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The impact of social determinants of health on eye care utilization in a national sample of people with diabetes

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Abstract

Objective or Purpose: To evaluate the association of social determinants of health (SDoH) with eye care utilization among people with diabetes mellitus using the 2013–2017 National Health Interview Survey (NHIS).

Design: Retrospective cross-sectional study

Subjects, Participants, and/or Controls: Participants ≥18 years of age with self-reported diabetes

Methods, Intervention, and/or Testing: SDoH in the following domains were used: 1) economic stability, 2) neighborhood, physical environment, and social cohesion, 3) community and social context, 4) food environment, 5) education, and 6) health care system. An aggregate SDoH score was calculated and divided into quartiles with Q4 representing those with the highest adverse SDoH burden. Survey-weighted multivariable logistic regression models evaluated the association of SDoH quartile with eye care utilization in the preceding 12 months. A linear trend test was conducted. Domain specific mean SDoH scores were calculated, and the performance of domain specific models were compared using area under the curve (AUC).

Main Outcome Measure: Eye care utilization in the preceding 12 months

Results—Of 20,807 adults with diabetes, 43% had not utilized eye care. Greater adverse SDoH burden was associated with decrements in odds of eye care utilization ($p<0.001$ for trend).

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Conflicts of Interest

None of the authors

Participants in the highest quartile of adverse SDoH burden (Q4), had 59% lower odds (OR 0.41, 95% CI 0.37–0.46) of eye care utilization than those in Q1. The domain specific model using economic stability had the highest performing AUC (0.63, 95% CI 0.62 to 0.64).

Conclusions—Among a national sample of people with diabetes, adverse SDoH were associated with decreased eye care utilization. Evaluating and intervening upon the effects of adverse SDoH may be a means by which to improve eye care utilization and prevent vision loss.

Precis

Adverse social determinants of health across multiple domains were associated with decreased eye care utilization among a nationally representative sample of people with diabetes mellitus.

INTRODUCTION

Social determinants of health (SDoH) are the conditions in which people live, work, and play and the wider set of social structures and economic systems that shape the conditions of daily living.[1] Several frameworks exist that organizes SDoH into various domains.[1,4,5] The Kaiser Family Foundation is one of these frameworks and divides SDoH into domains of economic stability, neighborhood, physical environment, and social cohesion, community and social context, food environment, education, and health care system.[5] Mounting evidence indicates that SDoH affect health outcomes, possibly to a greater degree than medical care.[2,3] Diabetic retinopathy, the ophthalmic manifestation of diabetes mellitus, is no exception to the impacts of SDoH. Studies have demonstrated the role of employment status, educational attainment, and income in the prevalence of diabetic retinopathy.[6,7] The same adverse SDoH that are associated with more prevalent diabetic retinopathy have also been associated with underutilization of eye care services.[8–10] Underutilization of eye care is a major risk factor for vision loss from diabetic retinopathy as it can lead to missed opportunities for the early detection and prompt intervention of vision-threatening complications.[10,11] The American Academy of Ophthalmology recommends, at a minimum, annual eye examinations for the screening and follow-up of diabetic retinopathy.[12] Despite these national guidelines, eye care utilization among patients with diabetes ranges anywhere between 15% to 77%.[13–15]

There is a paucity of ophthalmic literature that evaluates a multidimensional set of SDoH in a nationally representative sample. Existing studies either only focus on a specific population or includes a limited set of SDoH.[6,10,16] Understanding the most impactful SDoH can help guide further interventions to address SDoH on the national level. The purpose of this study was to evaluate the association of a comprehensive set of SDoH using the Kaiser Family Foundation framework with eye care utilization among a nationally representative sample of adults with diabetes mellitus.

METHODS

Study Design / Data Source

This was a retrospective study of pooled data from the 2013–2017 National Health Interview Survey (NHIS). NHIS is a cross-sectional household interview survey conducted by the

National Center for Health Statistics, part of the Centers for Disease Control and Prevention, of the civilian noninstitutionalized people residing in the 50 states and in the District of Columbia.[17] The multistage area probability sampling of this survey adjusts for nonresponse and allows for national representativeness. Adults ≥18 years of age with self-reported diabetes during the study period were included. (Supplemental Material) All methods adhered to the declaration of Helsinki. The study was considered exempt by the Johns Hopkins University Institutional Review Board, as the data are publicly available and de-identified.

Variables

Social Determinants of Health—We used the SDoH framework as outlined by the Kaiser Family Foundation.[5] A list of 55 questions were used to represent 33 SDoH variables in the following 6 domains: 1) economic stability, 2) neighborhood, physical environment, and social cohesion, 3) community and social context, 4) food environment, 5) education, and 6) health care system.[18] Each variable was dichotomized for analysis and the higher value assigned to represent the more adverse SDoH (e.g., uninsured as compared to insured). (Supplemental Material) The aggregate SDoH score across all years of the survey was summed and divided into quartiles with the lowest quartile (Q1) representing the participants with the least adverse SDoH burden and Q4 with the highest adverse SDoH burden. We also calculated a domain specific SDoH score as the mean SDoH score within each of the 6 domains.

Eye Care Utilization—The outcome was self-reported eye care utilization in the preceding 12 months. Participants were considered to have had eye care utilization if they responded “Yes” to the following question “During the past 12 months, have you seen or talked to an optometrist, ophthalmologist, or eye doctor (someone who prescribes eyeglasses) about your own health?”[16] (Supplemental Material)

Statistical Analysis

Survey weights provided by NHIS were employed in all analyses to account for the complex design of the NHIS. Summary statistics were used to describe participant characteristics stratified by eye care utilization status. Pearson’s $\chi 2$ test was used to compare categorical variables. The analyses were divided into three parts focused on: 1) individual SDoH variables, 2) adverse SDoH quartile with sensitivity analyses, and 3) domain specific SDoH scores.

Part 1: The association of each SDoH variable with eye care utilization was calculated using logistic regression in univariable models, and multivariable models adjusted for race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, or Hispanic), age (18–44, 45–64, or 65+); sex (male or female), geographic region (Northeast, Midwest, South, or West), Charlson Comorbidity index (CCI)), vision impairment (yes or no), and year of the survey.[19] (Supplemental Material) The CCI is a composite measure representing the overall health of the patient with a higher scores indicating sicker patients.[19] Missing responses for most SDoH variables were minimal, ranging from <1% to 9% of unweighted

respondents, with the exception of one variable on the inability to pay for medical bills that had a 81% missing response.

Part 2: The association of the adverse SDoH quartile with eye care utilization was analyzed in a similar fashion in univariable and multivariable models. A linear trend test was conducted by adjusted estimates after estimation to evaluate the linear relationship between increasing adverse SDoH quartile and eye care utilization. An F-test was performed to evaluate the significance of an interaction term between race/ethnicity and adverse SDoH quartile. Sensitivity analyses were performed on the multivariable models to stratify rather than adjust by race/ethnicity. This was done to avoid the inappropriate operationalization of race/ethnicity as proxies for socioeconomic status. Additional sensitivity analyses were performed on the multivariable models by representing aggregate SDoH score as a continuous variable centered at the sample mean, rather than quartiles, and with an interaction term between race/ethnicity and aggregate SDoH score. Sub-analyses were performed to evaluate the association between adverse SDoH quartile and eye care utilization in multivariable models among patients with Type 1 diabetes and those with Type 2 diabetes. (Supplemental Material)

part 3: Summary statistics were provided to describe the domain specific SDoH scores. A set of separate multivariable logistic regression models were constructed to evaluate the association between each of the 6 domain specific SDoH scores with eye care utilization. The performance of each model was evaluated using ten-fold crossvalidation to generate the mean area under the receiver operating curve (AUC) and its associated 95% Confidence Interval (CI). The AUC of each domain model was compared to the AUC of the base model with only covariates using a nonparametric approach that utilizes the theory developed for generalized U-statistics.[20] The resulting test statistic follows an asymptotic chi-squared distribution ($\chi 2$ test).[20] Sensitivity analyses were performed to evaluate the domain specific models stratified by race/ethnicity. Sub-analyses were also performed among patients with Type 1 diabetes and those with Type 2 diabetes. All analyses were performed using Stata (StataCorp, College Station, TX, USA, Stata/SE Version 16.1).

RESULTS

A total of 20,807 individuals representing 27.5 million adults with diabetes mellitus were included in the study. (Table 1) Most participants were older than 45 years, and there was a roughly equal distribution of males and females. By race/ethnicity, 64% were non-Hispanic White, 16% non-Hispanic Black, 5% non-Hispanic Asian, and 17% Hispanic. In the lowest SDoH quartile (representing the group with the least adverse SDoH burden), there were more non-Hispanic White (75%) participants as compared to the overall sample. In the highest quartile (representing the group with the highest adverse SDoH burden), there were more non-Hispanic Black (20%) and Hispanic (30%) participants as compared to the overall sample. (Supplemental Table 2) About half the participants did not utilize eye care in the preceding 12 months. (Table 1)

Adverse SDoH in all six domains were associated with lack of eye care utilization in the preceding 12 months. (Table 3) Greater adverse SDoH burden, as represented by the

adverse SDoH quartile, was associated with decrements in odds of eye care utilization ($p<0.001$ for trend). (Table 4) In multivariable analysis, participants in the highest quartile of adverse SDoH burden (Q4), had an estimated 58% decreased odds (OR 0.42, 95% CI 0.37 to 0.47) of eye care utilization as compared to those with the least adverse SDoH burden (Q1). In stratified analysis, results were consistent across race/ethnic groups. Among non-Hispanic White persons, the highest quartile of adverse SDoH burden was associated with an estimated 57% decrease odds (OR 0.43, 95% CI 0.37 to 0.50) of eye care utilization, 52% (OR 0.48, 95% CI 0.37 to 0.62) among non-Hispanic Black persons, 90% (OR 0.10, 95% CI 0.04 to 0.24) among non-Hispanic Asian persons, and 65% (OR 0.35, 95% CI 0.26 to 0.49) among Hispanic persons. (Table 4) In the sub-analysis, greater adverse SDoH burden was associated with decreased odds of eye care utilization among participants with Type 1 diabetes (representing 7% of the weighted sample) as well as Type 2 diabetes (83%). (Supplemental Table 5)

The F-test did not show a significant interaction between race/ethnicity and SDoH quartile ($p=0.31$). However, in sensitivity analyses using aggregate SDoH score as a continuous variable in the multivariable model, there was a statistically significant interaction between race/ethnicity and aggregate SDoH score but only for the non-Hispanic Asian group. (Supplemental Table 6)

The average domain specific SDoH score was 0.35 (standard deviation (SD) 0.23) for economic stability, 0.28 (SD 0.32) for neighborhood, physical environment, and social cohesion, 0.07 (SD 0.25) for community and social context, 0.15 (SD 0.36) for food environment, 0.69 (SD 0.20) for education, and 0.05 (SD 0.10) for health care system. In analyses comparing the domain specific SDoH models, the model with the domain of economic stability had the highest AUC (0.63, 95% CI 0.62 to 0.64) as compared to other domains. (Table 7) In stratified analysis of each of the domain specific models, results were similar across race/ethnic groups. (Table 7) Results were also similar in the sub-analyses among participants with Type 1 diabetes as well as Type 2 diabetes. (Supplemental Table 8)

DISCUSSION

This study of multidimensional SDoH in a nationally representative sample of people with diabetes demonstrates the substantial impact of SDoH on eye care utilization. Increasing burden of adverse SDoH was associated with lower eye care utilization, a finding that was consistent across race and ethnic groups. Comparing between the SDoH domains, economic stability had a stronger association with eye care utilization as compared to the domains of neighborhood, physical environment, and social cohesion; community and social context; food environment; education; and health care system. These associations suggest possible areas of focus for screening or interventions to promote eye care utilization among people with diabetes.

We found an association between underutilization of eye care and adverse SDoH in all domains of the Kaiser Family Foundation framework. These adverse determinants have been previously linked either underutilization of health care or poor health outcomes. In our study, the neighborhood, physical environment, social support, and social cohesion

domain included questions on housing, and social cohesion within the neighborhood. Poor housing conditions has been associated with lower odds of eye care utilization among a sample of Washington, D.C. Medicaid beneficiaries with diabetes.[10] Studies in the broader diabetes literature suggest that less social support can be associated with worse glycemic control.[4] The domain of community and social context included questions representing psychological distress. Psychological distress has been linked to poor outcomes including all-cause mortality, cardiovascular disease, and cancer mortality among adults with and without diabetes.[21] The domain of food environment included questions on hunger and food insecurity. Food insecurity is a risk factor for poor diabetes management and adverse health outcomes as people might resort to more affordable energy-dense foods that directly raise serum glucose or divert necessary financial resources to purchase food.[4,22] The domain of education included questions on language, educational attainment, and use of health information technology. Lower educational attainment has been associated with poor vision outcomes and visual difficulties across multiple studies.[23] Lastly, the domain of health care system included questions on health coverage, provider availability, and quality of care. Health coverage, in the form of insurance, is a major risk factor for vision outcomes and eye care utilization.[23,24] Interestingly, the health care system domain included the greatest number of questions that were not significantly associated with eye care utilization, particularly some of the ones centered around provider availability. It could be that these questions reflected the availability of the individual's primary care or other providers and were not specific to their eye care provider.

In comparing AUCs from different SDoH domains, we found that the model with the domain specific SDoH score for economic stability outperformed models that included other domains. The domain of economic stability included survey questions on employment status, family income, medical bills, overall financial distress, and cost-related medication underuse. Numerous studies have demonstrated an association between lower family income, difficulty paying medical bills, and cost-related medication underuse with worse health outcomes and underutilization of health care, including eye care.[23,25,26] It could be that economic stability, as represented by this specific set of questions, operates slightly upstream of the other SDoH domains. One's family income and employment status certainly impacts quality of housing and physical environment (represented in the domains of neighborhood, physical environment, and social cohesion), type of neighborhood that one lives in (community and social context), food security (food environment), use of health information technology (education), and health coverage (health care system).

The negative impact of aggregate adverse SDoH burden on eye care utilization was similar across race and ethnic groups. We did not find a differential association of adverse SDoH by race and ethnicity in our primary analysis but did detect one in the sensitivity analysis.[27] We chose to represent aggregate adverse SDoH burden using quartiles in the primary analysis because it is a way to assess the general impact of SDoH while accounting for the interactions between factors.[18,28,29] There are some limitations to representing SDoH in this fashion. It assumes that each SDoH included in the score has an equal impact which may not be the case. However, despite the limitations, this metric has been used previously and has been associated with other negative health outcomes including stroke, vaccination, and hospitalization among others.[28–31] There could be several reasons for not

finding a difference in the interaction of race and ethnicity with adverse SDoH quartile. Since the power needed to detect statistically significant effect modification is higher than what is needed for a pairwise comparison, our sample could be underpowered to detect such a difference.[32] It could be that specific adverse SDoH have a differential impact by race and ethnicity, for example annual family income, while others do not.[27] By grouping SDoH together and representing it in quartiles for analysis, we could be reducing our ability to detect specific differences. The significant finding of aggregate adverse SDoH score, represented as a continuous variable, with race and ethnicity in the sensitivity analysis was entirely driven by the non-Hispanic Asian group. This group had very few respondents, particularly in the higher quartiles (with only 54 in quartile 4) which could be contributing to measurement error. This analysis calls attention to the need to further investigate the impact of adverse SDoH on eye care utilization among the non-Hispanic Asian community.

The underutilization of eye care with greater adverse SDoH burden impacted both patients with Type 1 and Type 2 diabetes. Although Type 1 and Type 2 diabetes have distinct pathophysiology and affect different patient populations, having more adverse SDoH appears to be a barrier to eye care in both groups. This is perhaps not surprising as adverse SDoH has been shown to negatively impact care across multiple diseases.[40] SDoH also impacts many aspects of diabetes care and not just vision health.[4,9] It is possible that specific patient populations and types of health care are more sensitive to certain SDoH than others, for example having someone accompany patients to office visits appears to be critical among those who have vision impairment.[41] However, because SDoH are interconnected, much more work is needed to isolate the effects of a given adverse SDoH independent of other SDoH.

This work emphasizes the interconnectedness of SDoH and their impact on health outcomes. Screening and addressing the impacts of adverse SDoH should consider the multidimensionality of these determinants.[10,33] Effective screening should be a balance between feasibility of the survey but simultaneously assessing multiple domains. Our work suggests that questions in each of the domains evaluated would be appropriate for such a screening tool. Although many standardized multidimensional SDoH collection tools exist, some customizations and additions are likely needed to tailor the screening to the population and health outcome of interest.[34,35] For example, quality of care was associated with eye care utilization but is often not represented in standard multidimensional evaluations of SDoH. Other studies have shown the association of diabetic retinopathy education and knowledge with eye care utilization, but again, most standard SDoH questionnaires do not contain ophthalmic-specific data.[26,36,37] More work should be done to construct the ideal screening SDoH tool that is appropriate for ophthalmic use. Ultimately, addressing adverse SDoH and connecting patients to needed services could be a means by which to improve eye care utilization among people with diabetes and prevent vision loss.

This study has several limitations. Due to the nature of the NHIS, the study relies on self-reported data. Although self-reported eye care utilization has been used in previous studies, the degree to which self-reported eye care utilization corresponds to actual utilization has not been directly studied. It is also unknown whether self-reported eye care utilization corresponds to receipt of a diabetic eye examination as the NHIS survey question includes

glasses prescription as an indication for eye care utilization. Additionally, the recommended frequency of diabetic eye examinations depends on the severity of eye disease.[12,38] We do not know if the self-reported utilization of eye care within the past 12 months is appropriate for that individual's level of eye disease, since that level of granularity is not included in this dataset. The definition of appropriate utilization used for this study reflects the most general recommendation of annual eye examinations.[12] Lastly, we were constrained by the survey questions used by the NHIS. Some of the questions used to represent specific SDoH variables might not be the most commonly used across studies. For example, the National Academy of Medicine, formerly known as the Institute of Medicine, recommends a single question to assess for food insecurity that asks respondents the amount of food the household has to eat.[39] For this study, a series of 10 questions were used to assess for food insecurity that also included details such as the number of days the respondent had to skip meals or not eaten for a whole day. Although both these sets of questions represent the concept of food insecurity, the use of distinct questions might generate artificial differences that make it challenging to compare between studies. Despite these limitations, this is among the few studies to examine the association of multidimensional SDoH and eye care utilization among a national sample, thus maximizing generalizability.

In conclusion, increasing burden of adverse SDoH has a progressively negative association with eye care utilization in a nationally representative sample of adults with diabetes mellitus. Evaluating and addressing multidimensional adverse SDoH could be a means by which to improve eye care utilization and prevent vision loss in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1:

Demographic characteristics of participants in the 2013–2017 National Health Interview Survey (NHIS) with self-reported diabetes mellitus stratified by self-reported eye care utilization in the preceding 12 months.

	Overall	No eye care utilization	Eye care utilization	p value
	N (Weighted %)	N (Weighted %)	N (Weighted %)	
Sample (N)	20807	8762	12045	
Weighted sample, (weighted %)	27467169 (100)	11755196 (43)	15711973 (57)	
Age category				<0.001
18 to 44	2469 (14)	1450 (20)	1019 (10)	
45 to 64	8466 (45)	3910 (48)	4556 (43)	
65 and older	9872 (41)	3402 (32)	6470 (47)	
Sex				0.650
Male	9679 (51)	4113 (51)	5566 (50)	
Female	11128 (49)	4649 (49)	6479 (50)	
Race/ethnicity				<0.001
Non-Hispanic White	12466 (64)	4877 (60)	7589 (67)	
Non-Hispanic Black	3707 (16)	1663 (16)	2044 (15)	
Non-Hispanic Asian	585 (5)	217 (3)	368 (4)	
Hispanic	3181 (17)	1612 (21)	1569 (14)	
Region				<0.001
Northeast	3364 (17)	1245 (15)	2119 (19)	
Midwest	4356 (22)	1693 (21)	2663 (23)	
South	8148 (40)	3658 (41)	4490 (38)	
West	4939 (21)	2166 (23)	2773 (20)	
Comorbidities				<0.001
CCI = 1	11393 (58)	5170 (62)	6223 (54)	
CCI ≥ 2	9414 (42)	3592 (38)	5822 (46)	
Vision impairment				<0.001
No	16556 (81)	7119 (83)	9437 (79)	
Yes	4245 (19)	1639 (17)	2606 (21)	
Survey Year				0.004
2013	4143 (19)	1851 (19)	2292 (18)	
2014	4458 (19)	1995 (20)	2463 (18)	
2015	4196 (19)	1797 (20)	2399 (19)	
2016	4407 (21)	1699 (20)	2708 (22)	
2017	3603 (22)	1420 (21)	2183 (23)	

Abbreviations: CCI = Charlson Comorbidity Index

Table 3:

The association of each social determinants of health (SDoH) variable with eye care utilization in the past 12 months.

	No eye care utilization	Eye care utilization	Unadjusted		Adjusted*	
	N (Weighted %)	N (Weighted %)	OR (%95 CI)	p value	OR (95% CI)	p value
Economic Stability						
Never or previously employed	5491 (58)	8199 (64)	1.25 (1.16, 1.35)	<0.001	0.85 (0.78, 0.93)	0.001
No sick leave	3895 (48)	4563 (40)	0.71 (0.65, 0.77)	<0.001	0.75 (0.69, 0.81)	<0.001
Low family income	5548 (62)	6039 (48)	0.55 (0.51, 0.6)	<0.001	0.54 (0.49, 0.59)	<0.001
Difficulty paying medical bills	2034 (24)	1955 (17)	0.64 (0.58, 0.7)	<0.001	0.71 (0.64, 0.79)	<0.001
Unable to pay medical bills	1214 (59)	1062 (54)	0.83 (0.69, 0.99)	0.035	0.83 (0.68, 1.00)	0.047
High Financial Distress Composite Score	2551 (32)	2573 (23)	0.63 (0.58, 0.69)	<0.001	0.74 (0.67, 0.81)	<0.001
Cost-related medication nonadherence	1353 (19)	1262 (11)	0.54 (0.48, 0.61)	<0.001	0.61 (0.54, 0.69)	<0.001
Foregone/delayed care due to cost	1938 (22)	1669 (15)	0.60 (0.55, 0.66)	<0.001	0.67 (0.61, 0.75)	<0.001
Neighborhood, physical environment, and social cohesion						
Renting (vs. owned home)	3667 (37)	3858 (27)	0.62 (0.57, 0.67)	<0.001	0.72 (0.66, 0.79)	<0.001
Disagree: people in neighborhood help each other	1918 (24)	2186 (18)	0.73 (0.67, 0.79)	<0.001	0.79 (0.72, 0.87)	<0.001
Disagree: people in neighborhood can be trusted	1867 (23)	2007 (16)	0.66 (0.60, 0.72)	<0.001	0.74 (0.67, 0.82)	<0.001
Disagree: this is a close-knit neighborhood	3208 (40)	4212 (36)	0.85 (0.79, 0.91)	<0.001	0.90 (0.84, 0.97)	0.008
Disagree: people in neighborhood I can count on	1820 (23)	2054 (17)	0.69 (0.63, 0.76)	<0.001	0.78 (0.71, 0.86)	<0.001
Community and social context						
Psychological distress (Kessler K6 Scale)	671 (8)	693 (6)	0.70 (0.60, 0.80)	<0.001	0.76 (0.64, 0.88)	0.001
Food Insecurity						
Food Insecurity	1614 (17)	1502 (11)	0.58 (0.52, 0.64)	<0.001	0.65 (0.58, 0.73)	<0.001
Education						
English language proficiency (not well/not at all)	722 (10)	672 (6)	0.60 (0.52, 0.7)	<0.001	0.66 (0.55, 0.81)	<0.001
<=High school	4042 (41)	4431 (32)	0.69 (0.64, 0.74)	<0.001	0.66 (0.61, 0.72)	<0.001
Health Information Technology use: Did not look up health info on internet	5780 (64)	7349 (58)	0.76 (0.70, .83)	<0.001	0.67 (0.61, 0.73)	<0.001
Health Information Technology use: Filled a prescription online	7879 (91)	10598 (87)	0.63 (0.55, 0.71)	<0.001	0.60 (0.52, 0.70)	<0.001
Health Information Technology use: Scheduled a healthcare appointment online	8053 (93)	11012 (90)	0.65 (0.55, 0.76)	<0.001	0.60 (0.50, 0.71)	<0.001
Health Information Technology use: Communicated with healthcare provider online	7912 (91)	10638 (87)	0.62 (0.54, 0.71)	<0.001	0.58 (0.50, 0.67)	<0.001
Health Information Technology use: Used internet chat rooms to learn about health	8280 (97)	11644 (96)	0.79 (0.63, 1.00)	0.047	0.73 (0.57, 0.93)	0.01

	No eye care utilization	Eye care utilization	Unadjusted		Adjusted*	
	N (Weighted %)	N (Weighted %)	OR (%95 CI)	p value	OR (95% CI)	p value
Health care system						
Uninsured	984 (12)	371 (3)	0.25 (0.21, 0.29)	<0.001	0.33 (0.28, 0.39)	<0.001
No usual source of care	561 (7)	221 (2)	0.27 (0.22, 0.33)	<0.001	0.35 (0.28, 0.44)	<0.001
Trouble finding a doctor/provider in past 12 months	344 (4)	350 (3)	0.72 (0.59, 0.88)	0.002	0.77 (0.62, 0.95)	0.015
MD's office does not accept you as new patient in past 12 months	280 (3)	349 (3)	0.97 (0.80, 1.17)	0.726	1.06 (0.87, 1.30)	0.58
MD's office does not accept your insurance in past 12 months	341 (4)	446 (4)	0.99 (0.82, 1.18)	0.897	1.11 (0.92, 1.35)	0.266
Delayed medical care: couldn't get through on phone	293 (3)	415 (4)	1.07 (0.87, 1.32)	0.513	1.15 (0.93, 1.44)	0.198
Delayed medical care: couldn't get appointment soon enough	680 (8)	989 (9)	1.03 (0.90, 1.18)	0.687	1.10 (0.95, 1.26)	0.206
Delayed medical care: wait too long at MD's office	582 (7)	694 (6)	0.89 (0.76, 1.04)	0.137	0.96 (0.81, 1.13)	0.632
Delayed medical care: not open when you could go	293 (4)	402 (4)	0.98 (0.78, 1.22)	0.855	1.05 (0.83, 1.33)	0.665
Delayed medical care: no transportation	427 (4)	480 (3)	0.80 (0.67, 0.95)	0.011	0.80 (0.66, 0.96)	0.019
Somewhat/very dissatisfied (quality) or no healthcare in past year	1065 (14)	734 (6)	0.42 (0.37, 0.48)	<0.001	0.48 (0.42, 0.56)	<0.001

Abbreviations: OR = odds ratio; CI = confidence interval

*Adjusted by age, sex, race/ethnicity, geographic region, Charlson Comorbidity Index, year of the survey, and vision impairment.

Table 4.

The association of adverse social determinants of health (SDoH) quartile with eye care utilization in the overall model and models stratified by race and ethnicity.

		No eye care utilization	Eye care utilization	Unadjusted		Adjusted *	
Race	***SDoH quartile***	**N (weighted %)**	**N (weighted %)**	**OR (95% CI)**	**p value**	**OR (95% CI)**	**p value**
Overall	Ql	2478 (32)	4839 (45)	Reference		Reference	
	Q2	1883 (20)	2832 (22)	0.78 (0.70, 0.85)	<0.001	0.70 (0.63, 0.77)	<0.001
	Q3	2261 (24)	2574 (20)	0.57 (0.52, 0.63)	<0.001	0.57 (0.51, 0.63)	<0.001
	Q4	2140 (24)	1800 (14)	0.40 (0.36, 0.45)	<0.001	0.42 (0.37, 0.47)	<0.001
	p for trend				<0.001		<0.001
Non-Hispanic White	Q1	1713 (39)	3572 (51)	Reference		Reference	
	Q2	1124 (22)	1844 (23)	0.81 (0.72, 0.91)	0.001	0.73 (0.64, 0.83)	<0.001
	Q3	1108 (21)	1361 (16)	0.61 (0.53, 0.69)	<0.001	0.59 (0.51, 0.67)	<0.001
	Q4	932 (19)	812 (10)	0.43 (0.37, 0.5)	<0.001	0.44 (0.38, 0.51)	<0.001
	p for trend				<0.001		<0.001
Non-Hispanic Black	Q1	340 (23)	579 (33)	Reference		Reference	
	Q2	360 (19)	458 (20)	0.72 (0.55, 0.96)	0.023	0.65 (0.49, 0.87)	0.004
	Q3	507 (31)	549 (27)	0.60 (0.46, 0.78)	<0.001	0.54 (0.41, 0.71)	<0.001
	Q4	456 (27)	458 (20)	0.52 (0.39, 0.68)	<0.001	0.47 (0.35, 0.62)	<0.001
	p for trend				<0.001		<0.001
Non-Hispanic Asian	Q1	94 (42)	175 (60)	Reference		Reference	
	Q2	46 (22)	97 (22)	0.69 (0.31, 1.56)	0.376	0.46 (0.21, 1.03)	0.06
	Q3	50 (23)	69 (14)	0.44 (0.21, 0.94)	0.034	0.37 (0.16, 0.85)	0.02
	Q4	27 (13)	27 (3)	0.18 (0.07, 0.51)	0.001	0.12 (0.04, 0.39)	<0.001
	p for trend				0.001		0.001
Hispanic	Q1	227 (16)	325 (25)	Reference		Reference	
	Q2	286 (17)	333 (21)	0.79 (0.53, 1.16)	0.227	0.67 (0.45, 1.01)	0.055
	Q3	483 (29)	487 (30)	0.64 (0.45, 0.91)	0.012	0.57 (0.40, 0.82)	0.003
	Q4	616 (38)	424 (25)	0.41 (0.29, 0.57)	<0.001	0.37 (0.26, 0.53)	<0.001
	p for trend				<0.001		<0.001

*Overall model is adjusted by age, sex, geographic region, race/ethnicity, Charlson Comorbidity Index, year of the survey, and vision impairment; stratified models are adjusted by age, sex, geographic region, Charlson Comorbidity Index, year of the survey, and vision impairment.

Abbreviations: OR = odds ratio; CI = confidence interval

Table 7:

Comparing the performance of multivariate models using area under the curve (AUC) with the domain specific adverse social determinants of health (SDoH) score, in the overall and stratified by race and ethnicity.

Race	Model	AUC (95% CI)	p value
Overall	Base model only *	0.612 (0.604, 0.620)	
	Base model with economic stability	0.637 (0.630, 0.645)	<0.001
	Base model with neighborhood, physical environment, and social cohesion	0.617 (0.609, 0.625)	0.001
	Base model with community and social context	0.616 (0.608, 0.624)	0.005
	Base model with food Insecurity	0.616 (0.608, 0.624)	0.002
	Base model with education	0.626 (0.618, 0.633)	<0.001
	Base model with health care system	0.617 (0.609, 0.625)	<0.001
Non-Hispanic White	Base model only *	0.600 (0.590, 0.610)	
	Base model with economic stability	0.632 (0.622, 0.642)	<0.001
	Base model with neighborhood, physical environment, and social cohesion	0.607 (0.597, 0.617)	0.001
	Base model with community and social context	0.604 (0.594, 0.614)	0.006
	Base model with food Insecurity	0.608 (0.598, 0.618)	<0.001
	Base model with education	0.615 (0.605, 0.625)	<0.001
	Base model with health care system	0.604 (0.594, 0.615)	0.005
Non-Hispanic Black	Base model only *	0.591 (0.573, 0.610)	
	Base model with economic stability	0.609 (0.591, 0.627)	0.003
	Base model with neighborhood, physical environment, and social cohesion	0.593 (0.575, 0.612)	0.576
	Base model with community and social context	0.596 (0.578, 0.615)	0.811
	Base model with food Insecurity	0.588 (0.570, 0.607)	0.508
	Base model with education	0.607 (0.589, 0.625)	0.001
	Base model with health care system	0.595 (0.577, 0.613)	0.125
Non-Hispanic Asian	Base model only *	0.607 (0.559, 0.655)	
	Base model with economic stability	0.628 (0.581, 0.675)	0.203
	Base model with neighborhood, physical environment, and social cohesion	0.626 (0.579, 0.674)	0.196
	Base model with community and social context	0.615 (0.567, 0.663)	0.290
	Base model with food Insecurity	0.607 (0.559, 0.655)	0.941
	Base model with education	0.630 (0.583, 0.677)	0.154
	Base model with health care system	0.614 (0.566, 0.662)	0.580
Hispanic	Base model only *	0.640 (0.621, 0.659)	
	Base model with economic stability	0.663 (0.644, 0.682)	<0.001
	Base model with neighborhood, physical environment, and social cohesion	0.642 (0.623, 0.661)	0.499
	Base model with community and social context	0.642 (0.623, 0.661)	0.912
	Base model with food Insecurity	0.642 (0.623, 0.661)	0.320
	Base model with education	0.650 (0.631, 0.669)	0.025
	Base model with health care system	0.654 (0.636, 0.673)	<0.001

Abbreviations: AUC = area under the curve; CI = confidence interval; SDoH = social determinants of health

[*] Overall model includes age, sex, geographic region, race/ethnicity, Charlson Comorbidity Index, year of the survey, and vision impairment; stratified models include age, sex, geographic region, Charlson Comorbidity Index, year of the survey, and vision impairment.