Published in final edited form as:

Ophthalmic Epidemiol. 2015 ; 22(5): 321–332. doi:10.3109/09286586.2015.1066395.

Visual Impairment in White, Chinese, Black and Hispanic Participants from the Multi-Ethnic Study of Atherosclerosis Cohort

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Abstract

Purpose—To describe the prevalence of visual impairment and examine its association with demographic, socioeconomic, and health characteristics in the Multi-Ethnic Study of Atherosclerosis (MESA) cohort.

Methods—Visual acuity data was obtained from 6134 participants, aged 46 to 87 years old at time of examination between 2002 and 2004 (mean age 64 years, 47.6% male), from six communities in the United States (U.S.). Visual impairment was defined as a presenting visual acuity of 20/50 or worse in the better-seeing eye. Risk factors were included in multivariable logistic regression models to determine their impact on visual impairment for men and women in each racial/ethnic group.

Results—Among all participants, 6.6% (N=421) had visual impairment, including 5.6% (N=178) of men and 7.5% (N=243) of women. Prevalence of impairment ranged from 4.2% (N=52) and 6.0% (N=77) in White men and women, respectively, to 7.6% (N=37) and 11.6% (N=44) in Chinese men and women, respectively. Older age was significantly associated with visual impairment in both men and women, particularly in those with lower socioeconomic status, but

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Conflict of Interest

None of the authors have any proprietary interests or conflicts of interest related to this submission. This submission has not been published anywhere previously and it is not simultaneously being considered for any other publication.

the effects of increasing age were more pronounced in men. Two-thirds of participants already wore distance correction and not unexpectedly, lower prevalence of visual impairment was seen in this group; however, 2.4% of men and 3.5% of women with current distance correction had correctable visual impairment, most notably among seniors.

Conclusion—Even in the United States where prevalence of refractive correction is high, both visual impairment and uncorrected refractive error represent current public health challenges.

Keywords

multi-ethnic; prevalence; risk factors; uncorrected refractive error; visual impairment

INTRODUCTION

Current estimates suggest that approximately 285 million individuals are visually impaired worldwide, of whom 39 million are blind.^[1] Prevalence of visual impairment increases significantly at older ages, with approximately 65% of all visually impaired people and 82% of blind persons being aged 50 years or older.^[1] In 2000, approximately 3.3 million individuals aged 40 years or older in the United States (U.S.) had some level of vision loss (low vision or blindness, defined as a best-corrected visual acuity in the better-seeing eye of < 6/12 [$< 20/40$] or 6/60 [$20/200$], respectively) with more than 900,000 persons reported blind. Projections suggest that the number of blind persons in the U.S. will increase 70% to 1.6 million by 2020 with a similar increase expected in the number of persons with low vision.^[2] Worldwide prevalence of visual impairment may also increase as life expectancy increases the size of the elderly population, placing more individuals at risk of impairment due to the normal process of aging and, specifically, age-related eye disease.^[1]

Visual impairment is associated with poorer quality of life and increased risk of health problems in older adults, including chronic health conditions, falls and fractures, depression, and death.^[3-11] Quality of life in visually impaired older persons is compromised by a reduced ability to remain independent and participate fully in routine daily activities, provide and care for themselves and other family members, enjoy leisure activities, operate vehicles, and navigate safely as a pedestrian.^[9-10] In addition to untold personal and societal costs, direct medical expenses resulting from visual impairment was estimated to be \$2.3 trillion (U.S. dollars) worldwide in 2010 and is projected to increase 20% by 2020.^[12] Since an estimated 80% of all visual impairment could be prevented or cured,^[1] it is important to identify affected individuals and provide adequate access to the resources needed to improve vision and therein, preserve quality of life.

The Multi-Ethnic Study of Atherosclerosis (MESA) cohort^[13] is a diverse, population-based sample of adults from four racial/ethnic groups living in six U.S. communities. It provides an opportunity to validate existing U.S. estimates of visual impairment^[2,14] and extend earlier findings to men and women from specific racial/ethnic groups, which may then be compared to other estimates from populations of similar ethnicity. The current study calculates the prevalence of visual impairment and examines its association with relevant risk factors in men and women, overall and from different racial/ethnic groups in the MESA cohort.

MATERIALS AND METHODS

Study Population

Participants from the Multi-Ethnic Study of Atherosclerosis (MESA), a prospective cohort study of adults aged 45 to 84 years who were free of clinical cardiovascular disease at enrollment between July 2000 and July 2002, were sampled from six communities in the U.S. Study design and methodology have been described in detail elsewhere.^[13] Briefly, the MESA cohort was composed of 6814 men and women who were recruited using locally available resources, including lists of residences, dwellings, and telephone exchanges, at six field centers in Baltimore, Maryland; Chicago, Illinois; Forsyth County, North Carolina; Los Angeles, California; New York, New York; and St. Paul, Minnesota. In the final recruitment period, supplemental sources were utilized to ensure adequate samples of minorities and the elderly. From the 6814 participants examined at baseline, 6233 participants returned for a second examination between August 2002 and January 2004, of whom 6176 (99.1%) completed the vision component. Excluded were twenty-two participants who could not communicate effectively in English (to read aloud to the technician the characters in the autorefractor's visual acuity charts) and 20 participants with missing visual acuity data for either eye (unless the remaining eye had a presenting visual acuity of 20/40 or better). Therefore, the final sample consisted of 6134 individuals for the current analysis.

The Tenets of the Declaration of Helsinki were followed and approvals from all the necessary institutional review boards were obtained. All participants provided written informed consent.

Visual Impairment

Presenting visual acuity was measured in each eye separately by a trained technician in a dimly lit room using a Nidek ARK-760 autorefractor (Nidek Co Ltd, Tokyo, Japan) with built-in visual acuity charts containing the 20/20, 20/25, 20/30, 20/40, 20/50, 20/60, 20/80, and 20/200 lines using the same model equipment and technical protocol developed for and used in the U.S. National Health and Nutrition Examination Survey (NHANES).^[14] All lines on the visual acuity chart contained five characters (letters, numbers or both) except the 20/200 line, which, because of the large size of the characters on this line, contained only two characters. Participants completed this part of the examination using their usual distance refractive correction, if any. Beginning with the 20/50 line, the participant had to read at least four out of five characters correctly to advance to the next line (depicting characters smaller in size). If the person could not read the 20/50 line, the 20/200 line was presented, and if the person could read at least one of the two characters correctly, the 20/80 line was presented and if the participant could read at least four of the characters correctly, the 20/60 line was presented, and so on. The last line read correctly was recorded as the individual's visual acuity in that eye. If the presenting visual acuity was 20/30 or worse, visual acuity aided by automated objective refraction without refinement was also measured, starting with the 20/25 line, and if the person could read at least four characters, we considered the eye corrected. Otherwise, the 20/50 line was presented, and the same protocol described for assessing presenting acuity was followed.

Visual impairment was defined as a presenting visual acuity of 20/50 or worse in the better-seeing eye. Visual impairment due to uncorrected refractive error was defined as presenting visual impairment which improved, following automated refraction, to 20/40 or better. Presenting visual impairment that did not improve, following automated refraction, to 20/40 or better was defined as visual impairment due to non-refractive causes.

Participant Characteristics and Risk Factors for Visual Impairment

Questionnaires on demographic and lifestyle characteristics and health profiles were completed by all participants. Data used in this analysis included sex, race/ethnicity (White, Chinese, Black or Hispanic), education (less than high school, completed high school, completed some college or college graduate) and marital status (single, married, divorced or widowed), as collected at the initial MESA visit, and age, current employment (homemaker, employed, unemployed or retired), annual family income (< \$20,000, \$20,000-39,999, \$40,000-74,999 or \$75,000+), health insurance coverage (no insurance or some insurance), smoking status (never, former or current), diabetes (yes or no), hypertension (yes or no), and distance refractive correction (yes or no) collected at the second MESA visit (when visual acuity was measured). Health insurance status was categorized as none or some (private or government-provided) insurance. Diabetes status (yes/no) was defined as fasting glucose 7.0 mmol/L (126 mg/dl) and/or use of insulin or oral hypoglycemic medicine (i.e. untreated or treated). Hypertension (yes or no) was defined as systolic blood pressure 140 mmHg or diastolic blood pressure 90 mmHg or self-reported hypertension for which the participant reported current use of anti-hypertensive medication.

Statistical Analysis

Participant characteristics of the MESA cohort, overall and by race/ethnicity, were described using counts and percentages. The prevalence of visual impairment was estimated for each characteristic overall and within each racial/ethnic group, presented separately for men and women. Prevalence estimates were age-standardized to the 2000 U.S. Census population using the direct method to account for the differential age structure in the four racial/ethnic groups so the prevalence of visual impairment in each group could be contrasted, as well as compared against other U.S. studies utilizing the same standards. All participant characteristics, including age, education, marital status, current employment, annual family income, health insurance, smoking status, diabetes, hypertension, and refractive correction, were considered as possible risk factors and included as covariates in multivariable logistic regression analyses of visual impairment (impairment vs. no impairment). Multivariable logistic regression models were run separately for men and women to determine whether different risk factors were independently associated with visual impairment across racial/ethnic groups. Odds ratios (ORs) with 95% confidence intervals (CIs), adjusting for all other covariates, were included; p-values were reported relative to a reference group for each factor with the reference corresponding to an odds ratio of one. All analyses were two-sided, employed a 5% significance level, and were completed using SAS version 9.3 (SAS Institute, Cary, NC, USA).

RESULTS

Participant characteristics for individuals with visual acuity data from the MESA cohort are shown, by racial/ethnic group, in Table 1. White participants were older, more educated, more likely to be employed, have higher annual family incomes, have some health insurance, and already wear refractive correction compared to Chinese, Black, and Hispanic participants. Overall, 67.1% of the cohort wore refractive correction, ranging from 55.6% of Chinese to 75.0% of White participants.

Among all study participants, 6.6% (N=421) were visually impaired with the highest prevalence of impairment in Chinese participants (9.8%, N=81) followed by Hispanic (7.5%, N=107), Black (5.5%, N=104) and White (5.0%, N=129) participants. After adjustment for age and sex, Chinese remained significantly more likely to have visual impairment compared to the three other groups [Hispanic OR: 0.67 (95% CI: 0.48, 0.95), $p = 0.022$; Black OR: 0.60 (95% CI: 0.42, 0.88), $p = 0.008$; White OR: 0.64 (95% CI: 0.45, 0.92), $p = 0.014$].

The odds of visual impairment after adjustment for age was 28.3% greater for females than for males [OR: 1.28 (95% CI: 1.05, 1.57), $p = 0.018$]. This predominance in women was observed in each racial/ethnic group. Therefore, the prevalence of visual impairment for each characteristic was estimated in men and women separately (Table 2). Older age, lower annual family income, diabetes, and no current distance correction were also factors associated with higher risk of visual impairment in both men and women.

Visual impairment was due to uncorrected refractive error in 4.6% (N=286) of participants. Thus, the majority of visual impairment in this ethnically-diverse cohort was correctable, particularly at younger ages (< 65 years old), where more than 80% of visual impairment was due to uncorrected refractive error. Among participants with visual impairment due to nonrefractive causes (N=135), 21.5% had cataract (by self-report), 10.1% had age-related macular degeneration (AMD), 11.8% had mild non-proliferative retinopathy (NPR), and an additional 5.8% experienced moderate to severe NPR or proliferative retinopathy. The remainder was attributable to other conditions not directly investigated in this study. Figure 1 illustrates the prevalence of visual impairment due to uncorrected refractive error and non-refractive causes by racial/ethnic group and sex for different age groups (see also Supplemental Table A). Vision impairment, particularly due to non-refractive causes, was more common among those ages 65-87 years compared to those ages 46-64 years; however, in both age groups, uncorrected refractive error was the predominate reason for visual impairment.

In multivariable logistic regression analyses assessing risk factors (Tables 3 and 4), currently wearing distance refractive correction was the only consistent factor significantly associated with (reduced risk of) visual impairment in both men and women within and across racial/ethnic groups. Other factors associated with visual impairment in men were older age, lower income and no health insurance, but only older age was a consistent risk factor across racial/ethnic groups. In all women, older age and diabetes were significantly associated with

higher prevalence of visual impairment, but there were no consistent risk factors associated with impairment across racial/ethnic groups.

Figure 2 depicts, by age group, race/ethnicity and sex, the differences in prevalence of visual impairment due to uncorrected refractive error and non-refractive causes by whether participants had current distance refractive correction or not (see also Supplemental Table A). Although the prevalence of visual impairment is higher among those without any refractive correction, there are people already wearing refractive correction who are in need of a revised lens prescription to achieve 20/40 or better visual acuity.

DISCUSSION

Visual impairment affected 6.6% of individuals aged 45 years or older in the MESA cohort; of whom, the majority (67.9%) were able to achieve good visual acuity following refractive correction. In other words, for every 1000 adults aged 45 years or older, 66 were visually impaired, and of these, 45 could have good vision with new or updated refractive correction.

In the absence of a world-wide consensus on which method to use to measure visual acuity and define visual impairment, direct comparisons with other studies are approximate. In addition, the ability to attribute visual impairment to an underlying eye disease or diseases is dependent on whether a comprehensive ocular examination was performed. Accordingly, the lack of a comprehensive dilated eye examination in MESA allowed us only to report on refractive and non-refractive causes and limited our ability to attribute visual impairment to a specific cause. Nevertheless, the prevalence of visual impairment in the current analysis (6.6%) is higher than summary prevalence estimates from the Eye Diseases Prevalence Research group,^[2] based on pooling data from population-based studies from the U.S., Australia, and Europe, but is consistent with results from two recent U.S. studies^[14-15] that found 6.4% and 7.0% of individuals, respectively, were visually impaired (defined as a presenting visual acuity of 20/50 or worse in the better-seeing eye). These prevalence suggest a slight increase compared to earlier reports out of Australia and Europe,^[16-17] where differences in study design, particularly use of a best-corrected (not presenting) definition of impairment, likely was the reason behind the lower levels of impairment. Despite these differences, the observation that most cases of visual impairment are attributable to uncorrected refractive error is supported by this study, as well as others world-wide,^[14,16,18-20] and further justify the World Health Organization's Global Initiative for the Elimination of Avoidable Blindness referred to as Vision 2020: The Right to Sight [<http://www.who.int/blindness/en/>].

In MESA, women were more likely to have visual impairment compared to men, with prevalence of impairment increasing with advancing age for both men and women, from 3.9% and 4.7% in men and women aged 45-54 years, respectively, to 15.8% and 15.1% in men and women aged 75+ years old, respectively. Older age has been associated with visual impairment in numerous studies.^[2,15-16,18-19,21-29] However, the differential impact of sex on visual impairment has been inconsistent in the literature with some studies finding no differences between men and women.^[14-15,19,22,25] Among studies where significant sex differences were present, women were more likely to have visual impairment compared to

men,^[2,16,23-24,27-29] consistent with our results. In the present study, older age was a consistent predictor of increased visual impairment, but the effects were most pronounced in men and varied by racial/ethnic group, suggesting that the demographic characteristics (age, sex, and ethnicity) of the population may interact and result in different prevalence of impairment which, without adequate adjustment, could obfuscate comparisons of prevalence across countries.

Chinese participants had statistically significantly higher prevalence of visual impairment than Hispanic, Black and White participants in the MESA cohort. Chinese men and women also had higher prevalence of uncorrected refractive error compared to men and women in the other racial/ethnic groups. Many of the participants with visual impairment due to refractive error who were not already wearing refractive correction were found to have myopia (48 of 161); two had myopia > 5.0 diopters. A few individuals, particularly black and Hispanic women and Hispanic men, required correction for hyperopia. These findings are consistent with a previous analysis on refractive error in this cohort, which found hyperopia to be most common in Hispanic participants and myopia most common in Chinese participants.^[30] Due to the cross-sectional nature of the data collection, we could not discern why individuals with visual impairment who were already wearing refractive correction needed a new prescription. We can only speculate that adults, particularly seniors, already wearing refractive correction may not realize their visual acuity is worsening or there may be logistical constraints keeping them from seeking eye care and a revised prescription. However, when we excluded from analysis all individuals with myopia greater than or equal to 5.0 diopters, Chinese participants continued to have the highest prevalence of impairment and, in particular, visual impairment due to uncorrected refractive error, regardless of whether they already wore refractive correction. Chinese women, but not Chinese men, also had higher prevalence of impairment due to non-refractive causes compared to women from other racial/ethnic groups.

The ability to directly compare our results to other studies is limited by the inclusion of similar racial/ethnic groups and differences in study methodology as mentioned above; however, the finding that non-White individuals have higher prevalence of impairment is supported by several other studies.^[14-15,23,25-27] In three U.S. studies employing the same definition of visual impairment as ours, prevalence of visual impairment were reported by racial/ethnic group. Results from a U.S. NHANES study reported visual impairment was higher in Black (8.4%), Hispanic (10.7%), and Other (included Asian, Native American, and mixed race) (11.2%) participants compared to White individuals (5.0%).^[14] Similarly, in the Salisbury Eye Evaluation Study, African-Americans, across all age groups, were 1.5 times more likely to have visual impairment compared to White participants.^[15] A study utilizing survey data from Hispanic and non-Hispanic participants in the U.S. also found the prevalence of visual impairment in White participants was lower than in Mexican-American and Puerto Rican participants.^[23]

The high prevalence of visual impairment among Chinese participants in the current study, relative to other ethnicities represented in MESA, is actually lower than reports from studies in China which used more stringent criteria for defining visual impairment (i.e. a presenting acuity of worse than 20/63 in the better eye compared to our definition of a presenting acuity

of 20/50 or worse in the better eye). The Liwan Eye Study, conducted in an urban region of Southern China, found 10.1% of adults aged 50 years and older to have visual impairment, predominantly due to cataract and refractive error.^[28] Another study from rural north-east China reported 9.6% of adults aged 40 years and older had a presenting visual impairment, attributed, in large part, to cataract and uncorrected refractive error ^[29].

Among elderly Chinese in Taiwan,^[26] 9.6% of participants were found to have uncorrected, but correctable, visual impairment (6/12 in the better eye that improved after refractive correction), slightly higher than what we observed in MESA Chinese (8.1%). Notably, in that study, like ours, many of the visually impaired individuals already wore distance refractive correction but the prescription was outdated. Uncorrected refractive error was also found to be a significant issue among Latinos of predominately Mexican ancestry with limited health care access in Los Angeles where prevalence was 15.1%,^[25] considerably higher than the 5.6% of Hispanic individuals in MESA.

Risk factors significantly associated with visual impairment other than increasing age in our study were few, varied by racial/ethnic group and differed for men and women. Only current distance refractive correction was consistently associated, in an inverse direction, with visual impairment; this was observed for both men and women and across different racial/ethnic groups. Current use of any refractive correction was associated with a 40 to 70% decrease in odds of impairment among men and women, consistent with existing literature.^[19,22,26-27] Yet, not all participants wearing refractive correction were free from visual impairment, suggesting that regular eye examinations and spectacle replacement are important factors to consider when allocating resources and providing coverage to reduce the burden of visual impairment, particularly among older adults.

Participants with the least income in our study were less likely to have refractive correction and more likely to be visually impaired, consistent with other studies.^[14,16,21,25] Conversely, higher socioeconomic status (education, income and having health insurance) was generally associated with lower risk of visual impairment in some, but not all, groups. The fact that older people with existing refractive correction could have good vision but do not, indicates that the socio-cultural issues underlying correctable visual impairment are not fully known. Additionally, the impact of any association between visual impairment and concomitant health conditions differs by age, sex, and race/ethnicity. Generally, poorer health has been reported in people with visual impairment, correctable or not.^[11,26,31]

Strengths of the current study include a large cohort of racially and ethnically diverse individuals, standardized procedures for measuring visual impairment utilizing the identical methodology as in the NHANES study, use of presenting visual acuity in defining visual impairment, and an extensive profile of participant characteristics allowing us to investigate potential risk factors. However, there are some limitations. The study utilized a cross-sectional design with a single measurement of demographic and health variables. No pharmacologic dilation was used. Demographic composition of this sample may limit the generalizability of these findings to studies in other communities. Additionally, because the MESA eye examination was not comprehensive, we were unable to assign a cause to all cases whose visual impairment could not be improved with refractive correction, although as

has been reported previously, prevalence of AMD^[32] and diabetic retinopathy in the MESA cohort were low.^[33] Finally, it is possible that the presenting visual acuity of some eyes could be improved with refractive correction, but if the acuity did not improve to at least 20/40 we did not, for the purposes of this analysis, consider the improvement to be clinically meaningful enough to warrant refractive correction (or a new prescription if the person was already wearing correction); however, we recognize that for some people any improvement in visual acuity may be meaningful and worthwhile.

In conclusion, 5.6% of men and 7.5% of women from this MESA cohort of older adults (aged 45 years or older) were visually impaired. In the vast majority of instances, the provision of refractive correction (either de novo or an update to current correction) would ameliorate the impairment. Even in this U.S. cohort of adults where use of refractive correction was already high, uncorrected refractive error remains a public health problem, particularly among older individuals who may not realize they have unmet eye care needs among their health concerns.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

This research was supported by contracts N01-HC-95159, N01-HC-95160, N01-HC-95161, N01-HC-95162, N01-HC-95163, N01-HC-95164, N01-HC-95165, N01-HC-95167, N01-HC-95168, and N01-HC-95169 from the National Heart, Lung, and Blood Institute and by grants UL1-RR-024156 and UL1-RR-025005 from NCRR. Additional support was provided by National Institute of Health (NIH) grant HL69979-03 (Klein R, Wong TY) and the Intramural Research Program at the National Eye Institute (ZIAEY000403). The authors acknowledge the contributions of our recently deceased colleague, Dr. Mohammed F. Saad, who would have been a co-author on this manuscript. Additionally, we thank the other investigators, the staff, and the participants of the MESA study for their valuable contributions. A full list of participating MESA investigators and institutions can be found at <http://www.mesa-nhlbi.org>.

REFERENCES

1. World Health Organization (WHO). [14 August 2014] Visual impairment and blindness fact sheet. 2014. at <http://www.who.int/mediacentre/factsheets/fs282/en/>
2. The Eye Diseases Prevalence Research Group. Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol*. 2004; 122:477–485. [PubMed: 15078664]
3. Lin MY, Gutierrez PR, Stone KL, et al. Vision impairment and combined vision and hearing impairment predict cognitive and functional decline in older women. *J Am Geriatr Soc*. 2004; 52:1996–2002. [PubMed: 15571533]
4. Zhang X, McKeever Bullard K, Cotch MF, et al. Association between depression and functional vision loss in persons 20 years of age or older in the United States, NHANES 2005-2008. *JAMA Ophthalmol*. 2013; 131:573–581. [PubMed: 23471505]
5. Reuben DB, Mui S, Damesyn M, et al. The prognostic value of sensory impairment in older persons. *J Am Geriatr Soc*. 1999; 47:930–935. [PubMed: 10443852]
6. Crews JE, Jones GC, Kim JH. Double jeopardy: the effects of comorbid conditions among older people with vision loss. *J Vis Impair Blind*. 2006; 100:824–848.
7. Lee DJ, Gomez-Marin O, Lam BL, Zheng DD. Visual acuity impairment and mortality in US adults. *Arch Ophthalmol*. 2002; 120:1544–1550. [PubMed: 12427070]
8. Ivers RQ, Norton R, Cumming RG, Butler M, Campbell AJ. Visual impairment and risk of hip fracture. *Am J Epidemiol*. 2000; 152:633–639. [PubMed: 11032158]

9. Jones GC, Rovner BW, Crews JE, Danielson ML. Effects of depressive symptoms on health behavior practices among older adults with vision loss. *Rehabil Psychol*. 2009; 54:164–172. [PubMed: 19469606]
10. Horowitz A. Depression and vision and hearing impairments in later life. *Generations*. 2003; 27:32–38.
11. Wang X, Lamoureux E, Zheng Y, Ang M, Wong TY, Luo N. Health burden associated with visual impairment in Singapore: the Singapore Epidemiology of Eye Disease Study. *Ophthalmology*. 2014; 121:1837–1842. [PubMed: 24768238]
12. Gordoio A, Cutler H, Pezzullo L, et al. An estimation of the worldwide economic and health burden of visual impairment. *Glob Public Health*. 2012; 7:465–481. [PubMed: 22136197]
13. Bild DE, Bluemke DA, Burke GL, et al. Multi-ethnic study of atherosclerosis: objectives and design. *Am J Epidemiol*. 2002; 156:871–881. [PubMed: 12397006]
14. Vitale S, Cotch MF, Sperduto RD. Prevalence of visual impairment in the United States. *JAMA*. 2006; 295:2158–2163. [PubMed: 16684986]
15. Munoz B, West SK, Rubin GS, et al. Causes of blindness and visual impairment in a population of older Americans. *Arch Ophthalmol*. 2000; 118:819–825. [PubMed: 10865321]
16. Attebo K, Mitchell P, Smith W. Visual acuity and the causes of visual loss in Australia. The Blue Mountains Eye Study. *Ophthalmology*. 1996; 103:357–364. [PubMed: 8600410]
17. Klaver CCW, Wolfs RCW, Vingerling JR, Hofman A, de Jong PTVM. Age-specific prevalence and causes of blindness and visual impairment in an older population. *Arch Ophthalmol*. 1998; 116:653–658. [PubMed: 9596502]
18. Klein R, Lee KE, Gangnon RE, Klein BEK. Incidence of visual impairment over a 20-year period. *Ophthalmology*. 2013; 120:1210–1219. [PubMed: 23466270]
19. Foran S, Rose K, Wang JJ, Mitchell P. Correctable visual impairment in an older population: the Blue Mountains Eye Study. *Am J Ophthalmol*. 2002; 134:712–719. [PubMed: 12429248]
20. Evans BJ, Rowlands G. Correctable visual impairment in older people: a major unmet need. *Ophthalmic Physiol Opt*. 2004; 24:161–180. [PubMed: 15130165]
21. Ko F, Vitale S, Chou CF, Cotch MF, Saaddine J, Friedman DS. Prevalence of nonrefractive visual impairment in US adults and associated risk factors, 1999–2002 and 2005–2008. *JAMA*. 2012; 308:2361–2368. [PubMed: 23232894]
22. Thiagalingam S, Cumming RG, Mitchell P. Factors associated with undercorrected refractive errors in an older population: the Blue Mountains Eye Study. *Br J Ophthalmol*. 2002; 86:1041–1045. [PubMed: 12185135]
23. Lam BL, Lee DJ, Gomez-Marin O. Prevalence of usual-corrected binocular distance visual acuity impairment in Hispanic and non-Hispanic adults. *Ophthalmic Epidemiology*. 2000; 7:73–83. [PubMed: 10652174]
24. Varma R, Ying-Lai M, Klein R, Azen SP, Los Angeles Latino Eye Study Group. Prevalence and risk indicators of visual impairment and blindness in Latinos. The Los Angeles Latino Eye Study. *Ophthalmol*. 2004; 111:1132–1140.
25. Varma R, Wang MY, Ying-Lai M, Donofrio J, Azen SP, Los Angeles Latino Eye Study Group. The prevalence and risk indicators of uncorrected refractive error and unmet refractive need in Latinos: the Los Angeles Latino Eye Study. *Invest Ophthalmol Vis Sci*. 2008; 49:5264–5273. [PubMed: 18441303]
26. Kuang TM, Tsai SY, Hsu WM, Cheng CY, Liu JH, Chou P. Correctable visual impairment in an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Invest Ophthalmol Vis Sci*. 2007; 48:1032–1037. [PubMed: 17325143]
27. Rosman M, Wong TY, Tay WT, Tong L, Saw SM. Prevalence and risk factors of undercorrected refractive errors among Singaporean Malay adults: the Singaporean Malay Eye Study. *Invest Ophthalmol Vis Sci*. 2009; 50:3621–3628. [PubMed: 19264898]
28. Huang S, Zheng Y, Foster PJ, Huang W, He M. Liwan Eye Study. Prevalence and causes of visual impairment in Chinese adults in urban southern China. *Arch Ophthalmol*. 2009; 127:1362–1367. [PubMed: 19822854]

29. Song W, Sun X, Shao Z, et al. Prevalence and causes of visual impairment in a rural North-East China adult population: a population-based survey in Bin County, Harbin. *Acta Ophthalmol.* 2010; 88:669–674. [PubMed: 19900201]
30. Pan CW, Klein BE, Cotch MF, et al. Racial variations in the prevalence of refractive errors in the United States: the Multi-Ethnic Study of Atherosclerosis. *Am J Ophthalmol.* 2013; 155:1129–1138. [PubMed: 23453694]
31. Loprinzi, PD.; Zebardast, N.; Ramulu, PY. Cardiorespiratory fitness and vision loss among young and middle-age U.S. adults.. *Am J Health Promot.* 2014. [Epub ahead of print: <http://www.ncbi.nlm.nih.gov/pubmed/24717068>]
32. Klein R, Klein BE, Knudtson MD, et al. Prevalence of age-related macular degeneration in 4 racial/ethnic groups in the multi-ethnic study of atherosclerosis. *Ophthalmology.* 2006; 113:373–380. [PubMed: 16513455]
33. Wong TY, Klein R, Islam A, et al. Diabetic retinopathy in a multi-ethnic cohort in the United States. *Am J Ophthalmol.* 2006; 141:446–455. [PubMed: 16490489]

Figure 1.
Prevalence of Visual Impairment due to Uncorrected Refractive Error and Non-Refractive Causes by Age, Sex and Race/Ethnicity in the Multi-Ethnic Study of Atherosclerosis Cohort

Figure 2.
Prevalence of Visual Impairment due to Uncorrected Refractive Error and Non-Refractive Causes by Age, Sex, Race/Ethnicity and Use of Distance Correction in the Multi-Ethnic Study of Atherosclerosis Cohort

Table 1

Participant Characteristics of the Multi-Ethnic Study of Atherosclerosis Cohort

Characteristic	All Participants (N=6134)	Race/Ethnicity			
		White (N=2442, 39.9%)	Chinese (N=714, 11.7%)	Black (N=1648, 26.9%)	Hispanic (N=1322, 21.6%)
Age, years					
46-54	23.4% (1434)	21.6% (527)	24.2% (173)	23.7% (391)	26.0% (343)
55-64	29.2% (1788)	29.0% (707)	30.0% (214)	28.4% (468)	30.2% (399)
65-74	30.8% (1888)	31.2% (763)	29.7% (212)	31.9% (525)	29.4% (388)
75+	16.6% (1016)	18.2% (445)	16.1% (115)	16.0% (264)	14.5% (192)
Sex					
Female	52.4% (3210)	51.4% (1255)	50.1% (358)	55.4% (913)	51.7% (684)
Male	47.6% (2916)	48.6% (1187)	49.9% (356)	44.6% (735)	48.3% (638)
Education					
Less than high school	16.6% (1012)	4.7% (114)	21.5% (153)	11.3% (185)	42.1% (557)
Completed high school/GED	18.1% (1107)	16.4% (399)	16.7% (119)	18.7% (306)	21.3% (281)
Completed some college	28.6% (1750)	27.8% (678)	20.6% (147)	35.4% (579)	26.1% (345)
College graduate	36.7% (2247)	51.1% (1244)	41.2% (294)	34.7% (568)	10.5% (139)
Marital Status					
Single	8.4% (512)	9.3% (225)	2.7% (19)	11.2% (181)	6.7% (87)
Married	61.8% (3748)	66.6% (1615)	82.1% (585)	46.6% (752)	60.4% (790)
Divorced	17.3% (1048)	13.8% (335)	6.0% (43)	24.9% (401)	20.4% (267)
Widowed	12.5% (760)	10.3% (250)	9.3% (66)	17.4% (280)	12.5% (164)
Current Employment					
Homemaker	10.6% (647)	10.1% (246)	14.5% (103)	6.7% (109)	14.4% (189)
Employed	46.9% (2855)	49.8% (1212)	47.0% (335)	43.9% (713)	45.2% (595)
Unemployed	2.7% (165)	1.6% (39)	3.4% (24)	3.1% (50)	4.0% (52)
Retired	39.8% (2423)	38.5% (937)	35.2% (251)	46.4% (754)	36.5% (481)
Annual Family Income					
< \$20,000	23.1% (1358)	10.4% (245)	43.6% (309)	20.0% (308)	38.4% (496)
\$20,000-39,999	27.3% (1611)	21.3% (501)	23.0% (163)	31.9% (491)	35.3% (456)
\$40,000-74,999	26.2% (1541)	30.8% (724)	15.4% (109)	30.3% (466)	18.7% (242)

Characteristic	All Participants (N=6134)	Race/Ethnicity			
		White (N=2442, 39.9%)	Chinese (N=714, 11.7%)	Black (N=1648, 26.9%)	Hispanic (N=1322, 21.6%)
\$75,000 +	23.5% (1382)	37.5% (882)	18.1% (128)	17.8% (274)	7.6% (98)
Health Insurance					
No insurance	6.7% (411)	1.8% (44)	14.2% (101)	5.1% (83)	13.9% (183)
Some insurance *	93.3% (5697)	98.2% (2396)	85.8% (612)	94.9% (1555)	86.1% (1134)
Smoking Status					
Never	49.2% (2998)	43.9% (1070)	73.6% (525)	43.9% (717)	52.3% (686)
Former	39.2% (2389)	45.2% (1101)	20.8% (148)	39.9% (651)	37.2% (489)
Current	11.6% (708)	10.9% (266)	5.6% (40)	16.2% (264)	10.5% (138)
Diabetes					
No	85.4% (5192)	91.7% (2222)	85.6% (605)	80.5% (1313)	79.6% (1052)
Yes	14.7% (891)	8.3% (202)	14.4% (102)	19.5% (318)	20.4% (269)
Hypertension					
No	54.4% (3295)	61.0% (1469)	63.5% (452)	38.8% (632)	56.5% (742)
Yes	45.7% (2768)	39.0% (939)	36.5% (260)	61.2% (997)	43.5% (572)
Wear Distance Correction					
No	32.9% (2016)	25.0% (611)	44.4% (317)	33.5% (550)	40.5% (535)
Yes	67.1% (4108)	75.0% (1829)	55.6% (397)	66.5% (1092)	59.5% (786)

Percentages for participant characteristics in this table were not age-standardized.

* Includes all types of insurance, including private and government-provided

Prevalence of Visual Impairment among Men and Women, the Multi-Ethnic Study of Atherosclerosis

Table 2

Characteristic	Men				Women					
	All	White	Chinese	Black	Hispanic	All	White	Chinese	Black	Hispanic
Total	5.6% (178)	4.2% (52)	7.6% (37)	4.4% (40)	6.6% (49)	7.5% (243)	6.0% (77)	11.6% (44)	6.4% (64)	8.3% (58)
Age, years										
46-54	3.9% (27)	3.5% (9)	4.8% (4)	2.8% (5)	5.3% (9)	4.7% (35)	1.5% (4)	10.0% (9)	3.8% (8)	8.1% (14)
55-64	2.7% (22)	1.5% (5)	2.9% (3)	2.0% (4)	5.5% (10)	4.9% (47)	2.9% (11)	9.9% (11)	4.2% (11)	6.5% (14)
65-74	5.7% (52)	2.6% (10)	15.6% (17)	4.6% (11)	7.2% (14)	8.4% (81)	7.3% (28)	11.7% (12)	7.3% (21)	10.3% (20)
75+	15.8% (77)	12.7% (28)	21.3% (13)	17.4% (20)	17.6% (16)	15.1% (80)	15.1% (34)	22.2% (12)	16.1% (24)	9.9% (10)
Education										
Less than high school	11.5% (50)	5.6% (4)	5.9% (7)	9.1% (8)	11.5% (31)	13.7% (72)	18.9% (8)	22.4% (22)	13.5% (11)	10.8% (31)
Completed high school/GED	7.2% (32)	13.5% (14)	4.2% (3)	7.3% (10)	2.5% (5)	7.5% (54)	4.9% (16)	10.7% (8)	5.6% (13)	9.2% (17)
Completed some college	5.5% (44)	3.8% (10)	13.4% (12)	4.1% (12)	5.2% (10)	7.1% (64)	6.9% (28)	9.9% (8)	6.0% (20)	4.9% (8)
College graduate	4.2% (52)	3.1% (24)	6.5% (15)	3.7% (10)	1.8% (3)	5.1% (51)	4.8% (24)	4.6% (6)	5.7% (19)	3.1% (2)
Marital Status										
Single	7.0% (16)	7.4% (8)	8.3% (2)	4.5% (4)	6.8% (2)	8.8% (26)	7.5% (9)	3.0% (3)	6.8% (6)	12.0% (8)
Married	4.9% (104)	2.8% (27)	9.7% (31)	5.2% (21)	5.9% (25)	7.1% (107)	5.5% (35)	12.3% (28)	5.5% (16)	7.3% (28)
Divorced	7.4% (33)	8.6% (11)	10.0% (2)	4.7% (8)	10.5% (12)	7.6% (40)	6.7% (10)	13.1% (4)	7.3% (13)	8.4% (13)
Widowed	11.7% (25)	11.4% (6)	11.0% (2)	12.7% (7)	8.2% (10)	7.4% (66)	6.1% (21)	16.3% (9)	6.1% (27)	5.3% (9)
Current Employment										
Homemaker	9.8% (5)	4.2% (2)	14.9% (2)	3.0% (1)	0.0% (0)	5.7% (57)	5.3% (17)	9.2% (16)	3.6% (8)	7.0% (16)
Employed	3.9% (58)	3.0% (19)	4.8% (13)	2.1% (7)	6.0% (19)	7.8% (70)	4.9% (18)	9.7% (14)	5.8% (17)	8.5% (21)
Unemployed	7.4% (6)	6.7% (1)	0.0% (0)	3.6% (1)	13.8% (4)	7.8% (4)	6.0% (1)	6.7% (1)	0.0% (0)	3.9% (2)
Retired	8.4% (108)	5.7% (30)	14.7% (21)	9.0% (31)	9.5% (26)	9.6% (109)	9.7% (40)	12.0% (13)	9.1% (37)	9.2% (19)
Annual Family Income										
< \$20,000	14.3% (72)	12.3% (11)	4.9% (18)	12.1% (14)	14.7% (29)	10.6% (102)	7.6% (22)	15.8% (25)	5.5% (20)	10.7% (35)
\$20,000-39,999	5.6% (41)	5.2% (9)	7.9% (8)	5.5% (11)	5.5% (13)	8.1% (68)	6.0% (19)	15.5% (13)	4.9% (17)	8.7% (19)
\$40,000-74,999	3.7% (29)	3.8% (15)	2.7% (2)	3.2% (7)	3.8% (5)	5.7% (35)	5.5% (18)	8.7% (3)	6.2% (13)	0.6% (1)
\$75,000 +	3.5% (28)	3.3% (15)	12.7% (8)	2.6% (4)	2.0% (1)	4.3% (24)	3.9% (14)	3.6% (2)	4.7% (6)	5.9% (2)
Health Insurance										

Characteristic	Men					Women				
	All	White	Chinese	Black	Hispanic	All	White	Chinese	Black	Hispanic
No insurance	9.6% (19)	11.1% (3)	17.5% (4)	4.9% (2)	15.0% (10)	5.2% (14)	5.9% (1)	11.5% (6)	0.0% (0)	6.7% (7)
Some insurance*	5.8% (158)	4.2% (49)	7.2% (32)	5.5% (38)	5.6% (39)	7.4% (228)	6.1% (76)	10.7% (38)	6.6% (63)	8.4% (51)
Smoking Status										
Never	6.4% (70)	3.9% (18)	9.9% (23)	5.3% (13)	6.6% (16)	8.1% (156)	5.9% (40)	12.0% (43)	7.1% (37)	7.2% (36)
Former	4.9% (78)	4.3% (26)	6.0% (9)	4.9% (17)	6.0% (26)	6.2% (64)	5.3% (30)	0.0% (0)	4.8% (17)	10.0% (17)
Current	7.0% (28)	5.9% (8)	7.0% (4)	6.3% (9)	8.5% (7)	9.3% (22)	9.5% (7)	14.3% (1)	7.2% (9)	7.3% (5)
Diabetes										
No	5.7% (138)	3.8% (41)	8.1% (32)	5.3% (31)	6.1% (34)	6.7% (185)	5.5% (66)	10.8% (34)	5.5% (49)	7.1% (42)
Yes	8.3% (38)	7.2% (11)	3.2% (4)	5.4% (8)	8.7% (15)	14.0% (56)	15.1% (11)	18.2% (9)	10.7% (20)	17.1% (16)
Hypertension										
No	5.7% (91)	4.4% (29)	8.8% (25)	4.0% (12)	6.4% (25)	7.6% (116)	5.6% (39)	11.0% (24)	7.6% (23)	8.1% (30)
Yes	6.7% (85)	3.9% (22)	4.3% (12)	6.6% (28)	6.1% (23)	7.7% (127)	6.1% (38)	17.7% (20)	5.8% (41)	8.9% (28)
Wear Distance Correction										
No	9.2% (93)	6.4% (22)	11.3% (22)	7.8% (21)	9.8% (28)	10.9% (108)	8.1% (25)	14.6% (26)	8.2% (24)	12.3% (33)
Yes	4.1% (85)	3.6% (30)	4.8% (15)	3.8% (19)	4.3% (21)	6.1% (135)	5.3% (52)	9.7% (18)	5.8% (40)	6.0% (25)

Prevalence estimates are age-standardized to the 2000 U.S. Census population using the direct method to allow for direct comparison across the ethnic groups.

* Includes all types of insurance, including private and government-provided

Table 3

Multivariable Logistic Regression Analyses of Factors Associated with Visual Impairment among Men, the Multi-Ethnic Study of Atherosclerosis

Characteristic	All Men *			White			Chinese			Black			Hispanic		
	OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value	
Age, years															
46-54	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
55-64	0.62 (0.33, 1.15)	0.127		0.42 (0.12, 1.49)	0.178		0.65 (0.13, 3.18)	0.596		0.26 (0.05, 1.47)	0.127		0.95 (0.35, 2.58)	0.920	
65-74	1.93 (1.03, 3.59)	0.039		1.30 (0.40, 4.24)	0.664		8.85 (2.10, 37.33)	0.003		1.01 (0.20, 5.05)	0.989		1.26 (0.39, 4.05)	0.700	
75+	6.71 (3.46, 13.02)	<0.001		7.03 (2.25, 21.97)	<0.001		21.56 (3.78, 123.03)	<0.001		5.09 (0.99, 26.25)	0.052		4.59 (1.16, 18.16)	0.030	
Education															
Less than high school	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Completed high school/GED	0.95 (0.56, 1.62)	0.853		1.23 (0.33, 4.55)	0.762		0.77 (0.14, 4.16)	0.764		2.06 (0.60, 7.12)	0.253		0.41 (0.14, 1.17)	0.095	
Completed some college	0.70 (0.42, 1.18)	0.181		0.32 (0.09, 1.24)	0.100		2.07 (0.57, 7.54)	0.272		1.30 (0.37, 4.51)	0.683		0.65 (0.26, 1.57)	0.335	
College graduate	0.65 (0.37, 1.13)	0.128		0.37 (0.10, 1.41)	0.145		0.71 (0.18, 2.80)	0.620		1.74 (0.47, 6.47)	0.412		0.48 (0.12, 1.97)	0.310	
Marital Status															
Single	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Married	0.63 (0.34, 1.18)	0.148		0.28 (0.11, 0.73)	0.010		0.30 (0.03, 2.75)	0.289		2.45 (0.57, 10.48)	0.227		1.13 (0.22, 5.92)	0.882	
Divorced	1.15 (0.59, 2.26)	0.683		0.96 (0.33, 2.74)	0.932		0.29 (0.02, 4.14)	0.361		1.60 (0.37, 6.87)	0.531		2.53 (0.46, 14.02)	0.289	
Widowed	1.17 (0.55, 2.51)	0.683		0.55 (0.15, 2.04)	0.373		0.94 (0.05, 19.13)	0.966		2.03 (0.39, 10.65)	0.404		3.12 (0.52, 18.82)	0.214	
Current Employment															
Employed	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Unemployed	1.14 (0.44, 2.93)	0.790		1.45 (0.14, 15.31)	0.758		NC	NC		1.13 (0.11, 11.51)	0.921		1.03 (0.28, 3.76)	0.961	
Not Seeking Employment (e.g. homemaker, retired)	0.82 (0.51, 1.33)	0.424		0.94 (0.41, 2.19)	0.889		0.67 (0.22, 2.02)	0.473		1.67 (0.45, 6.17)	0.443		0.56 (0.22, 1.44)	0.228	
Annual Family Income															
< \$20,000	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
\$20,000-39,999	0.55 (0.35, 0.87)	0.011		0.38 (0.14, 1.08)	0.068		1.17 (0.40, 3.43)	0.778		0.50 (0.19, 1.33)	0.163		0.40 (0.18, 0.88)	0.022	
\$40,000-74,999	0.55 (0.32, 0.95)	0.033		0.61 (0.22, 1.64)	0.324		0.50 (0.09, 2.65)	0.413		0.32 (0.10, 1.02)	0.054		0.41 (0.13, 1.27)	0.122	
\$75,000 +	0.71 (0.38, 1.33)	0.283		0.76 (0.26, 2.25)	0.623		4.25 (1.06, 16.99)	0.041		0.35 (0.08, 1.51)	0.161		0.20 (0.02, 1.78)	0.148	
Health Insurance															
No insurance	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		

Characteristic	All Men *			White			Chinese			Black			Hispanic		
	OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value	
Some insurance **	0.53 (0.29, 0.97)	0.040		0.45 (0.10, 2.09)	0.310		0.46 (0.12, 1.82)	0.269		0.51 (0.09, 2.95)	0.456		0.68 (0.28, 1.68)	0.402	
Smoking Status															
Never	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Former	0.71 (0.49, 1.03)	0.074		0.76 (0.38, 1.53)	0.444		0.29 (0.11, 0.77)	0.013		1.09 (0.45, 2.64)	0.845		0.91 (0.44, 1.87)	0.788	
Current	1.02 (0.60, 1.72)	0.949		1.23 (0.45, 3.41)	0.684		0.88 (0.20, 3.78)	0.858		1.30 (0.42, 4.00)	0.648		1.20 (0.43, 3.34)	0.730	
Diabetes															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	1.25 (0.81, 1.91)	0.313		2.16 (0.97, 4.83)	0.060		0.49 (0.13, 1.75)	0.269		0.76 (0.29, 2.03)	0.589		1.33 (0.63, 2.80)	0.455	
Hypertension															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	0.94 (0.66, 1.35)	0.741		0.81 (0.42, 1.56)	0.518		0.66 (0.26, 1.64)	0.370		1.23 (0.53, 2.89)	0.631		1.28 (0.64, 2.60)	0.486	
Wear Distance Correction															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	0.43 (0.30, 0.61)	< 0.001		0.45 (0.23, 0.85)	0.014		0.39 (0.17, 0.88)	0.024		0.32 (0.15, 0.70)	0.005		0.44 (0.22, 0.89)	0.023	

OR=odds ratio, CI=confidence interval, NC=not calculated - category was excluded due to insufficient number of cases; p-value relative to reference category

* Models for all men were also adjusted for race/ethnicity

** Includes all types of insurance, including private and government-provided.

Table 4

Multivariable Logistic Regression Analyses of Factors Associated with Visual Impairment among Women, the Multi-Ethnic Study of Atherosclerosis

Characteristic	All Women *			White			Chinese			Black			Hispanic		
	OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value	
Age, years															
46-54	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
55-64	1.06 (0.66, 1.71)	0.805		2.10 (0.64, 6.90)	0.220		0.90 (0.33, 2.49)	0.839		0.88 (0.31, 2.48)	0.805		0.99 (0.42, 2.34)	0.982	
65-74	1.60 (0.95, 2.70)	0.080		4.58 (1.38, 15.22)	0.013		0.72 (0.20, 2.58)	0.609		1.38 (0.43, 4.40)	0.584		1.53 (0.58, 4.04)	0.394	
75+	3.05 (1.69, 5.51)	<0.001		9.16 (2.52, 33.33)	<0.001		1.89 (0.48, 7.45)	0.363		3.51 (0.97, 12.70)	0.056		1.24 (0.37, 4.19)	0.732	
Education															
Less than high school	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Completed high school/GED	0.79 (0.52, 1.20)	0.259		0.66 (0.24, 1.79)	0.411		0.40 (0.16, 1.04)	0.059		0.74 (0.27, 2.01)	0.550		1.33 (0.67, 2.62)	0.411	
Completed some college	0.78 (0.51, 1.20)	0.253		0.95 (0.36, 2.50)	0.913		0.52 (0.19, 1.42)	0.202		0.76 (0.29, 1.96)	0.567		0.76 (0.31, 1.86)	0.553	
College graduate	0.62 (0.38, 1.02)	0.058		0.62 (0.22, 1.79)	0.380		0.29 (0.10, 0.89)	0.030		0.72 (0.25, 2.06)	0.545		0.49 (0.10, 2.37)	0.371	
Marital Status															
Single	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Married	0.68 (0.42, 1.11)	0.119		0.62 (0.26, 1.47)	0.277		0.24 (0.05, 1.06)	0.060		0.74 (0.26, 2.14)	0.582		0.80 (0.32, 2.00)	0.626	
Divorced	0.62 (0.36, 1.07)	0.084		0.60 (0.22, 1.61)	0.308		0.51 (0.08, 3.20)	0.468		0.72 (0.25, 2.09)	0.551		0.51 (0.18, 1.40)	0.190	
Widowed	0.70 (0.42, 1.17)	0.172		0.59 (0.24, 1.49)	0.266		0.25 (0.05, 1.29)	0.098		1.18 (0.42, 3.32)	0.754		0.45 (0.16, 1.30)	0.140	
Current Employment															
Employed	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Unemployed	0.70 (0.21, 2.31)	0.553		1.35 (0.15, 11.92)	0.789		0.88 (0.10, 7.94)	0.910		NC	NC		0.66 (0.08, 5.44)	0.695	
Not Seeking Employment (e.g. homemaker, retired)	1.03 (0.69, 1.54)	0.876		1.26 (0.62, 2.56)	0.532		1.03 (0.40, 2.66)	0.960		1.00 (0.42, 2.39)	0.994		0.68 (0.31, 1.51)	0.348	
Annual Family Income															
< \$20,000	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
\$20,000-39,999	0.93 (0.64, 1.34)	0.692		0.65 (0.31, 1.38)	0.263		2.04 (0.84, 4.97)	0.117		0.76 (0.34, 1.69)	0.500		0.60 (0.30, 1.18)	0.138	
\$40,000-74,999	0.62 (0.38, 1.00)	0.052		0.67 (0.30, 1.51)	0.333		0.75 (0.18, 3.10)	0.693		0.74 (0.27, 2.01)	0.554		0.06 (0.01, 0.47)	0.008	
\$75,000 +	0.64 (0.35, 1.16)	0.139		0.59 (0.23, 1.51)	0.271		0.58 (0.11, 3.08)	0.526		0.97 (0.26, 3.64)	0.963		0.57 (0.10, 3.22)	0.527	
Health Insurance															
No insurance	1 [Reference]			1 [Reference]			1 [Reference]			NC	NC		1 [Reference]		

Characteristic	All Women*			White			Chinese			Black			Hispanic		
	OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value		OR (95% CI)	p-value	
Some insurance**	1.17 (0.63, 2.17)	0.619		0.31 (0.04, 2.79)	0.298		1.30 (0.43, 3.90)	0.645		NC	NC		1.95 (0.76, 5.00)	0.164	
Smoking Status															
Never	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Former	1.06 (0.76, 1.48)	0.732		1.11 (0.65, 1.90)	0.692		NC	NC		0.84 (0.44, 1.60)	0.595		1.26 (0.66, 2.40)	0.480	
Current	0.97 (0.56, 1.68)	0.912		0.65 (0.21, 1.98)	0.446		1.65 (0.17, 16.34)	0.670		1.24 (0.52, 2.95)	0.632		1.20 (0.38, 3.80)	0.760	
Diabetes															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	1.79 (1.25, 2.56)	0.001		2.39 (1.11, 5.14)	0.026		1.47 (0.60, 3.60)	0.395		1.97 (1.01, 3.85)	0.048		1.69 (0.88, 3.28)	0.118	
Hypertension															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	0.83 (0.61, 1.13)	0.232		0.83 (0.49, 1.42)	0.507		1.39 (0.65, 2.98)	0.397		0.61 (0.32, 1.15)	0.124		0.82 (0.44, 1.53)	0.534	
Wear Distance Correction															
No	1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]			1 [Reference]		
Yes	0.48 (0.36, 0.64)	<0.001		0.56 (0.33, 0.95)	0.032		0.58 (0.28, 1.21)	0.146		0.47 (0.26, 0.85)	0.012		0.33 (0.18, 0.60)	<0.001	

OR=odds ratio, CI=confidence interval, NC=not calculated - category was excluded due to insufficient number of cases; p-value relative to reference category

* Models for all women were also adjusted for race/ethnicity

** Includes all types of insurance, including private and government-provided.