot read 4th or 5th line of near vision chart)

“Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

P values test global within group differences in prevalence

NHANES = National Health and Nutrition Examination Survey

**Table 4**  
Multivariable Logistic Regression Analyses Predicting Presenting Near Vision Impairment

<b>Race/ethnicity</b>	<b>Near vision impairment OR (95% CI)</b>	<b>Moderate near vision impairment OR (95% CI)</b>	<b>Severe near vision impairment OR (95% CI)</b>
Nonhispanic White	1 (Reference)	1 (Reference)	1 (Reference)
Nonhispanic Black	1.6 (1.3–2.0)	1.6 (1.3–2.0)	1.6 (1.2–2.1)
Mexican-American	1.7 (1.3–2.2)	1.7 (1.3–2.3)	1.5 (1.1–2.1)
<b>Age</b>			
50–59	1 (Reference)	1 (Reference)	1 (Reference)
60–69	1.2 (0.9–1.5)	1.2 (0.9–1.5)	1.3 (0.9–1.8)
70–79	2.0 (1.6–2.6)	2.1 (1.6–2.8)	1.8 (1.3–2.6)
80+	3.4 (2.5–4.5)	3.4 (2.5–4.6)	3.4 (2.2–5.4)
<b>Sex</b>			
Female	1 (Reference)	1 (Reference)	1 (Reference)
Male	1.3 (1.1–1.5)	1.3 (1.1–1.5)	1.3 (0.9–1.7)
<b>Education</b>			
>=High School	1 (Reference)	1 (Reference)	1 (Reference)
<High School	1.6 (1.4–2.0)	1.6 (1.3–1.9)	1.8 (1.3–2.3)
<b>Private health insurance<sup>a</sup></b>			
Any	1 (Reference)	1 (Reference)	1 (Reference)
None	1.5 (1.2–1.8)	1.5 (1.2–1.8)	1.5 (1.1–2.1)
<b>Access to health care<sup>b</sup></b>			
Yes	1 (Reference)	1 (Reference)	1 (Reference)
No	1.0 (0.7–1.5)	1.0 (0.6–1.5)	1.0 (0.6–1.7)
<b>Income<sup>c</sup></b>			
2x poverty level or above	1 (Reference)	1 (Reference)	1 (Reference)
At and up to 2x poverty level	1.3 (1.1–1.6)	1.2 (1.1–1.5)	1.6 (1.1–2.2)
Below poverty level	1.5 (1.1–1.9)	1.4 (1.1–1.8)	1.8 (1.3–2.7)



	Near vision impairment OR (95% CI)	Moderate near vision impairment OR (95% CI)	Severe near vision impairment OR (95% CI)
<b>Near vision correction</b>			
Has corrective lenses	1 (Reference)	1 (Reference)	1 (Reference)
Has but did not have	15.5 (12.5–19.1)	13.0 (10.4–16.3)	23.6 (16.7–33.3)
Does not use	3.4 (2.6–4.4)	3.0 (2.3–3.9)	4.6 (3.1–6.8)
<b>Distance vision</b>			
Normal	1 (Reference)	1 (Reference)	1 (Reference)
Refractive error	1.9 (1.4–2.7)	1.7 (1.2–2.4)	2.7 (1.7–4.2)
Visual impairment	7.9 (5.9–10.5)	5.4 (3.8–7.7)	15.9 (11.2–22.6)

Odds ratio (OR) with 95% confidence intervals (CI) computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population.

Presenting near vision impairment defined as vision worse than 20/40 (cannot read 4th or 5th line of near vision chart)

“Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

<sup>a</sup>Defined as self-reported private health insurance coverage

<sup>b</sup>Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>c</sup>Defined using poverty income ratio, which accounts for family size

**Table 5**  
Multivariable Logistic Regression Analyses Predicting Presenting Near Vision Impairment, excluding forgetters

<b>Race/ethnicity</b>	<b>Near vision impairment OR (95% CI)</b>	<b>Moderate near vision impairment OR (95% CI)</b>	<b>Severe near vision impairment OR (95% CI)</b>
Nonhispanic White	1 (Reference)	1 (Reference)	1 (Reference)
Nonhispanic Black	1.7 (1.4–2.1)	1.7 (1.3–2.2)	1.8 (1.3–2.5)
Mexican-American	1.6 (1.2–2.2)	1.7 (1.2–2.3)	1.6 (1.1–2.3)
<b>Age</b>			
50–59	1 (Reference)	1 (Reference)	1 (Reference)
60–69	1.2 (0.9–1.6)	1.1 (0.8–1.5)	1.5 (0.9–2.4)
70–79	2.0 (1.5–2.7)	2.0 (1.4–2.9)	2.0 (1.3–3.1)
80+	3.3 (2.5–4.5)	3.2 (2.3–4.5)	3.9 (2.3–6.3)
<b>Sex</b>			
Female	1 (Reference)	1 (Reference)	1 (Reference)
Male	1.3 (1.1–1.5)	1.3 (1.1–1.6)	1.3 (0.9–1.8)
<b>Education</b>			
>=High School	1 (Reference)	1 (Reference)	1 (Reference)
<High School	1.5 (1.2–1.8)	1.4 (1.2–1.7)	1.8 (1.3–2.5)
<b>Private health insurance<sup>a</sup></b>			
Any	1 (Reference)	1 (Reference)	1 (Reference)
None	1.5 (1.2–1.9)	1.5 (1.2–2.0)	1.3 (0.9–1.8)
<b>Access to health care<sup>b</sup></b>			
Yes	1 (Reference)	1 (Reference)	1 (Reference)
No	1.2 (0.8–1.7)	1.2 (0.7–1.8)	1.2 (0.7–2.0)
<b>Income<sup>c</sup></b>			
2x poverty level or above	1 (Reference)	1 (Reference)	1 (Reference)
At and up to 2x poverty level	1.4 (1.1–1.8)	1.4 (1.1–1.8)	1.5 (0.9–2.2)
Below poverty level	1.5 (1.1–2.0)	1.4 (0.9–1.9)	1.7 (1.1–2.7)

	Near vision impairment OR (95% CI)	Moderate near vision impairment OR (95% CI)	Severe near vision impairment OR (95% CI)
<b>Near vision correction</b>			
Has corrective lenses	1 (Reference)	1 (Reference)	1 (Reference)
Does not use	3.3 (2.5–4.3)	2.9 (2.2–3.7)	4.6 (3.0–7.0)
<b>Distance vision</b>			
Normal	1 (Reference)	1 (Reference)	1 (Reference)
Refractive error	2.5 (1.8–3.4)	2.2 (1.5–3.3)	3.2 (1.9–5.5)
Visual impairment	8.8 (6.7–11.5)	6.2 (4.4–8.7)	17.2 (12.2–24.3)

Subjects who reported using near vision correction but did not have corrective lenses at the time of the examination were assumed to not have presenting near vision impairment (PNVI).

Odds ratio (OR) with 95% confidence intervals (CI) computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population.

PNVI defined as vision worse than 20/40 (cannot read 4th or 5th line of near vision chart)

“Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

<sup>a</sup>Defined as self-reported private health insurance coverage

<sup>b</sup>Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>c</sup>Defined using poverty income ratio, which accounts for family size

**Table 6**

Prevalence of functional near vision impairment, NHANES 1999–2008.

	Near vision impairment		
	Functional impairment % (95% CI)	No % (95% CI)	Yes % (95% CI)
<b>Total</b>	12.3 (11.4–13.2)	9.3 (8.5–10.1)	25.9 (23.1–28.1)
<b>Race/ethnicity</b>			
Nonhispanic Black	15.9 (14.2–17.8)	11.9 (10.3–13.8)	28.8 (24.4–33.6)
Mexican-American	19.3 (16.7–22.1)	14.8 (12.7–17.3)	27.4 (22.7–32.6)
Nonhispanic White	11.3 (10.4–12.3)	8.6 (7.7–9.5)	24.9 (21.5–28.7)
	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.2
<b>Age</b>			
50–59	12.5 (11.1–14.0)	11.3 (9.9–12.7)	21.9 (17.5–27.0)
60–69	9.0 (7.8–10.3)	7.0 (6.0–8.2)	24.6 (20.0–30.0)
70–79	11.6 (10.2–13.1)	7.1 (6.0–8.5)	24.6 (20.5–29.2)
80+	21.4 (19.2–23.8)	11.1 (8.4–14.4)	35.6 (30.4–41.1)
	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.0005
<b>Sex</b>			
Male	11.3 (10.3–12.4)	8.8 (7.8–9.8)	21.9 (18.6–25.7)
Female	13.1 (11.8–14.4)	9.7 (8.5–11.0)	29.9 (26.4–33.7)
	<i>P</i> =0.02	<i>P</i> =0.3	<i>P</i> =0.0007
<b>Education</b>			
<High School	19.0 (17.2–20.9)	13.6 (11.8–15.7)	31.0 (26.9–35.3)
High School	12.4 (10.8–14.3)	9.5 (8.0–11.2)	24.0 (19.5–29.3)
>High School	9.1 (8.0–10.3)	7.6 (6.6–8.8)	20.4 (16.3–25.1)
	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.002
<b>Private health insurance<sup>d</sup></b>			
Any	9.6 (8.7–10.7)	7.6 (6.7–8.6)	21.8 (18.6–25.5)
None	17.5 (16.0–19.1)	13.2 (11.6–14.9)	29.9 (26.1–34.0)

	Near vision impairment			
	Functional impairment % (95% CI)	Functional and near vision impairment % (95% CI)	No % (95% CI)	Yes % (95% CI)
	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> =0.003
<b>Access to health care<sup>b</sup></b>				
Yes	12.1 (11.3–13.0)	3.3 (2.9–3.7)	9.0 (8.3–9.8)	26.4 (23.1–28.8)
No	14.0 (10.4–18.6)	3.6 (2.5–5.3)	12.8 (8.8–18.2)	21.2 (14.5–29.9)
	<i>P</i> =0.3	<i>P</i> =0.6	<i>P</i> =0.06	<i>P</i> =0.2
<b>Income<sup>c</sup></b>				
2x poverty level or above	8.9 (7.9–9.9)	1.8 (1.5–2.1)	7.1 (6.3–8.2)	19.2 (15.9–23.0)
At and up to 2x poverty level	17.0 (15.6–18.5)	5.6 (4.7–6.6)	12.5 (10.7–14.4)	29.5 (24.8–34.7)
Below poverty level	25.9 (22.4–29.7)	9.4 (7.6–11.7)	21.4 (17.7–25.8)	37.4 (31.4–43.7)
	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> <0.0001	<i>P</i> <0.0001

Prevalence percentage with 95% confidence intervals (CI) computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population.

Presenting near vision impairment defined as vision worse than 20/40 (cannot read 4th or 5th line of near vision chart)

Functional near vision impairment defined as response of “moderate difficulty”, “extreme difficulty” or “unable to do because of eyesight” for either reading news print or doing near work.

“Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

<sup>a</sup>Defined as self-reported private health insurance coverage

<sup>b</sup>Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>c</sup>Defined using poverty income ratio, which accounts for family size

P values test global within group differences in prevalence

NHANES = National Health and Nutrition Examination Survey

**Table 7**  
Multivariable Logistic Regression Analyses Predicting Functional Near Vision Impairment

	Functional near vision impairment OR (95% CI)	Moderate functional near vision impairment, OR (95% CI)	Severe functional near vision impairment, OR (95% CI)
<b>Race/ethnicity</b>			
Nonhispanic White	1 (Reference)	1 (Reference)	1 (Reference)
Nonhispanic Black	1.1 (0.9–1.4)	0.9 (0.7–1.2)	1.3 (0.9–1.9)
Mexican-American	1.1 (0.8–1.4)	1.0 (0.8–1.3)	1.1 (0.7–1.7)
<b>Age</b>			
50–59	1 (Reference)	1 (Reference)	1 (Reference)
60–69	0.5 (0.4–0.6)	0.5 (0.4–0.7)	0.6 (0.4–0.8)
70–79	0.5 (0.4–0.6)	0.5 (0.4–0.7)	0.5 (0.3–0.7)
80+	0.7 (0.5–0.9)	0.7 (0.5–1.1)	0.7 (0.5–1.1)
<b>Sex</b>			
Female	1 (Reference)	1 (Reference)	1 (Reference)
Male	0.9 (0.8–1.1)	0.9 (0.7–1.1)	1.0 (0.7–1.3)
<b>Education</b>			
>=High School	1 (Reference)	1 (Reference)	1 (Reference)
<High School	1.3 (1.1–1.6)	1.2 (0.9–1.5)	1.7 (1.3–2.3)
<b>Private health insurance<sup>a</sup></b>			
Any	1 (Reference)	1 (Reference)	1 (Reference)
None	1.5 (1.2–1.8)	1.4 (1.1–1.8)	1.6 (1.2–2.1)
<b>Access to health care<sup>b</sup></b>			
Yes	1 (Reference)	1 (Reference)	1 (Reference)
No	1.1 (0.7–1.7)	1.0 (0.6–1.5)	1.3 (0.8–2.3)
<b>Income<sup>c</sup></b>			
2x poverty level or above	1 (Reference)	1 (Reference)	1 (Reference)
At and up to 2x poverty level	1.7 (1.4–2.0)	1.7 (1.4–2.2)	1.6 (1.2–2.2)



	Functional near vision impairment OR (95% CI)	Moderate functional near vision impairment, OR (95% CI)	Severe functional near vision impairment, OR (95% CI)
Below poverty level	2.5 (1.9–3.2)	2.3 (1.6–3.3)	2.9 (1.9–4.3)
<b>Near vision correction</b>			
Has corrective lenses	1 (Reference)	1 (Reference)	1 (Reference)
Has but did not have	1.0 (0.7–1.4)	1.0 (0.7–1.5)	1.0 (0.6–1.7)
Does not use	1.0 (0.8–1.3)	0.7 (0.5–0.9)	1.8 (1.3–2.4)
<b>Distance vision</b>			
Normal	1 (Reference)	1 (Reference)	1 (Reference)
Refractive error	1.8 (1.4–2.2)	1.5 (1.1–2.0)	2.4 (1.6–3.8)
Visual impairment	6.9 (5.4–8.9)	3.1 (2.1–4.5)	17.0 (12.0–24.0)

Odds ratio (OR) with 95% confidence intervals (CI) computed using mobile examination center (MEC) examination weights to provide estimates for the total US population and are age-standardized to the US 2000 Census population.

Functional near vision impairment defined as response of “moderate difficulty”, “extreme difficulty”, or “unable to do because of eyesight” for either reading newsprint or doing near work.

“Other” race/ethnicity is not reported because of small numbers and heterogeneous nature

<sup>a</sup>Defined as self-reported private health insurance coverage

<sup>b</sup>Defined as self-reported access to routine place for obtaining health care when sick or when needing advice regarding health

<sup>c</sup>Defined using poverty income ratio, which accounts for family size