Disparities in Eye Care Utilization Among the United States Adults With Visual Impairment: Findings From the Behavioral Risk Factor Surveillance System 2006-2009

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• PURPOSE: To estimate the prevalence of annual eye care among visually impaired United States residents aged 40 years or older, by state, race/ethnicity, education, and annual income.

• DESIGN: Cross-sectional study.

• METHODS: In analyses of 2006-2009 Behavioral Risk Factor Surveillance System data from 21 states, we used multivariate regression to estimate the state-level prevalence of yearly eye doctor visit in the study population by race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other), annual income (≥$35 000 and <$35 000), and education (< high school, high school, and > high school).

• RESULTS: The age-adjusted state-level prevalence of yearly eye doctor visits ranged from 48% (Missouri) to 69% (Maryland). In Alabama, Colorado, Indiana, Iowa, New Mexico, and North Carolina, the prevalence was significantly higher among respondents with more than a high school education than among those with a high school education or less ($P < .05$). The prevalence was positively associated with annual income levels in Alabama, Georgia, New Mexico, New York, Texas, and West Virginia and negatively associated with annual income levels in Massachusetts. After controlling for age, sex, race/ethnicity, education, and income, we also found significant disparities in the prevalence of yearly eye doctor visits among states.

• CONCLUSION: Among visually impaired US residents aged 40 or older, the prevalence of yearly eye examinations varied significantly by race/ethnicity, income, and education, both overall and within states. Continued and possibly enhanced collection of eye care utilization data, such as we analyzed here, may help states address disparities in vision health and identify population groups most in need of intervention programs. (Am J Ophthalmol 2012;154:S45–S52. © 2012 by Elsevier Inc. All rights reserved.)

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VISUAL IMPAIRMENT HAS BEEN ASSOCIATED WITH poor self-reported health status and restricted activity,[1] increased risk of falling and fear of falling,[2–4] social isolation,[5] and increased risk for death.[6] Among US residents aged 18 years or older, visual impairment ranks among the top 10 disabilities.[7] In 2000, more than 3.4 million Americans aged 40 years or older were visually impaired or blind, and this figure is projected to reach 5.5 million by 2020.[8] However, at least 50% of cases of blindness or visual impairment could be prevented by early detection and timely treatment.[9] According to a recent report, in 2007, visual impairment was a $51.4 billion annual burden to the US economy,[10] including the burden of vision problems to the US economy at $16 billion[11] and the financial burden of visual impairment and blindness to individual caregivers and other healthcare payers at $35.4 billion.[12]

The US population is becoming older and more racially and ethnically diverse. By 2030, about 1 in 5 US residents is expected to be aged 65 years or older.[13] And projections indicate that by 2050, 54% of US residents will be members of racial/ethnic minority groups[13] (ie, groups other than non-Hispanic whites), up from 34% in 2008.[14] In addition, the minorities have a higher prevalence rate of visual impairment and eye disease than non-minorities.[15,16] Given these demographic changes, the number of Americans with visual impairment and major eye disease is likely to continue increasing.[8]

People must have access to eye care services and then actually use the services if their eye conditions are to be detected and treated. However, not all US residents have sufficient access to these services, and US disparities in eye care utilization by race/ethnicity, education, and income are well documented.[17–22]

Most US vision-related studies have used national data sources, such as the National Health Interview Survey, the National Health and Nutrition Examination Survey, or the Medical Expenditure Panel Survey.[17] Results of the

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only study to report state-level estimates of the prevalence of self-reported visual impairment, eye disease, and use of eye care services[20] (from 5 states) showed wide variation in the state-level prevalence of self-reported visual impairment.

If state public health officials are to tailor vision health interventions to population groups most in need of them, they need to better understand state-level disparities in vision health and eye care utilization. In this study, we sought to identify state-level racial/ethnic and socioeconomic disparities in eye care utilization among visually impaired adults aged 40 years or older by analyzing 2006–2009 Behavioral Risk Factor Surveillance System (BRFSS) data from 21 states.

METHODS

• **DATA SOURCE:** The BRFSS collects data through continuous, random digit-dialed surveys of noninstitutionalized US civilians aged 18 years or older. Surveys are conducted by all 50 states, the District of Columbia, Puerto Rico, the Virgin Islands, and Guam. Survey participants are selected through a multistage cluster-design procedure. The BRFSS is de-identified publicly available data, exempt from institutional review board (IRB) approval. Details about its purpose, sampling design, data collection, and reporting are available elsewhere.[23]

The BRFSS survey currently contains more than 20 modules that address specific health concerns, including the Visual Impairment and Access to Eye Care module (the vision module). Since 2006, the vision module has been conducted among respondents aged 40 or older. Questions in the module address visual impairment, eye disease, access to eye care, eye care insurance, and eye examination frequency. From 2006 through 2009, 21 states administered the vision module. Eleven states (Arizona, Colorado, Florida, Maryland, Massachusetts, Missouri, New Mexico, North Carolina, Texas, West Virginia, and Wyoming) did so once, and 10 states (Alabama, Connecticut, Georgia, Indiana, Iowa, Kansas, Nebraska, New York, Ohio, and Tennessee) did so at least twice. Our study sample consisted of 28 129 respondents to the vision module during this period who reported having moderate to severe visual impairment. Sample sizes by state varied among states, ranging from 493 (West Virginia) to 3097 (Ohio). From the years 2006 to 2009, Ohio State conducted the BRFSS vision module every year, yet West Virginia only conducted this module in 2007. Median states' response rates, the percentage of persons who completed interviews among all eligible persons among states for BRFSS during that period, ranged from 48.2% to 52.5%; median states' cooperation rates, the percentage of persons who completed interviews among all eligible persons who were contacted, ranged from 73.3% to 75.0%.[24]

• **OUTCOME OF INTEREST:** Our outcome of interest was eye care utilization as measured by annual eye examination based on the recommended eye examination frequency for adults at risk.[25,26] The eye care utilization question was "When was the last time you had your eyes examined by any doctor or eye care provider?" Response options were "within the past month," "within the past year," "within the past 2 years," "2 or more years ago," or "never." In our analyses, we dichotomized these responses into having/not having had an examination in the previous year.

We determined respondents' visual impairment status on the basis of their responses to 2 questions about their visual acuity: "How much difficulty, if any, do you have in recognizing a friend across the street?" and "How much difficulty, if any, do you have reading print in newspapers, magazines, recipes, menus, or numbers on the telephone?" We classified those who answered "no difficulty" or "little difficulty" to both questions as not having moderate to severe visual impairment and those who answered "moderate difficulty," "extreme difficulty," "unable to do because of eyesight," or "blind" to either of the questions as having such impairment. Only those individuals with moderate to severe visual impairment were included in the analysis because they are our interested study group.

Race/ethnicity categories were non-Hispanic white, non-Hispanic black, Hispanic, and other; educational attainment categories were less than high school, high school, and more than high school; annual household income categories were ≥$35 000 and <$35 000; and age categories were 40 to 64 years and 65 years or older. Region, defined by 4 categories (South, West, Northeast, and Midwest), was based on US Census Bureau state and county federal information processing standard (FIPS) codes, which are a standardized set of numeric or alpha-

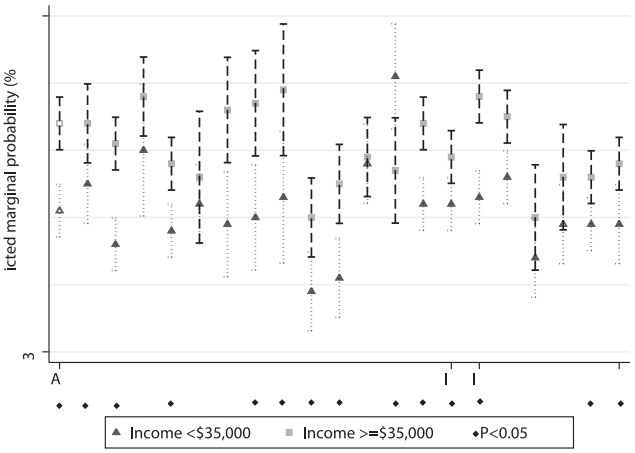

FIGURE. Proportions of adults with moderate to severe visual impairment having a yearly eye doctor visit, by state and income, represented by predicted marginal probabilities estimated from the logistic regression model adjusted for age, sex, race/ethnicity, and education. Wald *P* value with 48 degrees of freedom for state × income interaction was .007.

TABLE 1. Selected Characteristics of the US Adult Population Aged 40 or Older With Moderate to Severe Visual Impairment, Behavioral Risk Factor Surveillance System, 2006–2009

Characteristics	%	95% Confidence Interval	Unweighted N	Weighted N
Age				
40-64 years	73.5	[72.5,74.4]	18 178	8 000 000
≥65 years	26.5	[25.6,27.5]	9951	2 800 000
Sex				
Male	42.8	[41.6,44.1]	9511	4 600 000
Female	57.2	[55.9,58.4]	18 618	6 200 000
Race/ethnicity				
Non-Hispanic white	72.3	[71.2,73.4]	21 756	7 800 000
Non-Hispanic black	11.8	[11.1,12.5]	3253	1 300 000
Hispanic	11.5	[10.6,12.5]	1830	1 200 000
Other	4.4	[3.9,5.0]	973	470 000
Educational attainment				
<High school	16.8	[15.8,17.9]	4520	1 800 000
High school	33.7	[32.6,34.7]	10 339	3 600 000
≥High school	49.5	[48.3,50.7]	13 236	5 400 000
Annual income				
<$35 000	49.6	[48.4,50.9]	13 665	4 700 000
≥$35 000	50.4	[49.1,51.6]	10 523	4 700 000
Total[a]	100.0		28 129	10 800 000

[a]The totals for the various categories of characteristics are not the same because not all respondents answered every question.

betic codes issued by the National Institute of Standards and Technology to ensure uniform identification of geographic entities through all federal government agencies.[27]

• **ANALYSIS:** We described selected characteristics of the adult population aged 40 years or older with moderate to severe visual impairment. We also estimated the state-level age-adjusted prevalence of yearly eye doctor visits by race/ethnicity, annual income, and education level using cross-tabulations. Estimates were age-standardized to the year 2000 US Census population using 2 age groups: 40 to 64 years and ≥65 years.[28] To assess the extent to which disparities in the prevalence of yearly visits associated with race/ethnicity, income, and education varied by state of residence, we tested for 2-way interactions between state and each of these demographic variables using multivariate logistic regression adjusted for all covariates. We only reported predicted marginal probabilities for significant interactions which were presented in the Figure. Predicted marginal probabilities are a type of direct standardization where the predicted values from the logistic regression models are averaged over the covariate distribution in the population.[29]

We used SAS.9.2 (SAS Institute, Cary, North Carolina, USA) software for data management and SUDAAN 9.0 (Research Triangle Institute, Research Triangle Park, North Carolina, USA) and Stata 10.1 (Stata Corp, College Station, Texas, USA) for analyses, accounting for the complex survey design of BRFSS. Taylor linearization was used for calculating standard errors.[30] We considered differences in results to be significant if $P < .05$.

RESULTS

THE PREVALENCE OF MODERATE TO SEVERE VISUAL IMPAIRment among US adults aged 40 years and older was 15.5% in 2006–2009. Of survey participants who reported moderate to severe visual impairment, 26.5% were aged 65 or older, 72.3% were non-Hispanic whites, and almost 50% had more than a high school education and an annual income ≥$35 000 (Table 1). Overall, approximately 58% (95% confidence interval [CI] = 57%-59%) reported having visited an eye doctor within the previous year; by state, the percentage who reported having done so ranged from 48% (95% CI = 44%-53%) in Missouri to 69% (95% CI = 64%-74%) in Maryland (Table 2).

• **DISPARITIES IN EYE CARE UTILIZATION:** Racial/ethnic disparities in the prevalence of yearly eye doctor visits varied by state (Table 2). For example, in Massachusetts, the prevalence of such visits was significantly higher among Hispanics (80%; 95% CI = 68%-91%) than among non-Hispanic whites (60%; 95% CI = 54%-67%), whereas in North Carolina, the prevalence was lowest among Hispanics (30%; 95% CI = 14%-

TABLE 2. Age-adjusted Proportion[a] of Yearly Eye Doctor Visits Among the US Adult Population Aged 40 or Older With Moderate to Severe Visual Impairment, for Each State by Race/Ethnicity

		Total		Non-Hispanic White		Non-Hispanic Black		Hispanic		Other		
Region[b]	State	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	*P* Value[c]
South	Alabama	57	[54–60]	57	[54–60]	57	[52–62]	N/A[d]	N/A[d]	59	[42–76]	.792
	Florida	62	[58–66]	60	[55–65]	68	[56–80]	63	[54–73]	65	[50–81]	.832
	Georgia	55	[52–58]	55	[52–57]	57	[51–63]	N/A[d]	N/A[d]	52	[37–68]	.922
	Maryland	69	[64–74]	66	[60–72]	74	[65–83]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	.706
	North Carolina	55	[52–57]	55	[52–59]	57	[50–64]	30	[14–47]	47	[33–62]	.011
	Tennessee	54	[49–59]	52	[47–57]	57	[42–72]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	.091
	Texas	59	[54–64]	56	[49–64]	66	[56–77]	64	[55–73]	N/A[d]	N/A[d]	.635
	West Virginia	55	[50–60]	56	[51–61]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	.774
West	Arizona	61	[54–68]	59	[51–67]	N/A[d]	N/A[d]	59	[44–74]	N/A[d]	N/A[d]	.425
	Colorado	49	[45–53]	50	[46–54]	N/A[d]	N/A[d]	39	[29–49]	N/A[d]	N/A[d]	.071
	New Mexico	51	[47–55]	55	[50–61]	N/A[d]	N/A[d]	45	[38–51]	55	[43–66]	.011
Northeast	Connecticut	60	[57–64]	59	[55–63]	66	[53–78]	68	[57–79]	74	[59-89]	.636
	Massachusetts	63	[58–68]	60	[54–67]	N/A[d]	N/A[d]	80	[68–91]	N/A[d]	N/A[d]	.004
	New York	60	[58–63]	60	[57–63]	57	[48–65]	62	[54–70]	61	[49–73]	.795
Midwest	Indiana	55	[52–58]	55	[52–58]	44	[34–54]	68	[51–85]	73	[57–88]	.059
	Iowa	62	[58–65]	62	[59–65]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	.105
	Kansas	63	[60–66]	63	[60–66]	54	[41–68]	61	[46–76]	67	[54–81]	.318
	Missouri	48	[44–53]	48	[43–53]	54	[41–66]	N/A[d]	N/A[d]	N/A[d]	N/A[d]	.959
	Nebraska	53	[49–58]	53	[48–58]	N/A[d]	N/A[d]	37	[14–60]	N/A[d]	N/A[d]	.135
	Ohio	54	[51–57]	53	[50–55]	61	[53–69]	55	[37–72]	61	[48–74]	.309
	Wyoming	55	[52–59]	56	[52–59]	N/A[d]	N/A[d]	53	[37–69]	N/A[d]	N/A[d]	.454
Total		58	[57–59]	57	[55–58]	60	[57–63]	61	[57–65]	61	[56–67]	.446

[a]Proportions were estimated from cross-tabulations, age-standardized to the year 2000 US Census population.

[b]Region was based on US Census Bureau State FIPS Codes.

[c]*P* values were derived from x^2 tests with 3 degrees of freedom.

[d]N/A indicates the estimate was not available, the sample size was <50, or the relative standard error was >0.30.

47%) and highest among non-Hispanic blacks (57%; 95% CI = 50%-64%).

In Alabama, Colorado, Indiana, Iowa, New Mexico, and North Carolina, study participants with more than a high school education were significantly more likely to report having visited an eye doctor in the previous year than were those with less education. In Alabama, Georgia, Massachusetts, New Mexico, New York, Texas, and West Virginia, the prevalence of annual eye doctor visits was significantly higher among people with annual incomes of at least $35 000 than among those making less, whereas in Massachusetts, it was significantly higher among those with annual incomes below $35 000 (73% vs 56%) (Table 3).

When controlled for age, sex, race/ethnicity, education, and income, results of the test of the state-by-income interaction showed significant disparities in the prevalence of yearly eye doctor visits and variation in income levels among the states ($P = .007$). As shown in the Figure, state-level predicted marginal probabilities of having had an eye examination in the previous year ranged from 39% (Colorado) to 71% (Massachusetts) among those with annual incomes <$35 000 and from 50% (Colorado and Missouri) to 69% (Arizona) among those with annual incomes ≥$35 000. In all states except Massachusetts, respondents in the higher income category were more likely to have had an eye doctor visit within the previous year.

DISCUSSION

USING 2006–2009 BRFSS DATA, WE FOUND THAT THE PREVALence of eye doctor visits within the previous year among US residents aged 40 or older with moderate to severe vision impairment varied among states participating in the surveys, as well as by race/ethnicity, education, and income.

Prevalence rates were lowest in Colorado, Missouri, and New Mexico, possibly at least in part because of relatively low population densities in these states. Results from previous studies have shown that people who live in rural areas tend to have lower rates of dilated eye examinations than those who live in urban areas[31] and that many rural areas may not have sufficient eye care providers or vision rehabilitation services.[32] However; state population density is not consistently predictive of annual eye care prevalence rates. For example, the rate

TABLE 3. Age-adjusted Proportion[a] of Yearly Eye Doctor Visits Among the US Adult Population Aged 40 or Older With Moderate to Severe Visual Impairment, for Each State by Education and Annual Income

		Education							Annual Income				
		<HS		HS		>HS			<$35 000		≥$35 000		
Region[b]	State	%	95% CI	%	95% CI	%	95% CI	*P* Value[c]	%	95% CI	%	95% CI	*P* Value[d]
South	Alabama	47	[41–53]	58	[53–62]	62	[58–66]	.015	52	[49–56]	64	[60–69]	.005
	Florida	53	[42–64]	61	[54–67]	65	[60–70]	.211	58	[52–63]	67	[61–73]	.336
	Georgia	51	[44–57]	52	[47–56]	60	[56–63]	.122	47	[43–51]	62	[58–66]	<.001
	Maryland	69	[55–84]	70	[61–78]	69	[62–75]	.699	63	[54–73]	72	[66–77]	.547
	North Carolina	44	[37–51]	51	[47–56]	61	[57–65]	.006	49	[45–54]	59	[54–63]	.201
	Tennessee	45	[36–55]	55	[47–62]	58	[50–67]	.67	52	[45–59]	58	[48–67]	.971
	Texas	56	[44–67]	55	[45–65]	63	[56–71]	.525	50	[43–57]	65	[55–74]	.028
	West Virginia	49	[39–59]	53	[45–61]	62	[55–70]	.345	49	[43–56]	68	[61–76]	.043
West	Arizona	59	[41–76]	56	[44–69]	63	[54–73]	.938	55	[44–66]	71	[62–81]	.204
	Colorado	30	[20–39]	48	[41–55]	52	[47–57]	.011	41	[35–46]	52	[47–58]	.315
	New Mexico	42	[34–51]	47	[40–54]	57	[51–62]	.021	45	[39–50]	58	[52–64]	.005
Northeast	Connecticut	69	[59–80]	57	[51–63]	61	[56–65]	.137	59	[53–65]	59	[55–64]	.089
	Massachusetts	73	[61–85]	59	[48–70]	63	[56–70]	.41	73	[66–80]	56	[47–64]	<.001
	New York	52	[44–60]	59	[54–63]	64	[60–67]	.071	55	[51–59]	66	[62–70]	.015
Midwest	Indiana	42	[34–51]	57	[52–61]	57	[53–62]	.016	52	[48–56]	58	[54–63]	.647
	Iowa	51	[39–63]	57	[52–62]	68	[64–72]	.033	50	[44–55]	66	[62–71]	.014
	Kansas	53	[43–64]	60	[55–65]	66	[62–70]	.171	56	[51–61]	66	[62–70]	.685
	Missouri	43	[33–54]	43	[36–50]	54	[47–61]	.078	45	[39–51]	49	[42–56]	.97
	Nebraska	61	[46–75]	49	[42–56]	55	[48–62]	.413	49	[42–56]	56	[49–63]	.735
	Ohio	50	[42–58]	50	[46–54]	58	[55–62]	.092	49	[45–53]	57	[53–61]	.532
	Wyoming	54	[41–67]	52	[47–58]	58	[54–63]	.399	48	[42–54]	58	[54–63]	.809
Total		52	[48–56]	55	[53–57]	62	[60–63]	<.001	52	[51–54]	62	[60–64]	<.001

CI = confidence interval; HS = high school.

[a]Proportions were estimated from cross-tabulations, age-standardized to the US 2000 Census population.

[b]Region was based on US Census Bureau State FIPS Codes.

[c]*P* values were derived from χ^2 tests with 2 degrees of freedom.

[d]*P* values were derived from χ^2 tests with 1 degree of freedom.

in Wyoming (population density: 5.1 people per square mile) was about the same as that in Ohio (population density: 277 people per square mile).[33] To understand the geographic variation in vision health and access to eye care and the cause of the variation, further studies documenting the patients' own characteristics and the performance of individual clinicians, medical groups, hospitals, and health plans are needed.

In all states that administered the vision module, except Massachusetts, the prevalence of annual eye examinations was positively associated with both education level and income level, associations consistent with those found in previous studies.[18–20,34] Lack of awareness regarding vision health remains a major problem, especially among people at lower income and education levels—those at highest risk for vision impairment.[35] In addition, out-of-pocket costs for eye care may make access to eye care prohibitive for people at low income levels.

One possible reason for our unexpected finding that Massachusetts residents with annual incomes below $35 000 were more likely to have visited an eye doctor in the previous year than those with higher annual incomes may be that Massachusetts has expanded MassHealth, the state Medicaid program; created health insurance exchanges; and required all residents to purchase health insurance while subsidizing premiums or providing tax credits for those with low incomes.[36] In addition, Massachusetts specifically provided vision care for adults with family income <300% of poverty,[37] which may be serving to increase adult residents' access to eye care. Massachusetts has the lowest proportion of uninsured people of any state on the country, and residents' access to health care has increased substantially since the purchase of health insurance was mandated by state law in 2006.[38,39] Consistent with our findings, results from a previous study showed that low-income people in Massachusetts were more likely to have had a doctor visit in 2006–2007.[37] However, Massachusetts has not eliminated the income-related disparities in eye care utilization.[40] Additional studies are needed to understand why some people with moderate to severe visual impairment do not see an eye doctor as often as they should. In addition, quality of care should be considered as previous study had examined the efficiency of health providers in caring for patients with chronic illness and found more frequent use of hospital and physician services is not associated with better performance on functional outcomes or

satisfaction with care. Therefore, further research is warranted to assess whether variation in annual eye care prevalence rates is associated with variation in visual outcomes and satisfaction.[41]

Our results showing that, in some states, Hispanics and non-Hispanic blacks were less likely to have visited an eye doctor in the previous year than non-Hispanic whites were consistent with results of previous studies.[18,23,42] However, we did not find this to be true in all states; for example, in Massachusetts, we found the prevalence of such visits to be higher among Hispanics than among non-Hispanic whites, again possibly because Massachusetts' health insurance mandate has increased insurance coverage among Hispanics and reduced financial barriers to all types of health care.

Surveys such as the BRFSS vision module are important tools with which to assess vision health and eye care utilization at the state level. However, only 21 states administered the vision module during 2006–2009, and only 11 states did so more than once during this period. If state-level policy makers with limited resources and competing priorities are to make informed decisions about which demographic groups should be targeted by health care assistance policies, they need access to state-level data that define the most vulnerable populations within their state so that they can tailor strategies to reach those most at risk. As we attempted to demonstrate here, state-level surveys such as the BRFSS Vision Module can be an important source of such data.

Our study is subject to at least 3 limitations. First, our results are not representative of the entire population of visually impaired US adults aged 40 or older because only 21 states and no US territories administered the vision module during the study period and because BRFSS surveys exclude people without land-line telephones (who tend to have lower incomes and are less likely to receive preventive care than people with land-line telephones[43]) and those who are incarcerated. Second, given that all data were derived from self-reports of survey participants, their accuracy may have been affected by recall bias or by social desirability bias (which might cause people to claim that their vision is better than it is or that they visit eye care professionals more often than they actually do). Third, respondents might have relocated from one state to another in the 12 months prior to the survey, introducing a bias toward the null in terms of state differences.

Among people aged 40 or older with visual impairment, we found state-level disparities in eye care utilization by race/ethnicity, annual income, and education level. State health officials need reliable state-level data (such as that collected via the BRFSS vision module) as a basis for determining their state's vision health priorities, identifying disparities in vision health and access to vision care, and establishing effective intervention programs that target groups most in need of services. More research may be needed to assess geographic variation in visual health and eye care utilization at the state, regional, and national level for eliminating disparities in vision health to improve vision health for the nation.

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Biosketch

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