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Attributes Associated with Eye Care Utilization in the United States: A Meta-Analysis

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Abstract

Objective—To model the factors that are associated with the use of eye care services among the United States population with and without diabetes, stratifying by age group.

Design—Meta-analysis.

Participants—We analyzed data from three datasets: the Behavioral Risk Factors Surveillance System combined years 2006-2009, the National Health and Nutrition Examination Survey combined years 2005-2008, and the National Health Interview Survey year 2008. For all three datasets, we analyzed data from all survey participants aged 40 or older who participated in vision-related survey modules.

Methods—We performed multivariate logistic regression analyses to assess associations between any eye care utilization within the previous year and 14 indicators of patient demographics and health. We estimated separate regressions for persons with and without diabetes stratified by age group. We combined estimates across datasets using a random effects model estimated using Markov Chain Monte Carlo algorithms.

Main Outcome Measures—Use of eye care in the previous year and personal factors associated with eye care use.

Results—Annual eye care utilization rates ranged from 46% to 51% in participants without diabetes and 64% to 72% in participants with diabetes. For people with and without diabetes, health insurance, an eye disease diagnosis, and higher income were associated with higher odds of eye care utilization. Being male was associated with lower odds of eye care utilization in some diabetes status and age group categories. Other variables, such as more education, being married, black race, Hispanic/Latino ethnicity, health status, heavy drinking, and limited ability to read small print were associated with eye care utilization in only some diabetes status and age group categories.

Conclusions—Our findings indicate that economic and ocular health factors are associated with the greatest odds of annual eye care utilization. Access to health insurance and income levels

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greater than \$35,000 United States Dollars (value at the time of interview), are associated with eye care utilization, independent of other demographic factors.

Vision impairment affects approximately 1 in 28 Americans over the age of 40,¹ and many of the leading causes of vision impairment and blindness can be treated effectively if detected through routine eye exams. However, according to a recent analysis of the National Health Interview Survey (NHIS), only 33% of people at the highest risk for serious vision loss, such as those with diabetes or of age 65 years or older, reported having a dilated eye exam within the past year.² The number of Americans at risk for serious visual problems will increase as the United States (U.S.) population ages.³ Understanding the factors associated with the use of eye care services will help identify the populations most at risk for underutilization and illuminate potential reasons why these populations fail to utilize recommended care.

Although several studies have used multivariate analysis to model the use of eye care services,^{2, 4-10} only four used data representative of the U.S. population, and only three modeled eye care utilization for people with diabetes. None of the three studies that reported results for people with diabetes used data generalizable to the U.S. adult population.^{6, 8, 9} People with diabetes are at greater risk for ocular diseases and thus understanding their eye care utilization practices will be useful for future outreach.

Previous models have identified consistent trends among six factors associated with eye care utilization: general health, eye health, age, sex, socioeconomic status, and race/ethnicity.^{2, 4-10} In summary, good general health, poor eye health, female sex, older age, and education are all associated with increased eye care utilization. The association between race, especially black race and eye care utilization, however, is less clear. Several studies^{2, 7, 9} have found that blacks were less likely than whites to utilize eye care services, while one study evaluating a population of a different age group found that blacks were more likely than whites to report using eye care.¹¹ The differing age groups evaluated in these studies suggest that the results may be confounded by patient age.

Here we conduct a meta-analysis of the factors associated with eye care utilization among the U.S. population with and without diabetes, stratifying by age group. We used separate models for those with and without diabetes because this group is influenced by different eye care recommendations.^{12, 13}

METHODS

Data

This meta-analysis used data from the Behavioral Risk Factor Surveillance System (BRFSS) years 2006-2009; the National Health and Nutrition Examination Survey (NHANES) years 2005-2008; and NHIS year 2008. RTI Ethics Committee decided approval was not required for this study because it was based on secondary data sources only. We included questions on eye care utilization, patient demographics, self-reported diagnoses of eye disease, and reading limitations caused by visual impairment.

BRFSS is an annual random-digit-dial telephone survey of state population-based samples of the civilian noninstitutionalized population of adults aged 18 or older in each of the 50 states and the District of Columbia. Our analysis used data from the 15 states that participated in the BRFSS Visual Impairment and Access to Eye Care module between 2006 and 2009. Our sample from BRFSS included 31,919 people from 2006; 22,120 people from 2007; 43,076 people from 2008; and 16,295 people from 2009. Additional BRFSS survey methodology is reported elsewhere.¹⁴⁻¹⁷

NHANES is a probabilistic survey of the U.S. civilian noninstitutionalized population collected via household interviews. The survey methodology of NHANES is described elsewhere.¹⁸ Questions on eye care service utilization and diabetic retinopathy were located in the diabetes questionnaire section and were asked only to those with diabetes.^{19, 20} Thus, only the NHANES population with diabetes was included in analysis. Our study used information on 440 people surveyed from 2005 to 2006 and 668 people surveyed from 2007 to 2008.

NHIS is a probabilistic interview survey representative of the noninstitutionalized civilian U.S. population. Similar to NHANES, the NHIS data were also collected via household interview. NHIS methods have been described previously.^{21, 22} During 2008, additional visual health questions were added to NHIS.²³ Our sample included 13,471 people surveyed in 2008.

For all three datasets, we analyzed data from survey participants aged 40 or older who participated in the vision-related survey modules, defined as having a valid response to the dependent variable question measuring when a respondent had last utilized eye care services. Since the dependent variable question was asked of all BRFSS respondents with diabetes regardless of participation in the vision module, our BRFSS inclusion criteria also required that a respondent not have all responses missing in the vision module. We matched questions measuring the dependent and independent variables across the datasets by identifying the questions that provided the best match for each concept across the data (Appendix 1, available at <http://aaojournal.org>).

Variables

For our dependent variable in each model we used respondent self-report of having had an eye exam in which the pupils were dilated within the past year. For independent variables, we included the demographic characteristics age in years, male sex, and race. Race was categorized as self-reported black, white, and other, with white as the reference group. Hispanic ethnicity was also included. We categorized socioeconomic status using completion of 4 years of college and/or completion of a bachelor's degree, annual income of at least \$35,000 United States Dollars (USD, value at the time of interview), and marital status. We determined insurance status using a self-reported measure of health insurance without differentiating by insurance type. Patient health and absence of self-protective health behaviors were assessed using self-reported general health and self-reported heavy drinking. We gauged eye-related reading limitations using a self-reported limited ability to read small print. Self-reported eye disease diagnoses were measured using an affirmative answer to any self-reported history of cataract surgery, age-related macular degeneration, diabetic retinopathy, or glaucoma.

Models

We developed a multivariate logistic regression model in SAS statistical software version 9.2 (Cary, NC) with SAS-Callable SUDAAN Version 10.0.1 (Research Triangle Park, NC). Multiple years of complex sample design data were combined using a weighting schema which was adjusted by multiplying the overall weight by the proportion each year contributed to each national total survey sample population. We replaced missing data by performing the Markov Chain Monte Carlo (MCMC) algorithm for multiple imputation without rounding on all variables of interest in each dataset.^{24, 25} We computed simple frequentist descriptive statistics for each variable before the imputation step (Tables 1 and 2, available at <http://aaojournal.org>).

Separate multivariate logistic regressions using the same variables were run on each dataset for patients with and without diabetes for two age groups: participants aged 40 to 64 and participants aged 65 or older. We computed adjusted odds ratios and their standard errors from logistic regressions using Taylor linearization. To control for potential confounding variables such as age, education, income, and insurance status we included those variables as covariates in each model. Confounding resulting from diabetes status and age was controlled by stratifying results for people with and without diabetes.

For each of the four subgroups (people with and without diabetes by age group), we summarized our multivariate model logit estimates using a normal Bayesian random effects model with an unknown but normally distributed mean and uniformly distributed variance associated with the prior random effects parameters. We specified the model using the MCMC procedure in SAS 9.2. The SAS MCMC procedure uses a general sampling procedure to generate estimates from a target distribution defined by priors and the likelihood function.²⁶ In this application, we used the random-effects model to allow for methodological and clinical differences between the three populations.

To take advantage of SUDAAN's functionality in managing complex sampling weights, we estimated both descriptive statistics and our logistic regression models using frequentist methods. We used Bayesian methods to summarize the logistic results across studies due to the number of studies used for meta-analysis. The Bayesian-estimated intervals do not depend upon the asymptotic assumptions from which frequentist intervals derive their 'confidence', and therefore are referred to as credible intervals (CrI).

RESULTS

The sample populations from each dataset were similar with respect to eye care utilization, demographic characteristics, and general health (Tables 1 and 2, available at <http://aaojournal.org>). We found several significant differences between the datasets in relation to ocular health, with percentages of the population with limited reading ability and diabetic retinopathy varying for the dataset NHIS. These differences between datasets were likely due to differences in question wording for these variables in NHIS (Appendix 1, available at <http://aaojournal.org>).

Attributes Commonly Associated with Eye Care Utilization

Several attributes were associated with eye care utilization across all groups (Tables 3 and 4, available at <http://aaojournal.org>). Among the U.S. population with and without diabetes ages 40 and older we found that those having a self-reported ocular disease, having health insurance, and/or having an annual income greater than \$35,000 USD had the greatest odds of eye care utilization. Those with ocular disease without diabetes had a 2.15 (CrI 1.87-2.45) and 2.56 (CrI 2.33-2.83) greater odds of seeking eye care among those ages 40-64 and 65 and older, respectively. Odds ratios were slightly lower for participants with ocular disease and diabetes, with odds ratios of 1.57 (CrI 1.21-2.01) and 1.85 (CrI 1.50-2.24) among those ages 40-64 and 65 and older, respectively.

Populations ages 40-64 with health insurance had greater odds of seeking eye care services in both populations with diabetes (odds ratio 2.30, CrI 1.91-2.78) and without diabetes (odds ratio 2.08, CrI 1.92-2.25). The effect of insurance was smaller for populations ages 65 and older compared with the younger population among both people with diabetes (odds ratio 1.44, CrI 1.00-2.05) and without diabetes (odds ratio 1.45, CrI 1.14-1.80).

Having an income greater than \$35,000 was also positively associated with eye care utilization among all stratified groups. Odds of seeking eye care among people with an

income greater than \$35,000 per year without diabetes were 1.38 (CrI 1.27-1.49) and 1.40 (CrI 1.26-1.54) among those ages 40-64 and 65 and older, respectively. Odds ratios were similar among people with an income greater than \$35,000 and diabetes, with odds ratios of 1.45 (CrI 1.24-1.76) and 1.38 (CrI 1.09-1.72) among those ages 40-64 and 65 and older, respectively.

Race/Ethnicity and Eye Care Utilization

Among populations ages 40-64, black race is significantly associated with greater eye care utilization among persons without diabetes (odds ratio 1.34, CrI 1.24-1.43) and with diabetes (odds ratio 1.32, CrI 1.13-1.54). In the population 65 and older, both blacks with and without diabetes did not exhibit significantly higher odds of utilizing eye care than whites. Hispanic ethnicity was a significantly associated with eye care utilization for people ages 40-64 among groups without diabetes (odds ratio 1.29, CrI 1.17-1.43) and with diabetes (odds ratio 1.37, CrI 1.14-1.72). Similar to black race, those of Hispanic ethnicity did not exhibit significantly higher odds of eye care utilization among those ages 65 years and older, when compared to whites.

DISCUSSION

As the U.S. population ages and the incidence of diabetes increases over the coming decades,²⁷ we can expect a proportionate increase in the population at risk for eye disease. The ability to target eye care interventions to the highest risk groups will gain in importance as the number of persons at risk for eye disease increases. To identify the populations most at risk for underutilization of eye care use and to illuminate potential reasons why these populations fail to utilize recommended care, we have conducted a study to determine attributes associated with eye care utilization among groups with and without diabetes in age groups 40-64 years and 65 years and older.

The proportion of Americans ages 40 or older who utilize eye care services varies greatly depending on whether an individual has diabetes. Among persons without diabetes, 46% to 51% of participants across the studies reported utilizing eye care services in the past year, and 63% to 66% reported having utilized services within the past 2 years. Utilization rates for persons with diabetes were higher, with 64% to 72% utilizing eye care services within the past year, and 78% to 85% utilizing eye care services over the past 2 years. These rates show that most persons with diabetes are trying to comply with recommendations that individuals with diabetes receive an eye exam every 1 to 2 years.^{13, 28}

Several variables were associated with the utilization of eye care services across all age groups, regardless of diabetes status. In accordance with previous research, self-reported diagnosis of a vision disorder was one of the attributes associated with the greatest odds of eye care utilization (odds ratios ranged from 1.57-2.56 across groups) among persons with and without diabetes. This suggests that either provider diagnosis motivates additional follow-up care or that eye care utilization helps identify and successfully communicates diagnoses.^{7, 9} Future research should examine whether receiving a diagnosis substantially increases future utilization among patients who are already routine users of eye care services. Furthermore, in accord with previous findings, we find that having health insurance is associated with eye care service utilization across all stratified groups.^{2, 5, 8, 10} Future utilization of eye care services may thus increase if the Patient Protection and Affordable Care Act of 2010 results in increases in insurance coverage among the 50.7 million Americans who currently lack insurance.^{29, 30}

Our findings also support previous studies that indicate that men, those without college education, and those with lower incomes have lower eye care utilization rates when

controlling for covariates.^{2, 4, 5, 7, 10, 11} This suggests that primary care physicians and public health practitioners, as those who see the broadest patient populations, should focus efforts on effective communication of the importance of eye care towards these sub-populations that utilize eye care less frequently. Once these patients reach eye care services, ocular health care professionals should focus on delivering effective communication towards people with varying levels of education, as previous studies highlight.^{5, 31}

We also found that a self-reported limited ability to read small print was associated with lower eye care utilization. Although this seems paradoxical, it may be a result of not seeing an eye care physician recently. For example, people who have not visited an eye care professional in the past year would not have had any recent visual acuity problems corrected with glasses or contacts and therefore would have trouble reading small print. In contrast, those with recent eye examinations are more likely to have corrected their acuity defects and therefore have no trouble reading small print.

We found that blacks ages 40 to 64 were more likely than whites to report going to an eye examination within the last year, whereas blacks ages 65 or older did not report a significantly different amount of eye care utilization when compared to whites, a result that in part supports previous research.^{7, 9, 11} Like our study, Schaumberg et al.¹¹ found that blacks were more likely to utilize eye care services than whites among a study population that was primarily younger than age 65. However, our results differ from those reported by Sloan et al.⁹ which show that blacks aged 65 or older were less likely to utilize services than whites. Our results show that among populations age 65 and older, black race was not significantly associated with eye care use or non-use when compared to whites. Thus, our results indicate that after controlling for socioeconomic factors, black race is associated with eye care utilization only among those aged 40-64 (with and without diabetes). A similar result was observed for those with Hispanic/Latino ethnicity, with study participants showing greater odds of utilizing eye care than whites among those aged 40-64.

There were several limitations to our study which should be noted. In general, the survey results from the datasets used are considered valid and reliable;^{2, 32} however, these data are still subject to selection bias and nonsampling errors such as information bias, residual confounding, and other limitations.

Several limitations are related to the sampling of the datasets used. Not all of the data were collected in the same manner or among the same populations. NHANES and NHIS are nationally representative datasets, and the vision survey questions in them were asked of a randomly selected portion of individuals that are representative of the noninstitutionalized civilian population. BRFSS vision data, however, were collected in the 15 states that participated in the BRFSS Visual Impairment and Access to Eye Care module between 2006 and 2009, and thus the BRFSS vision data are representative only of the state populations in which the data were collected. In addition, for the NHANES dataset, the eye care utilization question was only asked of participants with diabetes. Thus, we could only analyze BRFSS and NHIS data for people without diabetes, whereas for people with diabetes, we analyzed data from BRFSS, NHANES, and NHIS. Also, since all three studies were conducted via telephone or in-home interviews, the datasets exclude people without a telephone, as well as institutionalized and homeless populations, who may be at an increased risk of health disorders. This may introduce a degree of selection bias into the odds ratios related to socioeconomic status (income, education, having health insurance), lowering associated odds ratios.

Several factors may cause nonsampling error. Underreporting of health-related behaviors such as whether the participant utilized eye care in the past year may introduce information

bias into our odds ratio estimates. In addition, these data are also subject to residual confounding. Although we have controlled for age and socioeconomic variables in analyses, factors not included in these datasets may confound the relationship between our dependent and independent variables because data on these factors were not collected.

Furthermore, the wording of survey questions varied slightly between datasets, which could in part explain some of the differences in results found across studies. We found the greatest differences in question wording from survey to survey among the limited ability to read small print, cataract surgery, and diabetic retinopathy questions (see Appendix 1, available at <http://aaojournal.org>). There were other small differences in survey question wording, but these were the most notable.

We have identified the attributes associated with eye care utilization generalizable to the U.S. population stratified by age group and people with and without diabetes. Our results support previous findings that people with diagnosed ocular health disorders and those having health insurance are most likely to seek eye care. Odds ratio differences between stratified eye care utilization groups exhibited similar trends, however, the magnitude of odds ratios differed. This study will enable improved intervention targeting toward at risk groups for eye diseases. Lastly, future cost effectiveness analyses will benefit from the ability to stratify analyses by age and diabetes sub-groups.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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