Barriers to eye care among people aged 40 years and older with diagnosed diabetes, 2006-2010

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Tables/Figures: 4 (4 tables/figures)
Running head: barrier to eye care, diabetes, visual impairment
Abstract: 246 ( 250 word limit)
Word Count: 3373 ( 4000 word limit)
Key Words: diabetes, barriers to care, eye care, visual impairment
References: 38 ( 40 references)
Abstract

Objective: To examine barriers to receiving recommended eye care among people aged ≥40 years with diagnosed diabetes.

Method: We analyzed 2006-2010 Behavioral Risk Factor Surveillance System data from 22 states (n=27,699). Respondents who had not sought eye care in the preceding 12 months were asked the main reason why. We categorized the reasons as cost/lack of insurance, no need, no eye doctor/travel/appointment, and other (meaning everything else). We used multinomial logistic regression to control for race/ethnicity, education, income, and other selected covariates.

Results: Among adults with diagnosed diabetes, non-adherence to the recommended annual eye examinations was 23.5%. The most commonly reported reasons for not receiving eye care in the preceding 12 months were “no need” and “cost or lack of insurance” (39.7% and 32.3% respectively). Other reasons were no eye doctor, no transportation or could not get appointment” (6.4%), and “other” (21.5%). After controlling for covariates, adults aged 40-64 were more likely than those aged ≥65 years (relative risk ratios [RRR]=2.79; 95% CI =2.01, 3.89) and women were more likely than men (RRR=2.33; 95% CI=1.75, 3.14) to report “cost or lack of insurance” as their main reason. However, people aged 40-64 were less likely than those aged ≥65 years to report “no need” (RRR=0.51; 95% CI=0.39, 0.67) as their main reason.

Conclusion: Addressing concerns about “cost or lack of insurance” for adults under 65 years and “no perceived need” among those 65 years and older could help improve eye care service utilization among people with diabetes.
Introduction:

Diabetes affects 27 million people in the United States and, if current trends continue, between one in five and one in three U.S. adults will have diabetes by 2050 (1). Diabetic retinopathy is the leading cause of new cases of vision impairment and blindness among people with diabetes and, among people with diabetes, 28.5% have diabetic retinopathy (2). A previous study analyzed data from the National Health and Nutrition Examination Survey in 1999-2002 and 2005-2008 and found that, in the United States, vision impairment related to diabetes increased by 20 percent over less than a decade (3). Blindness due to diabetes costs the nation, annually, about $500 million in health care and associated costs (4). The efficacy and effectiveness of screening for diabetic retinopathy among individuals with diabetes is well established (5).

To prevent vision loss, yearly eye examinations are recommended for people with diabetes, beginning at the time of diagnosis of type 2 diabetes or after five years of type 1 diabetes, with increasing frequency depending on severity of eye disease (6). Although regular comprehensive eye examinations are critical for early detection, timely treatment, and maintaining vision health (7), people with diabetes have been receiving this recommended eye care at suboptimal levels (8–10). In the United States, Medicare covers an annual eye examination for those with diabetes (11), and most health insurance covers medical eye examination and payment for eye diseases such as diabetic retinopathy, cataract, and glaucoma (12). However, 25%-47% of those with diabetes do not have yearly eye examinations (8-9).

To develop interventions that increase the use of preventive eye care, we need to better understand why people do not seek care. We analyzed data from the Behavioral Risk factors
Surveillance System (BRFSS) to estimate the prevalence of not having an eye examination in the preceding 12 months, to describe the reasons reported by those without seeking eye care, and to identify factors associated with these reasons.

**Methods:**

*Data Source and Sample*

The BRFSS is an annual state-based random-digit-dialed telephone survey of the noninstitutionalized U.S. civilian population (13). The BRFSS was designed to provide information on sociodemographics, chronic illness, health behaviors, and access to health care. The BRFSS also includes optional modules that states may choose to add. We analyzed data from the BRFSS from the 22 states (Alabama, Arizona, Arkansas, Colorado, Connecticut, Florida, Georgia, Indiana, Iowa, Kansas, Maryland, Massachusetts, Missouri, Nebraska, New Mexico, New York, North Carolina, Ohio, Tennessee, Texas, West Virginia, and Wyoming) that conducted the Visual Impairment and Access to Eye Care Module (vision module) at least once between 2006 and 2010. Our sample included 27,699 respondents aged ≥40 years with diagnosed diabetes. Median state response rates, the percentage of persons, among all eligible persons in states administering the BRFSS during that period, who completed the interview ranged from 50.6% to 54.6%; median state cooperation rates, the percentage, among all eligible persons who were contacted, who completed interview ranged from 75.2% to 79.7% (14).

*Measures*

We classified respondents as having diagnosed diabetes if they answered ‘yes’ to the question, ‘Have you ever been told by a doctor or other health care provider that you have diabetes?’ Women who indicated gestational diabetes that resolved upon delivery were not
considered to have diabetes. We categorized people as having visited an eye care professional in the preceding 12 months if they answered “within the past month” or “within the past year” to the question, “When was the last time you had your eyes examined by any doctor or eye-care provider?” Those who indicated times longer than one year were considered to have not visited an eye care provider in the preceding 12 months. Persons who had not visited an eye care professional in the preceding 12 months were asked the main reason why they had not done so; respondents were only allowed to indicate one main reason. We classified their responses into four categories: (1) cost or lack of insurance; (2) no need, consisting of “have not thought of it” and “no reason to go;” (3) no eye doctor/travel/appointment, consisting of “do not have/know an eye doctor,” “too far/no transportation,” and “could not get an appointment;” and (4) other.

Covariates included age (40-64 years, and 65 years and older); sex; race/ethnicity (non-Hispanic white, non-Hispanic black, non-Hispanic Asian, Hispanic, or non-Hispanic persons of ‘other’ races); educational attainment (<high school, high school, more than high school); income (<$35,000 or ≥$35,000); health insurance coverage at the time of survey (‘yes’ or ‘no’); eye insurance coverage at the time of survey (“yes” or ”no”); any self-reported eye disease (glaucoma, age-related macular degeneration, diabetic retinopathy, or cataract); time since diagnosis of diabetes (<5 years, 5-14 years, or ≥ 15 years); ever had diabetes education (“yes” or ”no”); and have ever taken diabetes medicines (“yes” or “no”). Self-reported vision impairment was defined using two questions: “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 “a little difficulty,” “moderate difficulty,” “extreme difficulty,” “unable to do because of eyesight,” or “blind” to either question as having vision impairment (“yes” or
“no”). To control for possible differences by year and state, we included year and state variables in the models.

**Analytic methods**

First, we examined the characteristics of the population aged ≥40 years with diagnosed diabetes, separated by those who had made an eye care visit in the preceding 12 months and those who had not. Then among those without seeking eye care, we estimated how responses to the question about main reasons for not seeking eye care were distributed by selected socio-demographic, clinical, and diabetes-related characteristics. We used Wald Chi-square statistics to test whether the main reason was independent of each characteristic. Finally, using multinomial logistic regression, for each barrier to eye care, we calculated an adjusted relative risk ratio (RRR), which is the ratio of two probabilities (e.g., “cost or lack of insurance” vs. “no need” [reference group]). This model controlled for age, sex, race/ethnicity, education, income, health insurance coverage, eye insurance coverage, any known eye disease, time since diagnosis of diabetes, diabetes education, diabetes medication, vision impairment, state of residence, and survey year.

All analyses were conducted using survey procedures in Stata 12.1 to account for the BRFSS’s complex sampling design. Analyses were weighted to account for individual selection probabilities, nonresponse, and post-stratification. We considered the results of hypothesis tests significant when the p-value was <0.05.

**Results:**

Table 1 presents characteristics of the study population. In 2006-2010, 23.5% (95% confidence interval [CI]: 22.6%-24.4%) of persons aged ≥40 years with diagnosed diabetes had not sought eye care in the preceding 12 months. Among those with diabetes not seeking eye care,
nearly 51% were women; 30% were aged ≥65 years; 15.1% were non-Hispanic blacks; 11.3% were Hispanics; 62.2% reported annual income <$35,000; 33% reported vision impairment and 35.6% had any known eye diseases. Among those sought eye care, nearly 51% were men; 45.8% were ≥65 years; 15.4% were non-Hispanic blacks; 9.2% were Hispanics; nearly half reported annual income <$35,000; 25.0% reported vision impairment; and 55.5% reported any known eye diseases.

Of those who reported not seeking eye care in the preceding 12 months, 39.7% reported “no need”; 32.3% reported “cost or lack of insurance”; 6.4% reported “no eye doctor, no transportation, or could not get an appointment”; and 21.5% reported other reasons (Table 2). Cost or lack of insurance was most often the main reason given by women (40.1%), persons aged 40-64 years old (38.5%), Hispanics (38.4%), those incomes < $35,000 (42.1%), persons with <HS education (40.3%), those not using diabetes medication (42.0%), and those with vision impairment (45.3%). In contrast, “No need” was the reason most commonly given by men (49.6%), persons 65 years or older (51.3%), non-Hispanic whites (42.2%) and non-Hispanic blacks (38.8%), those with incomes greater than $35,000 (51.6%), persons with at least a high school education (42.5%), those not using diabetes medication (35.0%), and those without vision impairment (47.3%). However, any known eye diseases, and diabetes education was not associated with any reason given.

Table 3 shows the results from multinomial logistic regression modeling of the main reason for not seeking eye care. After adjusting for covariates, adults aged 40-64, women, people with an income of <$35,000, and people with vision impairment were more likely to report ‘cost/lack of insurance’ vs. ‘no need’ as a main reason for not seeking eye care (RRR=3.13 [95%CI: 2.19-4.47]; RRR=3.12 [95%CI: 2.32-4.20]; RRR=2.88 [95%CI: 2.03-4.09]; RRR=3.14 [95%CI: 2.38-4.16]).
2.35-4.22], respectively). In contrast, people with health insurance coverage and eye care coverage were less likely to report ‘cost/lack of insurance’ vs. ‘no need’ as a main reason (RRR=0.36 [95%CI: 0.23-0.56]; RRR=0.28 [95%CI: 0.21-0.38], respectively). Females vs. males (RRR=3.60 [95%CI: 2.11-6.16]), Hispanics vs. non-Hispanic whites (RRR=3.52 [95%CI: 1.50-8.25]), people with time since diabetes diagnoses ≥15 years vs. time <5 years (RRR=2.11 [95%CI: 1.08-4.11]), those with diabetes medication vs. without (RRR=1.88 [95%CI: 1.06-3.32]), and those with vision impairment vs. without (RRR=2.19 [95%CI: 1.34-3.58]) were more likely to report ‘no eye doctor/travel/appointment’ vs. 'no need' as the main reason for not seeking eye care.

The reasons given for not seeking eye care among those with diagnosed diabetes varied among the 22 states (Figure 1). ‘Cost or lack of insurance’ as the main reason cited for not seeking eye care ranged from 12.6% (95%CI=6.6%-22.5%, Massachusetts) to 50.0% (95%CI=41.2%-58.7%, Tennessee). Those reporting no need ranged from 27.0% (95%CI=20.6%-34.5%, Tennessee) to 56.6% (95%CI, 46.0%-66.6%, New Mexico). No eye doctor/travel/appointment as the main reason for barriers to eye care ranged from 1.2% (95%CI=0.4%-3.7%, Missouri) to 13.4% (95%CI=6.4%-26.0%, Maryland) (Appendix A).

Discussion

Nearly one in four people aged ≥40 years with diagnosed diabetes have not sought eye care in the preceding 12 months. More than one third of people with diagnosed diabetes who did not receive eye care reported “no need” as a main reason and another one third reported cost or lack of health insurance coverage. People reporting barriers to receiving eye care were highly
associated with socio-demographic factors, health insurance coverage, time since diagnosis of diabetes, diabetes medication, and vision impairment.

Our estimated percentage of people receiving eye care in the last year is consistent with the estimate in another study. Ali and colleagues analyzed data from the BRFSS and found the proportion of persons aged ≥18 years with diabetes who had received an annual eye examination declined from 75.1% in the period 1999-2002 to 73.5% in year 2007-2010 (9). Ali’s estimate is slightly lower than ours, which may be due to differences in the dataset or differences in the age range of the sample. Among those with diagnosed diabetes overall, we found the perception of “no need” to be the main reason for not seeking eye care, followed by “cost or lack of health insurance”. Eye problems often have no early signs or symptoms; therefore, one of the possible reasons for reporting “no need” as the main reason could be the lack of knowledge about how diabetes affects the eyes and the need for a regular eye examination to prevent vision loss (15,16). Another possible reason could be lack of reminders from physicians. Having a physician reminder was associated with increased eye care visits and subsequent better eye health (17). Therefore, intervention to increase the awareness of the need for an annual eye examination might improve eye health among people with diabetes who reported “no need” as the reason. In addition, people with diabetes tend to come from families with diabetes and might also remind family members and others in their community of the need to have a regular eye examination.

Our study indicated that the reason given for not seeking eye care differed between age categories. We found that those who reported “no need” as a barrier were most likely to be aged ≥65 years, whereas those who reported “cost or lack of health insurance” were most likely to be aged 40-64 years. Medicare covers one eye examination every 12 months for people who have diabetes (11). Thus, it was not surprising that we found that adults aged <65 years indicated “cost
or lack of health insurance” as their main reason for not seeking eye care more often than did their older counterparts. However, although adults aged ≥65 years have the highest prevalence of vision impairment (18), a large proportion reported “no need” as the main reason for not seeking eye care. Older adults might not be aware of their vision impairment because symptoms progress slowly or that they might consider vision impairment to be a normal part of aging (19).

Men and women reported different main reasons for not seeking eye care. Men were more likely than women to report “no need” to seek eye care; women were more likely to report “cost or lack of insurance” as their main reason. These results agree with prior studies and may reflect women having had less financial access to care than men, and men are less likely to utilize healthcare services (20, 21).

“Cost or lack of insurance” appears to be a major barrier to seeking eye care for low income persons. Those with low income were less likely to report “no need” as the main reason for not seeking care. Instead, “cost or lack of insurance” was the reason most commonly given by low income persons. Previous studies demonstrated that persons in the low income population were less able to cover out-of-pocket costs (22,23).

Of note, respondents with visual impairment were more likely to report “cost or lack of insurance” as a barrier, and less likely to report “no need. This persisted even after adjustment for covariates (including age, income, etc.) Our results were consistent with previous studies that have found cost or lack of health insurance was a barrier for people with vision impairment (8,24). “No need” and a general lack of awareness about the importance of eye examination are another barrier for eye care (12,25) in people with diabetes, who are at increased risk of developing vision impairment or vision loss (3,26). Thus, diabetes eye health education
programs or interventions that increase the awareness of the need for eye care among people with diabetes may be important in preventing vision loss (18, 27).

We also found racial/ethnic differences in barriers to getting eye care. Hispanics were more likely to report “no eye doctor/travel/appointment” as the main reason for not seeking eye care. In a study examining barriers to eye care among Hispanics, those not seeking eye care were more likely to lack health insurance, to have had no routine physical examination in the past year, to be less educated, and to have an A1c level >9.0%, putting them at increased risk for complications of diabetes (28). Another study also demonstrated that cost, availability of services, and convenience of accessing care were main barriers to obtaining eye care among Hispanics (29).

We found that those with a longer time since diagnosis of diabetes were more likely to report “no eye doctor/travel/appointment” as the main reason for not seeking eye care. Previous studies have shown that the likelihood of developing diabetes-related complications, including vision problem, increases along with time since diagnosis of diabetes (26, 30). Owsley et al. conducted focus groups among African Americans to examine the perceived barriers to eye care and found that clinic accessibility was the primary barrier to care (31). Interventions may target those persons for whom it has been longer since diagnosis of diabetes and that improve the accessibility of eye care might work to decrease vision problem among people with diabetes. We found no evidence that the lack of diabetes education was associated with any specific reason for not seeking eye care. Diabetes education is an opportunity to increase awareness, and therefore one might have expected fewer “no need” responses among people who had participated in diabetes education. Increasing the amount of information about the need for regular comprehensive eye care that is included in diabetes education curricula might increase awareness.
of the need for eye examinations. Because lack of physician reminder was associated with less use of eye care, reminder/recall systems might help further.

Barriers to receiving eye care among people with diagnosed diabetes varied between states. Among the 22 states including the BRFSS vision module during the study period, the estimated percentage of respondents reporting “cost or lack of insurance” as the main reason for not seeking eye care was lowest for adults in Massachusetts, the state with the smallest proportion of residents without health insurance (32). According to one report from 1997-1999, the prevalence of dilated eye examinations every two years among people with diabetes were lowest in Georgia, Illinois, Indiana, and Michigan and highest in Florida, and several states in the Midwest (33). Even within states, there are differences among rural and urban counties. Chou and colleagues have shown that people who lived in a county with low density of eye care providers experienced reduced likelihood of having annual dilated eye examination (34). In Arkansas, a previous study showed that fewer rural residents reported having eye insurance coverage and dilated eye exams within the previous year (35). In a study that examined Medicare claims data from 1999-2001, Arkansas was found to have the lowest diabetic eye examination rate across all states (36). Given the geographic variation in eye care, state specific strategies may be a more appropriate approach to intervention. Surveys such as BRFSS that provide state-level data can help planners understand potential areas of unmet healthcare needs.

The findings in this report are subject to several limitations. First, BRFSS data are self-reported, and therefore subject to recall and social desirability bias. Second, given a response of “no diabetes,” BRFSS data cannot be used to distinguish between “persons without diabetes” and those with undiagnosed diabetes; about 27% of those with diabetes are unaware of their condition (37). Third, the correlation between perceived and clinically diagnosed vision
impairment is unknown. Fourth, these results are not representative of the entire U.S. because only 22 states and no U.S. territories administered the optional vision module at least once during the study period. Similarly, not all states conducted the vision module the same number of times over the study period, thereby over-representing states that conducted it more often in our sample. Fifth, people without telephones, who live in cell phone only households, are institutionalized, or whose disabilities so severe they cannot use the phone were not represented in our sample. Although there could be nonresponse bias (median state response rates were about 50%), BRFSS data are subject to post-stratification to make weighted respondent demographics match state demographics (38). Notwithstanding these limitations, major strengths of our study are the BRFSS’s large sample sizes in each survey year that can provide stable estimates of our study outcomes. BRFSS is the only survey that provides state level data on vision, eye health, and use of access to eye care services. In addition, the BRFSS vision module is unique in including detailed questions on individual barriers to eye care services and offering the resultant data to the public health community, which is widely familiar with the BRFSS survey.

**Conclusion**

Increasing eye care utilization, reducing vision impairment, and improving quality of life among people with diabetes are public health priorities. Having eye insurance coverage does not guarantee eye care service utilization. However, not having eye insurance coverage places members of an already vulnerable population of persons with diagnosed diabetes (those with low income, people aged 40-64, and women) at increased risk for vision loss by increasing their likelihood of not receiving eye care. Thus, targeting interventions toward low income individuals, adults aged 40-64 years, and those without health insurance coverage may promote eye care among those with diabetes who perceive cost/no health insurance as a barrier to eye care.
Moreover, public health interventions aimed at heightening awareness among both adults aged ≥65 years and health-care providers might increase utilization rates among people with diabetes. By illustrating some primary reasons why people with diabetes do not seek eye care, findings from this study can help shape the development of targeted interventions and dissemination of effective public health messages to promote eye care.

Acknowledgement

We gratefully acknowledge the thoughtful comments and guidance of the method from Deborah B. Rolka, Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

ChiumFang Chou contributed to study concept and design, analyzed the data, and wrote the manuscript. C.S., X.Z., L.B., K.M.B., J.C. and J.S. contributed to interpretation of the data and drafting of the manuscript. Chium-Fang Chou is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

We appreciate also the editorial assistance provided by Tony Pearson-Clarke, a contractor to the Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

No potential conflicts of interest relevant to this article were reported.
Figure legends: Distribution of main reason for not seeking eye care among people with diagnosed diabetes, by state.
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Table 1: Characteristics of persons aged ≥40 years with diagnosed diabetes, 22 states\(^\dagger\), 2006-2010

|                     | Visited eye provider in the preceding 12 months |       |       |       |       |
|---------------------|-----------------------------------------------|-------|-------|-------|-------|
|                     |                                               | Yes   | No    |       |       |
| N (Population size, million) |                                              | 21,059 (5.8) | 6,640 (1.8) |       |       |
| %                   |                                               | %     | %     |       |       |
| SE\(^\dagger\)      |                                               | SE\(^\dagger\) |       |       |       |
| Age                 |                                               |       |       |       | <0.001|
| 40-64 years old     |                                               | 54.2  | 69.9  | 0.7   | 1.0   |
| 65+ years old       |                                               | 45.8  | 30.1  | 0.7   | 1.0   |
| Sex                 |                                               |       |       |       | 0.089 |
| Male                |                                               | 51.1  | 48.9  | 0.7   | 1.1   |
| Female              |                                               | 48.9  | 51.1  | 0.7   | 1.1   |
| Race/Ethnicity      |                                               |       |       |       | 0.129 |
| Non-Hispanic white  |                                               | 71.0  | 68.4  | 0.7   | 1.2   |
| Non-Hispanic black  |                                               | 15.4  | 15.1  | 0.5   | 0.8   |
| Hispanic            |                                               | 9.2   | 11.3  | 0.5   | 1.0   |
| Non-Hispanic other  |                                               | 4.3   | 5.2   | 0.3   | 0.6   |
| Educational attainment |                                           |       |       |       | <0.001|
| < High School       |                                               | 15.4  | 20.8  | 0.5   | 1.0   |
| High School         |                                               | 33.1  | 36.0  | 0.6   | 1.1   |
| More than High School |                                        | 51.5  | 43.1  | 0.7   | 1.1   |
| Income              |                                               |       |       |       | <0.001|
| <$35,000            |                                               | 49.8  | 62.2  | 0.7   | 1.2   |
| $35,000 or more     |                                               | 50.2  | 37.8  | 0.7   | 1.2   |
| Health Insurance Coverage |                                 |       |       |       | <0.001|
| Yes                 |                                               | 94.0  | 81.9  | 0.3   | 1.0   |
| No                  |                                               | 6.0   | 18.1  | 0.3   | 1.0   |
| Eye Insurance Coverage |                                         |       |       |       | <0.001|
| Yes                 |                                               | 68.6  | 45.9  | 0.6   | 1.1   |
| No                  |                                               | 31.4  | 54.1  | 0.6   | 1.1   |
| Any known eye disease |                                         |       |       |       | <0.001|
| Yes                 |                                               | 55.5  | 35.6  | 0.7   | 1.2   |
| No                  |                                               | 44.5  | 64.4  | 0.7   | 1.2   |
| Time since diagnosis of diabetes |                                       |       |       |       | <0.001|
| < 5 years           |                                               | 32.7  | 42.4  | 0.7   | 1.3   |
| 5-14 years          |                                               | 39.7  | 38.5  | 0.7   | 1.2   |
| ≥ 15 years          |                                               | 27.7  | 19.0  | 0.6   | 0.9   |
| Diabetes education  |                                               |       |       |       | <0.001|
| Yes                 |                                               | 57.3  | 44.5  | 0.7   | 1.2   |
| No                  |                                               | 42.7  | 55.5  | 0.7   | 1.2   |
| Diabetes medication | <0.001 | Vision Impairment | <0.001 |
|---------------------|--------|-------------------|--------|
| Yes                 | 58.1   | 0.7               | 49.2   | 1.2 |
| No                  | 41.9   | 0.7               | 50.8   | 1.2 |

* Data source: Behavioral Risk Factor Surveillance System (BRFSS) 2006-2010
† SE=Stander error
‡ The 22 states using the BRFSS vision module at least once in the years 2006--2010 included Alabama, Arizona, Arkansas, Colorado, Connecticut, Florida, Georgia, Indiana, Iowa, Kansas, Maryland, Massachusetts, Missouri, Nebraska, New Mexico, New York, North Carolina, Ohio, Tennessee, Texas, West Virginia, Wyoming.
§ Among persons aged ≥40 years with diabetes, the prevalence of not seeking eye care in the preceding 12 months was 23.5% (95%CI: 22.6-24.4).
∥ P value is from chi-square Wald test of the null hypothesis that the level of the covariate is independent of seeking eye care in the preceding 12 months.
Table 2: Distribution of the main reason for not seeking eye care among adults aged ≥ 40 years with diagnosed diabetes, stratified by selected socio-demographic and clinical characteristics.

|                      | No need§ | Cost/Insurance | No eye doctor/ travel/appointment‡ | Other¶ | %   | 95%CI  | %   | 95%CI  | %   | 95%CI  | P value¶ |
|----------------------|----------|----------------|------------------------------------|--------|-----|--------|-----|--------|-----|--------|----------|
| Total                | 39.7     | 32.3           | 6.4                                | 21.5   |     | (37.6,41.9) | (5.3,7.8) | (19.7,23.4) | <0.001 |
| Age                  |          |                |                                    |        |     |        |     |        |     |        |          |
| 40-64 years old      | 34.8     | 38.5           | 6.1                                | 20.6   |     | (32.2,37.5) | (4.7,7.9) | (18.3,23.0) | <0.001 |
| 65+ years old        | 51.3     | 17.8           | 7.2                                | 23.7   |     | (47.9,54.8) | (5.7,9.0) | (20.9,26.7) | <0.001 |
| Sex                  |          |                |                                    |        |     |        |     |        |     |        |          |
| Male                 | 49.6     | 24.0           | 4.3                                | 22.1   |     | (46.2,53.0) | (3.2,5.7) | (19.3,25.3) | <0.001 |
| Female               | 30.6     | 40.1           | 8.4                                | 20.9   |     | (28.1,33.2) | (6.6,10.7) | (18.8,23.1) | <0.001 |
| Race/Ethnicity       |          |                |                                    |        |     |        |     |        |     |        | 0.079    |
| Non-Hispanic white   | 42.2     | 30.7           | 5.3                                | 21.8   |     | (39.8,44.6) | (4.4,6.4) | (19.8,23.9) | <0.001 |
| Non-Hispanic black   | 38.8     | 33.2           | 7.8                                | 20.2   |     | (33.0,44.9) | (5.5,11.1) | (16.0,25.0) | <0.001 |
| Hispanic             | 28.5     | 38.4           | 10.5                               | 22.6   |     | (21.3,37.1) | (5.4,19.4) | (15.3,32.0) | <0.001 |
| Non-Hispanic other   | 38.5     | 37.0           | 8.1                                | 16.4   |     | (28.6,49.5) | (2.4,24.1) | (10.7,24.4) | <0.001 |
| Educational attainment|         |                |                                    |        |     |        |     |        |     |        | 0.001    |
| < High School        | 34.0     | 40.3           | 8.4                                | 17.3   |     | (29.3,39.0) | (5.3,12.9) | (14.0,21.2) | <0.001 |
| High School          | 42.5     | 31.8           | 4.7                                | 20.9   |     | (39.2,46.0) | (3.7,6.1) | (18.1,23.9) | <0.001 |
| More than High School| 40.3     | 28.8           | 6.9                                | 24.0   |     | (36.9,43.7) | (5.2,9.1) | (21.1,27.1) | <0.001 |
| Income               |          |                |                                    |        |     |        |     |        |     |        | <0.001    |
| <$35,000             | 33.5     | 42.1           | 6.4                                | 17.9   |     | (30.7,36.5) | (4.8,8.5) | (15.6,20.4) | <0.001 |
| >=$35,000            | 51.6     | 16.7           | 6.0                                | 25.7   |     | (47.7,55.5) | (4.4,8.1) | (22.5,29.2) | <0.001 |
| Health Insurance Coverage |       |                |                                    |        |     |        |     |        |     |        | <0.001    |
| Yes                  | 44.0     | 24.2           | 7.2                                | 24.6   |     | (41.7,46.4) | (6.0,8.6) | (22.5,26.8) | <0.001 |
| No                   | 21.8     | 67.5           | 2.9                                | 7.8    |     | (16.9,27.5) | (1.0,8.1) | (5.5,10.9) | <0.001 |
| Eye Insurance Coverage|        |                |                                    |        |     |        |     |        |     |        | <0.001    |
| Yes                  | 47.6     | 15.5           | 8.1                                | 28.8   |     | (44.5,50.9) | (6.7,9.8) | (25.9,31.8) | <0.001 |
| No                   | 32.8     | 47.3           | 5.0                                | 14.8   |     | (30.0,35.8) | (3.4,7.3) | (12.8,17.1) | <0.001 |
|any known eye disease | 0.081 |
|----------------------|-------|
|Yes                   | 38.1 (34.4,42.0) | 31.3 (27.9,35.0) | 8.6 (6.2,11.7) | 22 (19.1,25.1) |
|No                    | 41.2 (38.2,44.3) | 33.9 (30.9,37.1) | 5.3 (4.0,7.0)  | 19.5 (17.0,22.2) |

|Time since diagnosis of diabetes | 0.005 |
|---------------------------------|-------|
|< 5 years                        | 41.3 (37.5,45.3) | 35 (31.2,39.1) | 5.1 (3.1,8.3)  | 18.6 (15.7,21.8) |
|5-14 years                       | 39.2 (35.5,42.9) | 34.3 (30.8,38.1) | 5.4 (4.1,7.1)  | 21.0 (17.9,24.6) |
|≥ 15 years                       | 35.5 (30.6,40.7) | 29.3 (25.2,33.8) | 11.7 (8.8,15.4) | 23.5 (19.4,28.1) |

|Diabetes education | 0.339 |
|--------------------|-------|
|Yes                 | 38.0 (34.6,41.4) | 33.4 (30.0,37.0) | 6.1 (4.6,8.1)  | 22.5 (19.6,25.7) |
|No                  | 40.9 (37.8,44.1) | 33.3 (30.4,36.5) | 6.7 (5.0,8.9)  | 19.1 (16.7,21.8) |

|Diabetes medication | 0.004 |
|--------------------|-------|
|Yes                 | 32.0 (28.5,35.3) | 37.0 (33.7,40.7) | 7.8 (5.8,10.5) | 23.0 (20.3,26.6) |
|No                  | 35.0 (32.0,38.1) | 42.0 (38.9,45.1) | 5.1 (4.0,6.4)  | 18.0 (15.8,20.4) |

|Vision Impairment | <0.001 |
|------------------|-------|
|Yes               | 24.5 (21.5,27.8) | 45.3 (41.6,49.0) | 8.2 (6.5,10.5) | 22.0 (19.1,25.3) |
|No                | 47.3 (44.5,50.1) | 25.9 (23.5,28.5) | 5.6 (4.2,7.3)  | 21.2 (19.0,23.6) |

* Data source: Behavioral Risk Factor Surveillance System 2006-2010
† 95% CI=95% confidence interval
‡ “No eye doctor/travel/appointment” if respondents answered “do not have/know an eye doctor”, “too far, no transportation”, or “could not get appointments”.
§ “No need” if respondents answered “no reason to go” or “have not thought of it”.
|| Other if respondents’ answers not fitting into the preceding categories.
¶ P value is from chi-square Wald test of the null hypothesis that the level of the covariate is independent of the main reason chosen.
Table 3. Multinomial logistic estimation\(^{†}\) of relative risk ratios (RRR) and 95% confidence intervals (CI) for reasons for not seeking eye care among adults aged ≥ 40 years with diagnosed diabetes

|                        | Cost/Insurance | No eye doctor/travel/appointment\(^{‡}\) | Other\(^{‖}\) |
|------------------------|----------------|------------------------------------------|--------------|
|                        | RRR 95%CI\(^{‡}\) | RRR 95%CI | RRR 95%CI |
| **Age**                |                |                                            |              |
| 40-64 years old        | 3.13 (2.19 - 4.47) | 1.54 (0.91 - 2.61) | 1.25 (0.90 - 1.73) |
| 65+ years old [Reference] | 1.00         | 1.00                                      | 1.00         |
| **Sex**                |                |                                            |              |
| Male [Reference]       | 1.00           | 1.00                                      | 1.00         |
| Female                 | 3.12 (2.32 - 4.20) | 3.60 (2.11 - 6.16) | 1.66 (1.23 - 2.24) |
| **Race/Ethnicity**     |                |                                            |              |
| Non-Hispanic white [Reference] | 1.00         | 1.00                                      | 1.00         |
| Non-Hispanic black     | 0.73 (0.48 - 1.10) | 0.92 (0.48 - 1.77) | 0.72 (0.46 - 1.13) |
| Hispanic               | 1.01 (0.53 - 1.89) | 3.52 (1.50 - 8.25) | 1.88 (0.91 - 3.89) |
| Non-Hispanic other     | 1.22 (0.53 - 2.79) | 3.2 (0.95 - 10.86) | 1.32 (0.69 - 2.53) |
| **Educational attainment** |              |                                            |              |
| < High School          | 0.8 (0.51 - 1.25) | 0.89 (0.47 - 1.68) | 0.65 (0.42 - 1.01) |
| High School            | 0.70 (0.51 - 0.98) | 0.50 (0.29 - 0.86) | 0.78 (0.56 - 1.09) |
| More than High School [Reference] | 1.00         | 1.00                                      | 1.00         |
| **Income**             |                |                                            |              |
| <$35,000               | 2.88 (2.03 - 4.09) | 1.42 (0.85 - 2.37) | 1.02 (0.72 - 1.45) |
| >=$35,000 [Reference]  | 1.00           | 1.00                                      | 1.00         |
| **Health Insurance Coverage** |            |                                            |              |
| Yes                    | 0.36 (0.23 - 0.56) | 1.19 (0.35 - 4.06) | 1.53 (0.83 - 2.82) |
| No [Reference]         | 1.00           | 1.00                                      | 1.00         |
| **Eye Insurance Coverage** |              |                                            |              |
| Yes                    | 0.28 (0.21 - 0.38) | 1.20 (0.74 - 1.95) | 1.36 (0.99 - 1.88) |
|                                    |       |       |       |
|------------------------------------|-------|-------|-------|
| Any known eye disease              | 1.00  | 1.00  | 1.00  |
| Yes                                | 1.02 (0.73 - 1.41) | 1.3 (0.76 - 2.23) | 1.19 (0.87 - 1.64) |
| No [Reference]                     | 1.00  | 1.00  | 1.00  |
| Time since diagnosis of diabetes   | 1.00  | 1.00  | 1.00  |
| < 5 years [Reference]              | 1.00  | 1.00  | 1.00  |
| 5m14 years                         | 1.22 (0.86 - 1.73) | 1.14 (0.61 - 2.13) | 1.1 (0.78 - 1.54) |
| ≥ 15 years                         | 0.95 (0.63 - 1.45) | 2.11 (1.08 - 4.11) | 1.3 (0.86 - 1.97) |
| Diabetes education                 | 1.00  | 1.00  | 1.00  |
| Yes                                | 1.11 (0.82 - 1.49) | 0.84 (0.48 - 1.45) | 1.15 (0.84 - 1.57) |
| No [Reference]                     | 1.00  | 1.00  | 1.00  |
| Diabetes medication                | 1.00  | 1.00  | 1.00  |
| Yes                                | 1.36 (0.94 - 1.97) | 1.88 (1.06 - 3.32) | 1.39 (0.96-2.02) |
| No [Reference]                     | 1.00  | 1.00  | 1.00  |
| Vision Impairment                  | 1.00  | 1.00  | 1.00  |
| Yes                                | 3.14 (2.35 - 4.22) | 2.19 (1.34 - 3.58) | 1.65 (1.18 - 2.31) |
| No [Reference]                     | 1.00  | 1.00  | 1.00  |

* Data source: Behavioral Risk Factor Surveillance System (BRFSS) 2006-2010

† Multinomial logistic regression: the baseline comparison group is “no need” which defined as if respondents answered “no reason to go” or “have not thought of it”.

‡ 95% CI=95% confidence interval

§ “No eye doctor/travel/appointment” if respondents answered “do not have/know an eye doctor”, “too far, no transportation”, or “could not get appointments”.

|| Other if respondents’ answers not fitting into the preceding categories.

¶ This multinomial logistic regression also controls for year and state

#The 22 states using the BRFSS vision module at least once in the years 2006–2010 include Alabama, Arizona, Arkansas, Colorado, Connecticut, Florida, Georgia, Indiana, Iowa, Kansas, Maryland, Massachusetts, Missouri, Nebraska, New Mexico, New York, North Carolina, Ohio, Tennessee, Texas, West Virginia, Wyoming.
Figure 1: Distribution of main reason for not seeking eye care among people with diagnosed diabetes, by state.

* Data source: Behavioral Risk Factor Surveillance System 2006-2010
† “No eye doctor/travel/appointment” if respondents answered “do not have/know an eye doctor”, “too far, no transportation”, or “could not get appointments”.
‡ “No need” if respondents answered “no reason to go” or “have not thought of it”.
Appendix A: Distribution of the main reason for not seeking eye care among adults aged ≥40 years with diagnosed diabetes by states

| State           | No need† | Cost/Insurance | No eye doctor/travel/appointment† | Other¶¶ |
|-----------------|----------|----------------|-----------------------------------|---------|
|                 | %        | 95% CI         | %                                 | 95% CI  |
| New Mexico      | 56.6     | (46.0,66.6)    | 30.7                              | (21.6,41.7) |
|                 |          |                | 8.1                               | (4.3,14.6) |
|                 |          |                | 4.6                               | (1.7,11.8) |
| West Virginia   | 49.4     | (41.0,58.0)    | 30.3                              | (22.9,38.8) |
|                 |          |                | 5.7                               | (3.1,10.4) |
|                 |          |                | 14.5                              | (9.4,21.8) |
| Nebraska        | 49.3     | (32.8,65.9)    | 29.0                              | (12.7,53.3) |
|                 |          |                | 3.5                               | (1.3,9.3) |
|                 |          |                | 18.3                              | (10.6,29.7) |
| Iowa            | 46.9     | (40.3,53.7)    | 27.5                              | (21.8,34.1) |
|                 |          |                | 9.2                               | (5.7,14.5) |
|                 |          |                | 16.3                              | (12.1,21.6) |
| Arkansas        | 46.1     | (36.9,55.5)    | 30.3                              | (22.5,39.5) |
|                 |          |                | 2.6                               | (1.1,5.9) |
|                 |          |                | 21.0                              | (14.1,30.1) |
| Wyoming         | 46.0     | (38.4,53.9)    | 35.0                              | (27.6,43.2) |
|                 |          |                | 4.4                               | (2.2,8.5) |
|                 |          |                | 14.6                              | (10.0,20.8) |
| Massachusetts   | 45.7     | (31.6,60.6)    | 12.6                              | (6.6,22.5) |
|                 |          |                | 8.6                               | (2.7,24.1) |
|                 |          |                | 33.1                              | (20.6,48.4) |
| Alabama         | 44.9     | (40.7,49.2)    | 32.8                              | (28.9,36.9) |
|                 |          |                | 6.4                               | (4.8,8.5) |
|                 |          |                | 15.9                              | (13.3,19.0) |
| Kansas          | 44.6     | (37.3,52.0)    | 30.3                              | (23.9,37.5) |
|                 |          |                | 6.6                               | (4.0,10.7) |
|                 |          |                | 18.5                              | (13.5,24.8) |
| Texas           | 43.0     | (33.7,52.8)    | 32.1                              | (23.8,41.6) |
|                 |          |                | 7.9                               | (4.4,13.8) |
|                 |          |                | 17.1                              | (11.4,24.8) |
| New York        | 42.6     | (36.1,49.4)    | 21.7                              | (16.8,27.5) |
|                 |          |                | 5.7                               | (3.3,9.8) |
|                 |          |                | 30.0                              | (24.3,36.4) |
| Indiana         | 42.4     | (36.1,48.9)    | 35.0                              | (29.3,41.2) |
|                 |          |                | 4.8                               | (2.6,8.7) |
|                 |          |                | 17.9                              | (13.8,22.8) |
| Arizona         | 41.3     | (25.1,59.8)    | 25.2                              | (12.4,44.5) |
|                 |          |                | 11.4                              | (2.7,37.5) |
|                 |          |                | 22.1                              | (12.0,37.1) |
| Connecticut     | 40.7     | (33.8,48.0)    | 21.3                              | (16.0,27.7) |
|                 |          |                | 4.7                               | (2.8,7.9) |
|                 |          |                | 33.3                              | (26.9,40.4) |
| North Carolina  | 40.0     | (33.7,46.6)    | 39.5                              | (33.0,46.4) |
|                 |          |                | 5.7                               | (3.1,10.3) |
|                 |          |                | 14.8                              | (10.6,20.3) |
| Ohio            | 37.9     | (32.2,43.9)    | 36.3                              | (30.7,42.3) |
|                 |          |                | 5.4                               | (3.5,8.3) |
|                 |          |                | 20.4                              | (16.4,25.0) |
| Maryland        | 37.1     | (24.5,51.8)    | 20.8                              | (12.3,33.0) |
|                 |          |                | 13.4                              | (6.4,26.0) |
|                 |          |                | 28.7                              | (18.4,41.8) |
| Georgia         | 37.0     | (32.3,42.0)    | 33.9                              | (29.1,39.1) |
|                 |          |                | 7.2                               | (5.1,10.0) |
|                 |          |                | 21.9                              | (18.0,26.3) |
| Colorado        | 35.9     | (25.8,47.3)    | 32.4                              | (22.2,44.6) |
|                 |          |                | 5.5                               | (2.6,11.1) |
|                 |          |                | 26.2                              | (17.5,37.3) |
| Florida         | 34.9     | (26.4,44.5)    | 34.6                              | (25.5,44.9) |
|                 |          |                | 5.4                               | (2.2,12.6) |
|                 |          |                | 25.1                              | (17.4,34.9) |
| Missouri        | 28.3     | (20.3,38.0)    | 47.8                              | (36.9,58.9) |
|                 |          |                | 1.2                               | (0.4,3.7) |
|                 |          |                | 22.6                              | (13.9,34.6) |
| Tennessee       | 27.0     | (20.6,34.5)    | 50.0                              | (41.2,58.7) |
|                 |          |                | 10.0                              | (4.8,19.7) |
|                 |          |                | 13.1                              | (7.6,21.7) |
* Data source: Behavioral Risk Factor Surveillance System 2006-2010
† “No eye doctor/travel/appointment” if respondents answered “do not have/know an eye doctor”, “too far, no transportation”, or “could not get appointments”.
‡ “No need” if respondents answered “no reason to go” or “have not thought of it”.
¶¶ Other if respondents’ answers not fitting into the preceding categories.