Assessing the burden of worsening self-reported vision in older Americans using the Health and Retirement Study

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Abstract

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Background

Visual disorders are estimated to affect about 3.6% of Americans by 2020. Vision impairment has a substantial impact on individuals functionally. Vision impairment is associated with many comorbidities, functional limitations, as well as higher caregiving needs. This study aims to assess the transition to self-reported vision impairment and the effect on an individual's functionality and ability to live independently.

Methods

The Health and Retirement Study is an ongoing, biennial survey of older Americans that collects an abundance of data on an individual's family, health, and financial circumstances. The explanatory variable of interest was a dichotomous variable of vision impaired or not vision impaired as defined by their self-reported vision status. Outcomes studied were functional limitations defined as difficulty performing activities of daily living (ADLs) and instrumental activities of daily living (IADLs), likelihood of move to nursing home, and both informal and formal caregiving needs. Descriptive univariate and bivariate statistics were performed to describe the demographics of the sample over the ten waves of data used,

from 1995-2012. Multivariable logistic regressions controlling for sociodemographic characteristics, were performed to test the association between vision status and outcomes of interest for specific representative waves. Panel data methods of logistic regression were used to measure the association between a transition to impaired vision and the effect on functional limitations and nursing home residence while controlling for potential confounders and within-patient correlation. Specifically, mixed-effects logistic regressions with subject-level random-effects were conducted for the binary outcomes of nursing home residence, difficulty in performing at least one ADL, and difficulty in performing at least one IADL.

Results

The prevalence of overall vision impairment was, on average, about 6%. On average, about 5% and 7% of respondents had near and distal vision impairment, respectively. The overall prevalence of nursing home residence in our sample was approximately 2%. Prevalence of ADL and IADL limitations was stable across waves but ranged from 1%-20% for each of the six ADL and five IADL limitations. More respondents reported receiving informal caregiving versus formal caregiving; however the hours of caregiving received was similar for both formal and informal caregiving recipients. Multivariable logistic regression for three representative waves found numerically higher odds of a nursing home residence for vision impaired individuals compared to individuals with no vision impairment, though the difference was not significant. The odds ratios for 1998, 2006, and 2012 were 1.08 (95% CI: 0.64, 1.84), 1.09 (95% CI: 0.64, 1.86), and 1.22 (95% CI: 0.76, 1.97), respectively. Significant associations were found between vision impairment and functional limitations. Using a similar approach, the odds ratio for difficulty performing at least one ADL was 2.57 (95% CI: 2.16, 3.05), 2.37 (95% CI: 1.97, 2.84), and 2.31 (95% CI: 1.92, 2.77) in 1998, 2006, and 2012, respectively. The odds ratios for difficulty performing at least one IADL was 3.78 (95% CI: 3.15, 4.53), 3.94 (95% CI: 3.26, 4.76), and 3.49 (95% CI: 2.89, 4.22) in 1998, 2006, and 2012, respectively. In the mixed-effects logistic regression of the total study panel, a transition from no vision impairment to vision impairment was significantly associated with 1.37 times higher odds of a nursing home residence (95% CI: 1.05, 1.78), a 2.96 times higher odds of difficulty performing at least one ADL (95% CI: 2.71, 3.24), and a 4.02 times higher odds of difficulty performing at least one IADL (95% CI: 3.70, 4.37), after controlling for confounders.

Discussion

We found the estimated prevalence of visual impairment and functional limitations within our sample, and the association between the two, to remain relatively stable over time. Additionally, we found an age-adjusted transition to self-reported vision impairment within an individual to have significant detrimental effects on the ability to live independently and perform ADLs and IADLs without difficulty. Thus, prevention of this transition can substantially impact an individual's quality of life, and benefits derived from early detection and improved treatment of medical conditions that contribute to vision loss can have extensive value beyond simply improving vision.

Background

Visual disorders encompassing vision impairment, defined as best-corrected visual acuity less than 20/40, and blindness, defined as best-corrected visual acuity less than or equal to 20/200 in the better-seeing eye, have a large impact on the American population.[1] A population-based study estimated that in the year 2000, among Americans aged 40 years and older, 2.4 million (1.98%) were visually impaired and 937,000 (0.78%) were blind.[2] Projecting the rates to the year 2020, estimates suggest that 3.9 million Americans (2.5%) will be visually impaired and 1.6 million Americans (1.1%) will be blind.[2] The etiology of visual impairment and blindness varies by race, but age-related macular degeneration, diabetic retinopathy, cataract, and glaucoma are the leading causes.[2] The impact of visual disorders extends economically as well; the financial burden of visual disorders was estimated at $35.4 billion in 2004 USD.[3]

On an individual level, vision impairment has been associated with detrimental health effects. Previous studies have found that vision impairment in older adults was associated with comorbidities including depression[4], risk of hip fracture[5], and mortality risk.[6,7] Vision impairment has also been shown to be associated with disability and functional limitations.[7–17] Hung et al. described the prevalence of vision impairment and functional limitations over time in older Americans and found that the prevalence of vision impairment has decreased while the prevalence of functional limitations has remained comparably stable.[18] Studies that have assessed the association between vision impairment and functional limitations have primarily been cross-sectional in nature[9,10,12,13,15,16,19] or have studied a geographically-based population.[8,11,20,21] Cross-sectional studies preclude the ability to draw causal inferences as they are performed at one point in time and the temporal direction between explanatory and outcome variables cannot be determined. Sloan et al. studied the effects of changes in vision longitudinally in a nationally representative cohort and found the onset of impaired vision to be associated with limitations in Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL), but the study was focused on an older population; the mean age across their years of study was 81.6 years.[17] In addition to effects on the individual, vision impairment and blindness has also been found to be associated with higher caregiving needs including excess days of informal care and higher amounts of assistance received.[22,23]

Age has been found to be associated with self-reported visual impairment and the older population of Americans is projected to grow over time with the population aged 65 years and older estimated to make up about 20% of the population by 2030.[24,25] Therefore, as the population ages, the impact of vision impairment will also be expected to rise. Better understanding of the effect of self-reported vision impairment on an individual will provide direction on the best area to direct funding for research as well as provision of support services.

The objective of this study was to expand the scope of previous studies by characterizing the longitudinal burden of self-reported vision impairment in Americans aged 50 years and older, an age group of interest as it represents patients at risk of vision-loss from diseases such as diabetic retinopathy and age-related macular degeneration. Furthermore, we aimed to increase generalizability of findings by studying a national sample of individuals rather than a geographically-based population. We aimed to assess the impact of self-reported transition to vision impairment on three aspects of individual burden: functional limitations, nursing home status, and amount of caregiving received. Impact on functional limitations was measured by likelihood of difficulty in performing ADLs and IADLs. Nursing home status was measured by likelihood of moving to a nursing home. Caregiving received was measured by number of days per month receiving formal and informal care giving, and hours per day receiving formal and informal caregiving.

Methods

Data source:

The Health and Retirement Study (HRS) is a biennial, longitudinal survey of older Americans sponsored by the National Institute on Aging (grant number NIA U01AG009740) and conducted by the University of Michigan. The first HRS study originated in 1992, and surveyed community-dwelling respondents born 1931-1941 and their spouse, regardless of age. A companion study, the Asset and Health Dynamics Among the Oldest Old (AHEAD) study, conducted in 1993, surveyed community-dwelling respondents born in 1923 or earlier and their spouse, regardless of age. These studies were originally designed to investigate the period in which individuals and their spouses transitioned from the workforce to retirement, providing information on health, family, and economic situations. Three groups

were oversampled to permit subgroup analysis: African Americans, Hispanics, and Floridians. Individuals were re-surveyed every two years until 1998, when the two cohorts were merged and two additional cohorts, the War Baby (WB) cohort of individuals born 1942-1947 and the Children of the Depression (CODA) cohort of individuals born 1924-1930 and their spouses, were added to create a representative sample of the U.S. household population 50 years of age and older. To maintain this representativeness, two additional cohorts, the Early Baby Boomer (EBB) (individuals born 1948-1953) and the Mid Baby Boomer (MBB) (individuals born 1954-1959) cohorts, were added in 2004 and 2010, respectively. Details of the study are available at the HRS website (http://hrsonline.isr.umich.edu/). For this analysis, data from ten waves of data were used: 1995 AHEAD, 1996 HRS, 1998, 2000, 2002, 2004, 2006, 2008, 2010, and 2012.[26] The 1995 wave included only the original AHEAD cohort (individuals born 1923 or earlier who were community-dwelling in 1993). The 1996 wave included only the original HRS cohort (individuals born between 1934 and 1941 who were community-dwelling in 1992). All subsequent waves were the composite of all the merged cohorts and are a sample of Americans aged 50 years and older.

Outcomes:

The outcome measures of interest were likelihood of difficulty in performing ADLs and IADLs, likelihood of move to a nursing home, and amount of formal and informal (defined as paid versus unpaid) caregiving received measured in days per month and hours per day.

ADL limitations measured were difficulty dressing, walking across a room, bathing, eating, getting in and out of bed, and using a toilet. IADL limitations measured were difficulty preparing meals, shopping for groceries, using a phone, managing medications, and managing money. ADL and IADL limitations were converted to binary indicator variables where 1 indicated the respondent either reported difficulty with the task or reported they could not perform the task due to a health problem, and 0 indicated no difficulty in performing the task. We also created two binary indicator variables if respondents reported difficulty with any ADL or any IADL as well as two count variables indicating the number of ADLs or IADLs the respondent reported difficulty in performing.

For each respondent, days per month and hours per day receiving caregiving were calculated separately for paid and unpaid helpers. Days of help received could be reported as days per month, days per week, or daily help. To obtain the days per month a respondent reported receiving care, days per

week of help received were multiplied by 4.33 and respondents who reported receiving daily help were assigned a value of 31. If a respondent reported multiple caregivers, responses were collapsed and averaged across all helpers, again maintaining the distinction between formal and informal caregiving received.

Explanatory variable of interest:

Self-reported vision status was the primary explanatory variable of interest. At each wave, individuals were asked “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual.” An additional option that could be volunteered by the patient was “legally blind”. Similar to a previous study, vision impairment was defined as an indicator variable comprised of the composite of poor or legally blind responses.[27] A sensitivity analysis was performed where vision impairment was defined as the composite of fair, poor, or legally blind responses. Two secondary explanatory variables of interest were self-reported distal vision status and self-reported near vision status. The respondents were asked “How good is your eyesight for seeing things at a distance, like recognizing a friend across the street, using glasses or corrective lenses as usual?” and “How good is your eyesight for seeing things up close, like reading ordinary newspaper print, using glasses or corrective lenses as usual?” Similar to the self-reported vision status, distal and near vision impairment were defined as indicator variables comprised of poor and legally blind responses with a sensitivity analysis including fair, poor, and legally blind responses.

Covariates:

Covariates included were comprised of both time-invariant as well as time-varying covariates. Time-invariant covariates were: highest degree earned, gender, and race/ethnicity. Highest degree earned was categorized into five groups (less than high school, high school diploma or equivalent, completed college, graduate degree, and degree unknown/some college). Race/ethnicity was categorized as non-Hispanic white/Caucasian, non-Hispanic black/African-American, Hispanic, and other. Time-varying covariates measured were total household wealth, total household income, number of living children, current marital status, cognition level, and eight self-reported comorbidities (high blood pressure, diabetes, cancer, lung disease, heart condition, stroke, psychiatric disease, arthritis), and age at wave. Wealth was measured as total non-housing wealth and categorized into five groups representing the

approximate distribution of wealth in the United States: <$1,000, $1,000-$31,000, $31,000-$69,000, $69,000-$212,000 and >$212,000. Total household income represented total income on the household level comprising respondent and spousal (if applicable) income. It was categorized into four groups that were drawn along combined income tax brackets for married individuals (<$74,000, $74,000-$227,000, $227,000-$458,000, and >$458,000). A sensitivity analysis categorizing income by combined income tax brackets for single individuals showed no significant difference in results. Current marital status was dichotomized as married/partnered (defined as "living with a partner as if married") or not married. Total cognition was a summary measure calculated from word recall and mental status questions ranging on a scale from 0-35 where higher scores represent higher cognitive function. It was categorized into three categories with cutoffs identified from a previous study using the same dataset (high cognitive function, moderate cognitive function, and low cognitive function).[28] Indicator variables were created for the presence or absence of the eight comorbidities according to the respondent's reply to the question, "Has a doctor ever told you that you have …". Wealth imputation variables and cognition imputed variables were obtained from the RAND constructed "RAND Core Income and Wealth Imputation Files"[29] and "Cross-Wave: Imputation of Cognitive Functioning Measures 1992-2012" files, respectively.

Statistical Analysis:

Univariate descriptive statistics were run for each wave. Wave-specific characteristics of the sample are reported as proportions for categorical variables and mean (± standard deviation (SD)) for continuous variables. The cross-sectional prevalence of the outcomes (nursing home residence, ADL and IADL outcomes, and caregiving received) are reported as proportions for categorical outcomes and mean (± SD) for continuous outcomes. Bivariate analyses were run between vision status and the outcomes of interest testing for differences in outcomes by vision impairment status. For bivariate analyses and regression analyses, responses of "don't know", "not ascertained", "refused", or "not applicable" for the explanatory and outcome variables were excluded. We used Pearson's chi-square (X^2) test of independence for binary outcomes comparing proportion of respondents reporting difficulty with ADL or IADL or residing in a nursing home by vision impairment status (not vision impaired compared to vision impaired). Student's t-test, assuming unequal variances, was used to compare differences in means for continuous and count variables (number of ADL and IADL difficulties, number of helpers, amount of

caregiving received) again comparing the respondents with no vision impairment to those with vision impairment.

Multivariable logistic regression analyses were run to test the association between vision impairment on the odds of living in a nursing home, experiencing difficulty with any ADL, and experiencing difficulty with any IADL for three representative waves (1998, 2006, and 2012). These waves were chosen in order to allow the comparison of measures of association over time. The presented odds ratios compared odds of the outcome in individuals who reported vision impairment compared to individuals with no vision impairment. Analyses were adjusted for degree of educational attainment as a categorical variable, gender, race/ethnicity, household wealth as a categorical variable, household income as a categorical variable, marital status dichotomized as married/partnered or not married, cognitive status as a categorical variable, age as a continuous variable, and indicator variables for presence of eight comorbidities. The odds ratios were compared across waves qualitatively, but no formal statistical tests were performed as the study population was overlapping across waves as well as growing as new cohorts were added. Pearson residuals were calculated and plotted against the covariate of interest, vision status, to generally assess model specification.

To estimate the relationship between onset of vision impairment and functional limitations and nursing home status, mixed-effects logistic regressions were performed. A separate mixed-effects logistic regression was performed for each of the three outcomes (nursing home residence, difficulty performing at least one ADL, and difficulty performing at least one IADL). A mixed-effects approach was used to facilitate the estimation of subject-specific effects rather than population-averaged effects as estimated through generalized estimating equations (GEE).[30] Mixed-effects models are comprised of both fixed-effects and random-effects and the random-effects are added to account for the correlation between repeated measures on a single individual. In other words, the random-effects represent heterogeneity between individuals that is not captured by observed covariates in the model.[31] The mixed-effects model is estimated through a maximum-likelihood estimation approach and a benefit is that it produces unbiased estimates assuming missing data is missing at random (MAR) in contrast to the GEE approach which requires missing data to be missing completely at random (MCAR).[32] A likelihood ratio test was performed to test if the mixed-effect model with subject-specific random effects was preferable to a standard

multivariable linear regression which assumes independence between observations on the same individual.

All analyses were performed using Stata 13 (Stata Corporation, College Station, TX).[33] The HRS Public Release Data Files appears on the University of Washington's list of "Public Data Sets" thus exempting this study from any Human Subjects Review by the University of Washington Institutional Review Board.

Results

Descriptive statistics:

Characteristics of sample:

In total, 35,042 individuals contributed at least one core interview and of those, 3,332 individuals contributed only one core interview. The sample size ranged from 7,027 completing a core interview in 1995 to 22,032 completing a core interview in 2010 (Table 1). Response rate, which accounts for the number of respondents eligible to be interviewed, was high ranging from 87% to 93%. The distribution of number of waves for which a respondent provided a core interview by entry cohort is shown in Appendix A. The percentage of respondents with complete follow-up, calculated as the number of respondents providing a core interview for the maximum number of eligible waves, divided by the number of respondents providing at least one core interview by cohort, ranged greatly from 12.5% of the AHEAD cohort (representing the oldest cohort and earliest interviewed cohort at baseline), to 88.8% of the Mid-Baby Boomer cohort, who were first interviewed in 2010 and were eligible to be interviewed for a maximum of two waves (Appendix B).

As expected, the characteristics of the 1995 AHEAD wave, including individuals 70 years and older upon study entry and their spouses, differed from the characteristics of the 1996 HRS wave, representing individuals aged 51-61 upon study entry and their spouses (Table 1). The mean age of the AHEAD cohort in 1995 was 78 (SD: 7) years while the mean age of the HRS cohort in 1996 was 59 (SD: 6) years. There was a higher proportion of female respondents in the cohort interviewed in 1995 than the cohort interviewed in 1996, 64% female compared to 55%. There was a smaller proportion married/partnered in the cohort interviewed in 1995 compared to the cohort interviewed in 1996, 52%

versus 78%. From 1998 onward, after the two samples were merged and additional cohorts of respondents added to create one cohesive cohort, the sample characteristics remained consistent between waves. The sample remained predominantly female; approximately 59% of respondents each wave. The mean age of the sample in 1998 was 66 (SD: 11) years and it increased accordingly each wave until additional cohorts of younger respondents were added in 2004 and 2010. The majority of respondents were currently married or partnered; the percentage ranged between 62% and 67%. Across all waves, respondents were primarily of non-Hispanic white ethnicity. Over time, the proportion of respondents who completed college or a graduate degree increased and the proportion of respondents with less than a high school diploma decreased. The majority of the core interviews were conducted with the respondent; each wave, between 6% - 13% of interviews was conducted with a proxy reporter.

Vision impairment status:

The majority of respondents in each wave reported good, very good, or excellent vision status. Overall, distal, and near vision status for respondents in each wave is shown in Table 2. In 1995, 11.8% of respondents in the AHEAD cohort were categorized as vision impaired. The sensitivity analysis found 32.8% of respondents to be vision impaired. In contrast, in 1996, only 4.7% of respondents in the original HRS cohort were defined to be vision impaired while 21.2% of respondents were defined as vision impaired in the sensitivity analysis. From 1998 onward, the proportion of respondents categorized as vision impaired remained stable at about 6% of respondents each wave whereas about 22% of respondents each wave were defined as vision impaired in the sensitivity analysis. In 1995, 9.2% of respondents were defined as having distal vision impairment and 10.5% of respondents were categorized as having near vision impairment. In 1996, 3.3% of respondents were defined to have distal vision impairment and 6.6% of respondents were defined to have near vision impairment. In all subsequent waves, about 5% of respondents were categorized as having distal vision impairment and about 7% of respondents were categorized as having near vision impairment. Non-informative responses including other, don't know, not ascertained, and refused accounted for less than 0.5% of all responses in all waves.

The probability of transitioning between no vision impairment and vision impairment was also calculated. The possibility of transition from impaired status back to no impairment status can be

potentially explained by adaptation to visual limitations as well as effect of treatment modalities affecting vision including, but not limited to correction of refraction error or cataract surgery. At each interview, individuals with no vision impairment had a 3.7% chance of transitioning to being vision impaired at the next interview and a 96.3% chance of remaining with no vision impairment at the next interview. In contrast, individuals defined as being vision impaired had a 47.8% probability of transitioning to being categorized as having no vision impairment and a 52.2% probability of remaining as vision impaired in the next interview.

Nursing home status, functional limitations, and caregiving received:

All individuals were community-dwelling at baseline, but subsequent interviews were sought even if individuals transitioned to nursing home residence. In 1995, 3.8% of respondents resided in a nursing home (Table 3). In 1996, 0.27% of respondents resided in a nursing home. From 1998 forward, about 2% of respondents per wave were found to reside in a nursing home, even when excluding newly added cohorts of respondents in their baseline interview year. The proportion of respondents reporting difficulty with ≥1 ADL was 28.2% in 1995, 11.7% in 1996, and remained consistent across all the waves from 1998 onward between 17% - 19%. The proportion of respondents reporting difficulty with ≥1 IADL was 21.7% in 1995, 8.9% in 1996, and between 13% - 16% in all waves from 1998 onward. The mean count of both ADL and IADL difficulties was low, less than one across all waves with a strong majority of respondents reporting difficulty with zero ADLs and zero IADLs. The prevalence of difficulty with any of the ADLs ranged from 3% to 21%. The prevalence of difficulty with any of the IADLs ranged from 2% to 11%. The proportion of all respondents reporting on caregiving received ranged from a low of 4.5% in 1996 to a high of 17.9% in 1995. The mean number of helpers remained stable across all waves at about 1.7 helpers (range: 0-16). More individuals each wave reported informal caregiving compared to formal caregiving (defined as a helper who was unpaid versus paid); however, average hours per day of formal help tended to be higher than average hours per day of informal help across all waves. In contrast, there were no strong trends comparing average days per month of formal help received compared to average days per month of informal help across waves.

<u>Bivariate analyses: outcomes by vision impairment status</u>

The proportion of respondents residing in a nursing home differed by vision impairment status (Table 4). The percent of respondents with no vision impairment residing in a nursing home ranged from 0.2% to 3.1%. The percent of respondents with vision impairment residing in a nursing home ranged from 1.6% to 11.2%. The proportion of respondents residing in a nursing home differed significantly by vision impairment status for all waves ($p < 0.001$ for all waves). The proportion reporting difficulty with each of the six ADLs and each of the five IADLs also differed significantly by vision impairment status across all waves ($p < 0.001$ for all ADLs and all IADLs for all waves). On average, across all waves, 16% of respondents without current self-reported vision impairment reported difficulty with ≥1 ADL and 53% of respondents with current self-reported vision impairment reported difficulty with ≥1 ADL ($p < 0.001$). Across all waves, 12% of respondents without current self-reported vision impairment reported difficulty with ≥1 IADL whereas 50% of respondents with current self-reported vision impairment reported difficulty with ≥1 IADL ($p < 0.001$). Differences in formal and informal caregiving received by vision impairment status differed across the waves. While there were some waves with statistically significant differences between formal and informal caregiving received, the absolute difference in days per month and hours per day of help received, comparing vision impaired individuals to those with no vision impairment, was minimal and likely not meaningfully relevant for both formal and informal care.

Multivariable logistic regression for three representative waves

Vision impairment was associated with higher odds of residing in a nursing home. However, after controlling for confounders, the association was not significant (Table 5). The estimate of the odds ratio ranged from 1.08 (95% CI: 0.64, 1.84) in 1998 to 1.09 (95% CI: 0.64, 1.86) in 2006 and 1.22 (95% CI: 0.76, 1.97) in 2012. The estimate at each time point was comparable and not extremely variable. Vision impairment was associated with higher odds of difficulty performing ≥1 ADL after adjusting for confounders (Table 6). Here, the estimate of the odds ratio ranged from 2.57 (95% CI: 2.16, 3.05) in 1998 to 2.37 (95% CI: 1.97, 2.84) in 2006 and 2.31 (95% CI: 1.92, 2.77) in 2012. All three estimates were statistically significant and were comparable to each other. Vision impairment was also associated with higher odds of difficulty performing ≥1 IADL after adjusting for confounders (Table 7). The estimate of the odds ratio comparing odds of difficulty performing ≥1 IADL in vision impaired individuals to individuals with no vision impairment was 3.78 (95% CI: 3.15, 4.53) in 1998, 3.94 (95% CI: 3.26, 4.76) in 2006, and 3.49

(95% CI: 2.89, 4.22) in 2012. Again, all three estimates for each wave were fairly comparable and statistically significant. Examination of the Pearson residuals plotted against vision status did not suggest extreme misspecification of the model.

Mixed-effects logistic regression

A transition from no vision impairment to vision impairment was significantly associated with 1.37 times higher odds of residing in a nursing home (95% CI: 1.05, 1.78) after controlling for confounders (Table 8). A transition from no vision impairment to vision impairment was also significantly associated with 2.96 times higher odds of difficulty in performing at least one ADL (95% CI: 2.71, 3.24) and 4.02 times higher odds of difficulty in performing at least one IADL (95% CI: 3.70, 4.37) after controlling for confounders (Tables 9 and 10). Sensitivity analyses conducted using the combination of fair, poor, and legally blind responses to the question "Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?" to define vision impairment rather than the combination of poor and legally blind responses, resulted in attenuated odds ratios (odds ratio for nursing home residence, difficulty with ≥1 ADL, and difficulty with ≥1 IADL were 1.21, 2.19, and 2.60, respectively). The association between onset of vision impairment and nursing home residence was no longer significant at an alpha value of 0.05, but the significance of the association between vision impairment and difficulty in performing at least one ADL/IADL remained (Tables 11-13). In all regressions, the likelihood ratio test comparing the mixed-effects logistic regression to the simple multivariable logistic regression found the mixed-effects logistic regression with the inclusion of subject-specific random effects to be a significant improvement over the simple multivariable logistic regression which assumes independence between repeated observations within a subject.

Discussion

The objective of this study was to characterize the burden of transition to self-reported impaired vision over time on individual functional limitations, likelihood of move to a nursing home, and amount of caregiving received. Our major findings are the relative stability of prevalence estimates of visual impairment, functional limitations, and the association between the two over time as well as an association between the transition to vision impairment and nursing home residence and functional limitations.

We found that the older AHEAD cohort interviewed in 1995 reported a higher prevalence of both vision impairment as well as difficulty performing ADLs and IADLs compared to the younger HRS cohort interviewed in 1996 supporting previous findings of the association between older age and vision impairment.[34] From 1998 onward, we found the prevalence of vision impairment and functional limitations in our sample remained stable over time whereas previous studies have found the prevalence of self-reported vision impairment to decrease over time and the prevalence of functional limitations to remain stable.[18,35] However, direct comparisons with other studies are difficult to make, due to differences in measurement of both vision impairment and functional limitation. Vision status can be measured clinically or through a variety of self-reported measures whereas functional limitations can be reported individually or summarized with an index measure. The prevalence of overall vision impairment in our study, about 6%, is comparable to a study of individuals aged 65 years and older in Spain, but was noted to be on the low end compared to other estimates.[18,24,35–37] Differences in prevalence estimates can be explained by different definitions of vision impairment, less stringent and broader inclusion criteria for vision impairment in other studies, as well as study timing and study population as factors affecting these estimates.[2,35]

Though we found nursing home residence to differ significantly by vision status, we found in our simple multivariable logistic regressions for three representative waves, there was no significant association between vision impairment status and nursing home residence after controlling for highest educational attainment, gender, race/ethnicity, total household wealth, total household income, marital status, level of cognition, age at wave, and presence of additional comorbidities. Vision impaired individuals had an estimated 10-20% higher odds of residing in a nursing home, but these estimates were not significant. In contrast, both our bivariate and wave-specific logistic regressions support previous findings of a significant association between vision impairment and functional limitations. The odds ratios comparing odds of difficulty performing at least one ADL and at least one IADL in vision impaired individuals to individuals with no vision impairment remained fairly stable over the three represented waves. The stability in the odds ratio estimates across the three waves suggests that the association between vision impairment difficulty in performing ADLs and IADLs has not changed dramatically over time. Moreover, we found evidence that when comparing vision impaired individuals to those with no vision impairment, the odds of difficulty performing ≥1 IADL was greater than the odds of difficulty

performing ≥1 ADL, which is intuitive given that ADLs represent more basic functional requirements whereas IADLs represent a higher level of functioning as they are comprised of activities that support independent living and therefore could be more difficult for individuals with vision impairment to accomplish. A previous study that hypothesized a hierarchical relationship between IADLs and ADLs suggested that vision impaired individuals experiencing ADL limitations also experience IADL limitations, which supports our findings of higher odds of difficulty in performing any IADL compared to odds of difficulty in performing any ADL.[27]

Using an analytical approach that accounts for correlations between repeated measures on an individual, we found the transition to vision impairment in an individual was associated with significantly higher odds of residing in a nursing home, difficulty in performing at least one ADL, and difficulty in performing at least one IADL when controlling for sociodemographic characteristics. Our results have some similarities to results from a previous study by Sloan et al. who assessed the impact of transition to fair/poor distance and near vision on functional limitations and living arrangements in elderly Americans.[17] In their study sample with an average age of 82 years, Sloan et al. found onset of fair/poor near vision to be associated with a significantly lower probability of no difficulty performing any ADL and a significantly lower probability of no difficulty performing any IADL. They did not find a significant association between onset of fair/poor distance vision and functional limitations. They also did not find a significant association between onset of fair/poor vision and living arrangements. Differences in the results could be due to differences in assignment of vision impairment status. Sloan et al. looked at onset of near vision impairment and onset of distance vision impairment separately whereas our study looked at onset of general vision impairment. Additionally, Sloan et al. looked at effects of onset of fair or poor near and distance vision. In our primary analysis, we only included responses of poor as vision impaired. In our sensitivity analysis consisting of fair and poor responses being defined as vision impaired, we did find attenuated odds ratios and the relationship between vision impairment and nursing home residence was no longer significant, similar to the results of the Sloan study. This suggests that it is the onset of poor vision rather than fair vision that drives the decline in ability to live independently. However, the association between vision impairment and functional limitations remained statistically significant. Additionally, we were able to control for economic covariates such as household wealth and income along

with other comorbidities including high blood pressure, diabetes, cancer, lung disease, heart conditions, previous stroke, and arthritis that would be likely to affect both ability to live independently and ability to perform ADLs and IADLs without difficulty.

Our findings also support previous geographic-based studies that assessed the relationship between vision impairment and subsequent functional limitations. A previous study found the increase in odds of functional decline measured by difficulty in performing five activities (walking, climbing stairs, preparing meals, shopping, and doing housework) in older women attributable to baseline vision impairment adjusted for comorbidities, age, education, smoking, vertebral fracture, benzodiazepine use, body mass index, Lubben social network, grip strength, walking speed, and baseline functional status to be 1.79 (95% CI: 1.15-2.79).[14] While we found a higher odds ratio, 2.96 and 4.02 for ADL and IADL limitations, respectively, our study is not directly comparable due to differences in definition of functional limitation and differences in measurement of vision impairment. However, we see the same significant trend in functional decline attributable to vision impairment.

Similar to the results of our wave-specific multivariable logistic regressions, we found the adjusted odds ratio for transition from no vision impairment to vision impairment to be higher for difficulty in performing at least one IADL compared to difficulty in performing at least one ADL. This again supports a distinction between ADLs and IADLs and suggests that visual ability plays a stronger role in ability to perform IADLs without difficulty versus ADLs. It also suggests that support services for individuals with impaired vision may be of greater service if targeted first toward supporting IADLs, which are hypothesized to require greater visual ability.[27] Moreover, providing support for IADLs may additionally support an individual's ability to live independently as IADLs are tasks that support independent living.

One strength of this study is the use of a longitudinal panel dataset and the use of mixed-effects logistic regressions to model both the effect of the covariates as well as account for correlation between the repeated measures on an individual. This allows for a subject-specific interpretation about the effect of a change in vision status within an individual on the outcomes of interest. Additionally, our dataset is a nationwide sample of older Americans, but it is not limited to the oldest-old. Our sample of older Americans was, on average, 67 years of age and we found the onset of vision impairment to be significantly associated with nursing home residence, difficulty performing at least one ADL, and difficulty

performing at least one IADL. Therefore, we provide evidence to support the benefit of early identification of conditions that can lead to vision loss in older Americans. Early identification and treatment of conditions leading to vision loss can then delay or reduce vision impairment which can have multi-faceted detrimental effects on an individual.

There are some limitations to this study. First, vision impairment was assigned according to self-reported rating of vision status. While using a self-report might lead to misclassification, a potential advantage of using self-reported vision status is that it allows for examination of the association between functional vision, previously defined as an individual's perception of how one's vision ability affects the ability to function in daily activities, and outcomes of interest.[38] Additionally, the abundance of sociodemographic data available by using the Health and Retirement Study allows for finer control of potential confounders providing greater benefit than the limitation of using self-reported vision. Second, the ADL and IADL limitation questions were only asked of respondents who first reported difficulty with certain physical tasks like walking several blocks, sitting for two hours, stooping, etc. Thus the true prevalence of ADL and IADL difficulties in this population may be underestimated. Last, sampling weights were not applied so the estimated prevalence of vision impairment and functional limitation are not national estimates, but reflect the prevalence within our sample.

In conclusion, supporting findings from previous studies and extending them to a national sample of late middle-aged and older Americans, we found a transition to self-reported vision impairment within an individual to have significant detrimental effects on ability to live independently and perform ADLs and IADLs without difficulty. Therefore, preventing this transition can have substantial impacts on an individual's quality of life through fewer functional limitations and a higher likelihood of being able to live independently. Thus, benefits derived from improved treatment of medical conditions that contribute to vision loss whether they be new treatment modalities, availability of surgical options, or merely correction of refractive errors can have extended societal value beyond that of simple improvement in vision.

Table 1. Sample status and baseline characteristics of respondents who provided a core interview

	1995	1996	1998	2000	2002	2004	2006	2008	2010	2012
No. in sample	8,405	12,906	25,503	24,235	22,831	24,478	22,422	21,056	26,356	24,629
No. alive	7,554	12,623	23,754	22,240	20,559	22,632	20,775	19,478	24,519	23,061
No. interviewed (core)	7,027	10,964	21,384	19,578	18,166	20,129	18,469	17,217	22,032	20,553
No. interviewed (total)	7,802	11,198	22,881	21,285	20,153	21,821	19,926	18,665	23,610	21,890
No. not interviewed	603	1,708	2,622	2,950	2,678	2,657	2,496	2,391	2,746	2,739
% response	93.02%	86.86%	90.02%	88.03%	88.36%	88.94%	88.90%	88.39%	89.86%	89.13%
Cohort										
HRS	NA	10,964 (100.00%)	10,584 (49.49%)	10,044 (51.30%)	9,724 (53.53%)	9,362 (46.51%)	8,879 (48.08%)	8,493 (49.33%)	7,904 (35.88%)	7,395 (35.98%)
AHEAD	7,027 (100.00%)	NA	5,951 (27.83%)	5,000 (25.54%)	4,107 (22.61%)	3,365 (16.72%)	2,700 (14.62%)	2,142 (12.44%)	1,526 (6.93%)	1,165 (5.67%)
CODA	NA	NA	2,320 (10.85%)	2,124 (10.85%)	1,951 (10.74%)	1,777 (8.83%)	1,618 (8.76%)	1,454 (8.45%)	1,255 (5.70%)	1,112 (5.41%)
WB	NA	NA	2,529 (11.83%)	2,410 (12.31%)	2,384 (13.12%)	2,295 (11.40%)	2,237 (12.11%)	2,165 (12.57%)	2,138 (9.70%)	2,065 (10.05%)
EBB	NA	NA	NA	NA	NA	3,330 (16.54%)	3,035 (16.43%)	2,963 (17.21%)	4,254 (19.31%)	4,097 (19.93%)
MBB	NA	NA	NA	NA	NA	NA	NA	NA	4,955 (22.49%)	4,720 (22.96%)
Mean age ± SD in years	77.96 ± 6.68	58.85 ± 5.67	65.90 ± 11.11	67.09 ± 10.84	68.33 ± 10.49	66.53 ± 11.50	67.95 ± 11.10	69.16 ± 10.76	65.62 ± 11.97	66.81 ± 11.59
No. female (%)	4,512 (64.21%)	6,000 (54.72%)	12,426 (58.11%)	11,468 (58.58%)	10,710 (58.96%)	11,778 (58.51%)	10,883 (58.93%)	10,193 (59.20%)	12,814 (58.16%)	12,009 (58.43%)
Race										
Non-Hispanic white	5,634 (80.18%)	8,047 (73.39%)	16,325 (76.34%)	14,941 (76.32%)	13,842 (76.20%)	14,863 (73.84%)	13,750 (74.45%)	12,728 (73.93%)	14,159 (64.27%)	13,120 (63.83%)
Non-Hispanic black	902 (12.84%)	1,702 (15.52%)	2,976 (13.92%)	2,680 (13.69%)	2,475 (13.62%)	2,841 (14.11%)	2,568 (13.90%)	2,425 (14.08%)	4,179 (18.97%)	3,894 (18.95%)
Hispanic	405 (5.76%)	978 (8.92%)	1,653 (7.73%)	1,551 (7.92%)	1,471 (8.10%)	1,928 (9.58%)	1,710 (9.26%)	1,654 (9.61%)	2,962 (13.44%)	2,822 (13.73%)

Other	86 (1.22%)	230 (2.10%)	422 (1.97%)	402 (2.05%)	375 (2.06%)	494 (2.45%)	440 (2.38%)	409 (2.38%)	721 (3.27%)	702 (3.42%)
Missing/not obtained		7 (0.06%)	8 (0.04%)	4 (0.02%)	3 (0.02%)	3 (0.01%)	1 (0.01%)	1 (0.01%)	11 (0.05%)	16 (0.08%)
Highest degree of education										
< High school	2,905 (41.34%)	2,816 (25.68%)	6,098 (28.52%)	5,368 (27.42%)	4,715 (25.96%)	4,688 (23.29%)	4,154 (22.49%)	3,734 (21.69%)	4,361 (19.79%)	3,935 (19.15%)
High school diploma	3,211 (45.70%)	5,840 (53.27%)	10,945 (51.18%)	10,084 (51.51%)	9,492 (52.25%)	10,544 (52.38%)	9,725 (52.66%)	9,094 (52.82%)	11,609x (52.69%)	10,784 (52.47%)
Some or completed college	606 (8.62%)	1,469 (13.40%)	2,815 (13.16%)	2,652 (13.55%)	2,539 (13.98%)	3,159 (15.69%)	2,966 (16.06%)	2,831 (16.44%)	4,089 (18.56%)	3,884 (18.90%)
Graduate degree	305 (4.34%)	833 (7.60%)	1,522 (7.12%)	1,474 (7.53%)	1,415 (7.79%)	1,683 (8.36%)	1,574 (8.52%)	1,509 (8.76%)	1,926 (8.74%)	1,824 (8.87%)
Unknown		6 (0.05%)	4 (0.02%)		5 (0.03%)	55 (0.27%)	50 (0.27%)	49 (0.28%)	47 (0.21%)	127 (0.62%)
Marital status										
Not married	3,363 (47.86%)	2,365 (21.57%)	6,926 (32.39%)	6,571 (33.56%)	6,303 (34.70%)	6,774 (33.65%)	6,415 (34.73%)	6,199 (36.01%)	7,794 (35.38%)	7,649 (37.21%)
Married or partnered	3,664 (52.14%)	8,599 (78.43%)	14,458 (67.61%)	13,007 (66.44%)	11,863 (65.30%)	13,355 (66.35%)	12,054 (65.27%)	11,018 (63.99%)	14,238 (64.62%)	12,905 (62.79%)
Proxy Interview status										
Self-report	6,126 (87.18%)	10,225 (93.26%)	19,341 (90.45%)	17,517 (89.47%)	16,130 (88.79%)	18,327 (91.05%)	17,209 (93.18%)	16,077 (93.38%)	20,650 (93.73%)	19,408 (94.42%)
Proxy, spouse reporter	351 (5.00%)	673 (6.14%)	1,304 (6.10%)	1,299 (6.63%)	1,236 (6.80%)	1,172 (5.82%)	779 (4.22%)	674 (3.91%)	802 (3.64%)	641 (3.12%)
Proxy, non-spouse reporter	550 (7.83%)	66 (0.60%)	739 (3.46%)	762 (3.89%)	800 (4.40%)	630 (3.13%)	481 (2.60%)	466 (2.71%)	580 (2.63%)	505 (2.46%)
No. in nursing home (%)	268 (3.81%)	30 (0.27%)	429 (2.01%)	457 (2.33%)	460 (2.53%)	460 (2.29%)	438 (2.37%)	441 (2.56%)	469 (2.13%)	478 (2.33%)

AHEAD: Asset and Health Dynamics among the Oldest Old (born 1923 or earlier); HRS: Health and Retirement Study (born 1931-1941); CODA: Children of the Depression Era (born 1924-1930); WB: War Babies (born 1942-1947); EBB: Early Baby Boomer (born 1954-1959); MBB: Mid-Baby Boomer (born 1960-1965)

Table 2. Vision Impairment Status*

	1995	1996	1998	2000	2002	2004	2006	2008	2010	2012
Vision impairment status										
No impairment	6,192 (88.12%)	10,439 (95.23%)	20,015 (93.60%)	18,271 (93.32%)	16,974 (93.44%)	18,839 (93.59%)	17,283 (93.59%)	16,151 (93.81%)	20,567 (93.35%)	19,094 (92.90%)
Impairment	826 (11.75%)	516 (4.71%)	1,356 (6.34%)	1,293 (6.60%)	1,168 (6.43%)	1,267 (6.29%)	1,155 (6.25%)	1,048 (6.09%)	1,416 (6.43%)	1,393 (6.78%)
Other	3 (0.04%)	1 (0.01%)								
Don't know, not ascertained	6 (0.09%)	4 (0.04%)	13 (0.06%)	13 (0.07%)	22 (0.12%)	20 (0.10%)	27 (0.15%)	16 (0.09%)	47 (0.21%)	60 (0.29%)
Refused		2 (0.02%)		1 (0.01%)	2 (0.01%)	3 (0.01%)	2 (0.01%)	2 (0.01%)	2 (0.01%)	6 (0.03%)
Distal vision impairment status										
No impairment	6,368 (90.62%)	10,596 (96.66%)	20,343 (95.13%)	18,522 (94.61%)	17,188 (94.62%)	19,131 (95.04%)	17,528 (94.92%)	16,371 (95.09%)	21,028 (95.44%)	19,610 (95.41%)
Impairment	647 (9.21%)	359 (3.27%)	1,010 (4.72%)	1,025 (5.24%)	940 (5.17%)	961 (4.77%)	900 (4.87%)	805 (4.68%)	941 (4.27%)	888 (4.32%)
Other										
Don't know, not ascertained	12 (0.17%)	5 (0.05%)	30 (0.14%)	30 (0.15%)	37 (0.20%)	33 (0.16%)	38 (0.21%)	40 (0.23%)	60 (0.27%)	51 (0.25%)
Refused		2 (0.02%)	1 (0.00%)	1 (0.01%)	1 (0.01%)	4 (0.02%)	1 (0.01%)	1 (0.01%)	3 (0.01%)	4 (0.02%)
Near vision impairment status										
No impairment	6,277 (89.33%)	10,231 (93.33%)	19,859 (92.87%)	18,212 (93.02%)	16,916 (93.12%)	18,691 (92.86%)	17,236 (93.33%)	16,123 (93.65%)	20,395 (92.57%)	18,927 (92.09%)
Impairment	739 (10.52%)	722 (6.59%)	1,495 (6.99%)	1,328 (6.78%)	1,209 (6.66%)	1,392 (6.92%)	1,190 (6.44%)	1,054 (6.12%)	1,583 (7.19%)	1,568 (7.63%)
Other										
Don't know, not ascertained	2 (0.03%)	6 (0.05%)	30 (0.14%)	35 (0.18%)	39 (0.21%)	42 (0.21%)	40 (0.22%)	39 (0.23%)	49 (0.22%)	56 (0.27%)
Refused	9 (0.13%)	3 (0.03%)		3 (0.02%)	2 (0.01%)	4 (0.02%)	1 (0.01%)	1 (0.01%)	5 (0.02%)	2 (0.01%)

*Impairment defined as a response of poor or legally blind to the three questions (1) "Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?" for measuring overall vision status, (2) "How good is your eyesight for seeing things at a distance, like recognizing a friend across the street, using glasses or corrective lenses as usual? Is it excellent, very good, good, fair, or poor?" for measuring distal vision status, and (3) "How good is your eyesight for seeing things up close, like reading ordinary newspaper print, using glasses or corrective lenses as usual? Is it excellent, very good, good, fair, or poor?" for measuring near vision status.

Table 3. Cross-sectional prevalence of outcomes: nursing home status, ADL and IADL outcomes, and caregiving received

	1995	1996	1998	2000	2002	2004	2006	2008	2010	2012
No. in nursing home (%)	268 (3.81%)	30 (0.27%)	429 (2.01%)	457 (2.33%)	460 (2.53%)	460 (2.29%)	438 (2.37%)	441 (2.56%)	469 (2.13%)	478 (2.33%)
No. respondents (%) reporting difficulty with ADL outcomes										
Difficulty walking across a room										
No difficulty	4,516 (83.20%)	5,750 (92.97%)	8,766 (84.83%)	8,192 (84.22%)	8,048 (84.04%)	8,727 (84.86%)	8,309 (84.36%)	7,741 (83.87%)	9,295 (83.85%)	8,633 (83.62%)
Difficulty	899 (16.56%)	425 (6.87%)	1,537 (14.87%)	1,483 (15.25%)	1,492 (15.58%)	1,525 (14.83%)	1,510 (15.33%)	1,452 (15.73%)	1,765 (15.92%)	1,663 (16.11%)
Not applicable	13 (0.24%)	10 (0.16%)	30 (0.29%)	52 (0.53%)	36 (0.38%)	32 (0.31%)	30 (0.30%)	37 (0.40%)	25 (0.23%)	28 (0.27%)
Difficulty dressing										
No difficulty	4,285 (78.97%)	5,442 (87.99%)	11,531 (84.00%)	10,743 (83.66%)	10,517 (84.41%)	11,381 (84.96%)	10,613 (83.72%)	9,952 (83.69%)	11,711 (81.98%)	10,970 (82.52%)
Difficulty	1,129 (20.81%)	738 (11.93%)	2,166 (15.78%)	2,047 (15.94%)	1,908 (15.31%)	1,981 (14.79%)	2,029 (16.01%)	1,908 (16.05%)	2,555 (17.88%)	2,297 (17.28%)
Not applicable	12 (0.22%)	5 (0.08%)	30 (0.22%)	51 (0.40%)	34 (0.27%)	34 (0.25%)	35 (0.28%)	31 (0.26%)	20 (0.14%)	27 (0.20%)
Difficulty bathing										
No difficulty	4,417 (81.40%)	5,804 (93.84%)	8,572 (82.96%)	8,107 (83.35%)	8,026 (83.81%)	8,679 (84.39%)	8,316 (84.43%)	7,733 (83.78%)	9,210 (83.09%)	8,524 (82.56%)
Difficulty	990 (18.25%)	377 (6.10%)	1,729 (16.73%)	1,578 (16.22%)	1,514 (15.81%)	1,568 (15.25%)	1,502 (15.25%)	1,474 (15.97%)	1,858 (16.76%)	1,778 (17.22%)
Not applicable	19 (0.35%)	4 (0.06%)	32 (0.31%)	42 (0.43%)	36 (0.38%)	37 (0.36%)	31 (0.31%)	23 (0.25%)	17 (0.15%)	22 (0.21%)
Difficulty eating										
No difficulty	4,937 (90.97%)	5,982 (96.72%)	9,506 (92.00%)	8,976 (92.28%)	8,823 (92.14%)	9,505 (92.43%)	9,049 (91.88%)	8,505 (92.15%)	10,123 (91.32%)	9,405 (91.10%)
Difficulty	481 (8.86%)	200 (3.23%)	806 (7.80%)	720 (7.40%)	727 (7.59%)	743 (7.22%)	766 (7.78%)	702 (7.61%)	929 (8.38%)	891 (8.63%)
Not applicable	9 (0.17%)	3 (0.05%)	21 (0.20%)	31 (0.32%)	26 (0.27%)	36 (0.35%)	34 (0.35%)	23 (0.25%)	33 (0.30%)	28 (0.27%)
Difficulty getting in/out of bed										
No difficulty	4,653 (85.75%)	5,605 (90.62%)	8,760 (84.78%)	8,321 (85.55%)	8,258 (86.24%)	8,938 (86.91%)	8,467 (85.97%)	7,971 (86.36%)	9,331 (84.18%)	8,659 (83.87%)
Difficulty	766 (14.12%)	576 (9.31%)	1,551 (15.01%)	1,374 (14.13%)	1,282 (13.39%)	1,319 (12.83%)	1,354 (13.75%)	1,235 (13.38%)	1,725 (15.56%)	1,625 (15.74%)

Not applicable	7 (0.13%)	4 (0.06%)	22 (0.21%)	32 (0.33%)	36 (0.38%)	27 (0.26%)	28 (0.28%)	24 (0.26%)	29 (0.26%)	40 (0.39%)
Difficulty using a toilet										
No difficulty	4,712 (86.83%)	5,833 (94.31%)	8,992 (87.02%)	8,471 (87.09%)	8,380 (87.51%)	9,055 (88.05%)	8,502 (86.32%)	8,027 (86.97%)	9,533 (86.00%)	8,858 (85.80%)
Difficulty	703 (12.95%)	346 (5.59%)	1,306 (12.64%)	1,218 (12.52%)	1,147 (11.98%)	1,180 (11.47%)	1,299 (13.19%)	1,154 (12.50%)	1,509 (13.61%)	1,433 (13.88%)
Not applicable	12 (0.22%)	6 (0.10%)	35 (0.34%)	38 (0.39%)	49 (0.51%)	49 (0.48%)	48 (0.49%)	49 (0.53%)	43 (0.39%)	33 (0.32%)
Difficulty with any ADL										
No difficulty	5,044 (71.78%)	9,684 (88.33%)	17,585 (82.23%)	15,970 (81.57%)	14,747 (81.18%)	16,586 (82.40%)	14,858 (80.45%)	13,892 (80.69%)	17,787 (80.73%)	16,604 (80.78%)
Difficulty	1,983 (28.22%)	1,280 (11.67%)	3,799 (17.77%)	3,608 (18.43%)	3,419 (18.82%)	3,543 (17.60%)	3,611 (19.55%)	3,325 (19.31%)	4,245 (19.27%)	3,950 (19.22%)
Mean ADL count (SD)	0.71 ± 1.45	0.24 ± 0.82	0.43 ± 1.41	0.43 ± 1.14	0.44 ± 1.16	0.41 ± 1.12	0.46 ± 1.17	0.46 ± 1.18	0.47 ± 1.20	0.47 ± 1.21
No. respondents (%) reporting difficulty with IADL outcomes										
Difficulty preparing meals										
No difficulty	5,589 (79.68%)	10,150 (92.78%)	18,781 (87.94%)	17,033 (87.11%)	15,690 (86.40%)	17,625 (87.60%)	16,216 (87.83%)	15,095 (87.72%)	19,646 (89.72%)	18,341 (89.31%)
Difficulty	657 (9.37%)	324 (2.96%)	1,170 (5.48%)	1,040 (5.32%)	1,066 (5.87%)	1,040 (5.17%)	1,017 (5.51%)	949 (5.51%)	1,315 (6.01%)	1,369 (6.67%)
Not applicable	768 (10.95%)	466 (4.26%)	1,405 (6.58%)	1,481 (7.57%)	1,403 (7.73%)	1,454 (7.23%)	1,229 (6.66%)	1,164 (6.76%)	936 (4.27%)	826 (4.02%)
Difficulty grocery shopping										
No difficulty	5,388 (76.83%)	10,033 (91.71%)	18,465 (86.46%)	16,826 (86.05%)	15,569 (85.74%)	17,375 (86.51%)	15,820 (85.69%)	14,828 (86.17%)	19,168 (87.54%)	17,916 (87.24%)
Difficulty	800 (11.41%)	523 (4.78%)	1,537 (7.20%)	1,369 (7.00%)	1,297 (7.14%)	1,333 (6.64%)	1,417 (7.68%)	1,208 (7.02%)	1,809 (8.26%)	1,809 (8.81%)
Not applicable	825 (11.76%)	384 (3.51%)	1,354 (6.34%)	1,359 (6.95%)	1,293 (7.12%)	1,376 (6.85%)	1,225 (6.64%)	1,172 (6.81%)	920 (4.20%)	811 (3.95%)
Difficulty using the phone										
No difficulty	6,284 (89.59%)	10,641 (97.27%)	20,118 (94.20%)	18,418 (94.19%)	17,020 (93.73%)	18,978 (94.33%)	17,372 (94.10%)	16,137 (93.78%)	20,572 (93.95%)	19,292 (93.94%0
Difficulty	558 (7.96%)	247 (2.26%)	966 (4.52%)	848 (4.34%)	893 (4.92%)	842 (4.19%)	815 (4.41%)	819 (4.76%)	1,124 (5.13%)	1,054 (5.13%)
Not applicable	172 (2.45%)	52 (0.48%)	272 (1.27%)	288 (1.47%)	246 (1.35%)	299 (1.49%)	275 (1.49%)	252 (1.46%)	201 (0.92%)	190 (0.93%)
Difficulty taking medications										

No difficulty	6,099 (86.95%)	9,910 (90.59%)	19,211 (89.96%)	17,732 (90.68%)	16,963 (93.41%)	18,829 (93.71%)	17,322 (93.83%)	16,149 (93.85%)	20,550 (93.85%)	19,282 (93.89%)
Difficulty	490 (6.99%)	210 (1.92%)	799 (3.74%)	771 (3.94%)	772 (4.25%)	819 (4.08%)	836 (4.53%)	821 (4.77%)	1,011 (4.62%)	964 (4.69%)
Not applicable	425 (6.06%)	820 (7.50%)	1,346 (6.30%)	1,051 (5.37%)	424 (2.33%)	445 (2.21%)	304 (1.65%)	238 (1.38%)	336 (1.53%)	290 (1.41%)
Difficulty managing money										
No difficulty	5,826 (83.07%)	10,340 (94.52%)	19,305 (90.40%)	17,561 (89.81%)	16,197 (89.20%)	17,980 (89.37%)	16,377 (88.71%)	15,225 (88.48%)	19,377 (88.50%)	18,323 (89.22%)
Difficulty	641 (9.14%)	293 (2.68%)	1,075 (5.03%)	991 (5.07%)	985 (5.42%)	940 (4.67%)	948 (5.13%)	866 (5.03%)	1,490 (6.80%)	1,332 (6.49%)
Not applicable	546 (7.79%)	307 (2.81%)	976 (4.57%)	1,001 (5.12%)	977 (5.38%)	1,199 (5.96%)	1,137 (6.16%)	1,117 (6.49%)	1,030 (4.70%)	881 (4.29%)
Difficulty with any IADL										
No difficulty	5,505 (78.34%)	9,985 (91.07%)	18,494 (86.49%)	16,975 (86.70%)	15,619 (85.98%)	17,397 (86.43%)	15,808 (85.59%)	14,724 (85.52%)	18,464 (83.81%)	17,271 (84.03%)
Difficulty	1,522 (21.66%)	979 (8.93%)	2,890 (13.51%)	2,603 (13.30%)	2,547 (14.02%)	2,732 (13.57%)	2,661 (14.41%)	2,493 (14.48%)	3,568 (16.19%)	3,283 (15.97%)
Mean IADL count	0.45 ± 1.06	0.15 ± 0.55	0.26 ± 0.80	0.26 ± 0.80	0.28 ± 0.83	0.25 ± 0.76	0.27 ± 0.81	0.27 ± 0.80	0.31 ± 0.85	0.32 ± 0.89
Caregiving received										
No. (%) respondents reporting helpers	1,258 (17.90%)	496 (4.52%)	2,056 (9.61%)	2,701 (13.80%)	2,780 (15.30%)	2,957 (14.69%)	2,881 (15.60%)	2,709 (15.73%)	3,574 (16.22%)	3,372 (16.41%)
Mean count (SD) of helpers	1.70 ± 0.99	1.79 ± 1.14	2.23 ± 1.46	1.90 ± 1.33	1.69 ± 0.96	1.70 ± 1.01	1.71 ± 1.03	1.73 ± 1.07	1.88 ± 1.19	1.84 ± 1.15
No. respondents	329	67	522	431	458	457	471	471	641	619
Mean (SD) days paid help	18.54 (10.65)	16.28 (11.36)	18.51 (10.25)	19.94 (9.92)	18.19 (10.81)	17.50 (10.84)	18.56 (10.34)	18.17 (10.69)	18.47 (10.49)	18.03 (10.64)
No. respondents	319	67	514	424	454	444	465	465	619	601
Mean (SD) hours paid help	5.46 (6.09)	4.21 (5.45)	4.97 (5.83)	5.46 (5.98)	5.89 (6.49)	5.84 (6.42)	5.81 (6.29)	5.59 (6.23)	5.30 (5.69)	5.68 (5.86)
No.	1,118	422	1,718	2,447	2,374	2,509	1,588	2,323	3,150	2,937

respondents										
Mean (SD) days unpaid help	18.06 (12.07)	14.90 (11.81)	14.83 (11.32)	18.44 (11.86)	18.39 (11.96)	17.77 (11.98)	14.99 (11.66)	18.51 (12.03)	16.90 (11.78)	17.06 (11.74)
No. respondents	1,079	412	1,672	2,366	2,300	2,424	1,548	2,246	3,058	2,855
Mean (SD) hours unpaid help	3.75 (4.94)	3.36 (4.01)	3.45 (4.28)	3.86 (5.19)	4.23 (5.59)	4.11 (5.38)	3.32 (3.93)	4.26 (5.87)	3.62 (4.60)	3.66 (4.58)

SD: standard deviation

Table 4. Bivariate analyses comparing ADL and IADL outcomes, nursing home status, and caregiving received by vision impairment status

	1995	**1996**	**1998**	**2000**	**2002**	**2004**	**2006**	**2008**	**2010**	**2012**
Proportion in nursing home										
No vision impairment (n)	0.031 (6,192)	0.002 (10,439)	0.015 (20,015)	0.017 (18,271)	0.019 (16,974)	0.017 (18,839)	0.018 (17,283)	0.021 (16,151)	0.018 (20,567)	0.018 (19,093)
Vision impairment (n)	0.093 (826)	0.016 (516)	0.090 (1,356)	0.107 (1,293)	0.112 (1,168)	0.103 (1,267)	0.093 (1,155)	0.092 (1,048)	0.066 (1,416)	0.083 (1,393)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Proportion reporting difficulty with ADL outcomes										
Difficulty walking across a room										
No vision impairment (n)	0.134 (4,634)	0.056 (5,726)	0.126 (9,193)	0.127 (8,595)	0.131 (8,530)	0.125 (9,172)	0.131 (8,824)	0.138 (8,310)	0.140 (9,844)	0.138 (9,126)
Vision impairment (n)	0.358 (772)	0.228 (443)	0.342 (1,103)	0.367 (1,074)	0.371 (987)	0.349 (1,063)	0.354 (969)	0.339 (870)	0.319 (1,182)	0.340 (1,132)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty dressing										
No vision impairment (n)	0.178 (4,637)	0.104 (5,732)	0.138 (12,499)	0.140 (11,626)	0.132 (11,318)	0.128 (12,200)	0.142 (11,578)	0.144 (10,905)	0.159 (12,949)	0.151 (11,986)
Vision impairment (n)	0.392 (768)	0.314 (442)	0.370 (1,188)	0.367 (1,155)	0.368 (1,084)	0.357 (1,143)	0.355 (1,038)	0.357 (941)	0.376 (1,279)	0.377 (1,232)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty bathing										
No vision impairment (n)	0.150 (4,629)	0.050 (5,732)	0.139 (9,186)	0.135 (8,601)	0.132 (8,522)	0.129 (9,166)	0.130 (8,821)	0.140 (8,327)	0.146 (9,852)	0.150 (9,130)
Vision impairment (n)	0.382 (769)	0.196 (443)	0.399 (1,109)	0.381 (1,077)	0.377 (995)	0.352 (1,064)	0.345 (971)	0.347 (867)	0.354 (1,183)	0.347 (1,135)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty eating										

No vision impairment (n)	0.064 (4,638)	0.026 (5,733)	0.060 (9,198)	0.056 (8,611)	0.057 (8,534)	0.056 (9,170)	0.060 (8,824)	0.060 (8,325)	0.068 (9,843)	0.067 (9,127)
Vision impairment (n)	0.237 (771)	0.111 (443)	0.221 (1,107)	0.222 (1,078)	0.239 (993)	0.206 (1,061)	0.227 (966)	0.222 (869)	0.214 (1,175)	0.236 (1,132)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty getting in/out of bed										
No vision impairment (n)	0.117 (4,635)	0.079 (5,732)	0.129 (9,196)	0.120 (8,615)	0.114 (8,524)	0.109 (9,171)	0.119 (8,822)	0.117 (8,322)	0.139 (9,842)	0.135 (9,111)
Vision impairment (n)	0.286 (775)	0.271 (443)	0.324 (1,108)	0.317 (1,073)	0.303 (993)	0.289 (1,069)	0.299 (973)	0.294 (871)	0.298 (1,182)	0.332 (1,136)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty using a toilet										
No vision impairment (n)	0.109 (4,634)	0.046 (5,732)	0.107 (9,193)	0.107 (8,609)	0.104 (8,519)	0.100 (9,158)	0.117 (8,811)	0.112 (8,305)	0.120 (9,837)	0.121 (9,123)
Vision impairment (n)	0.256 (772)	0.179 (441)	0.288 (1,099)	0.273 (1,075)	0.255 (986)	0.244 (1,060)	0.264 (965)	0.258 (864)	0.276 (1,173)	0.281 (1,132)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty with any ADL										
No vision impairment (n)	0.242 (6,192)	0.101 (10,439)	0.154 (20,015)	0.159 (18,271)	0.164 (16,974)	0.152 (18,839)	0.171 (17,283)	0.172 (16,151)	0.169 (20,567)	0.168 (19,094)
Vision impairment (n)	0.580 (826)	0.426 (516)	0.524 (1,356)	0.538 (1,293)	0.536 (1,168)	0.526 (1,267)	0.545 (1,155)	0.514 (1,048)	0.526 (1,416)	0.515 (1,393)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mean ADL count										
No vision impairment (n)	0.563 (6,192)	0.199 (10,439)	0.344 (20,015)	0.346 (18,271)	0.359 (16,974)	0.336 (18,839)	0.380 (17,283)	0.389 (16,151)	0.393 (20,567)	0.387 (19,094)
Vision impairment (n)	1.785 (826)	1.114 (516)	1.608 (1,356)	1.624 (1,293)	1.652 (1,168)	1.531 (1,267)	1.569 (1,155)	1.531 (1,048)	1.557 (1,416)	1.584 (1,393)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Proportion reporting difficulty with IADL outcomes										
Difficulty preparing meals										
No vision impairment (n)	0.078 (5,560)	0.024 (9,986)	0.043 (18,746)	0.043 (16,998)	0.048 (15,700)	0.044 (17,607)	0.046 (16,234)	0.048 (15,147)	0.052 (19,664)	0.056 (18,388)
Vision impairment (n)	0.330 (678)	0.167 (480)	0.293 (1,196)	0.284 (1,061)	0.311 (966)	0.255 (1,042)	0.262 (976)	0.241 (887)	0.237 (1,255)	0.263 (1,260)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty grocery shopping										
No vision	0.093	0.040	0.059	0.058	0.059	0.056	0.065	0.061	0.069	0.073

impairment (n)	(5,557)	(10,094)	(18,879)	(17,199)	(15,959)	(17,714)	(16,288)	(15,200)	(19,713)	(18,424)
Vision	0.455	0.264	0.372	0.370	0.384	0.334	0.370	0.332	0.355	0.359
impairment (n)	(622)	(455)	(1,117)	(984)	(889)	(979)	(928)	(825)	(1,221)	(1,241)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty using the phone										
No vision	0.057	0.017	0.033	0.032	0.036	0.032	0.031	0.037	0.039	0.038
impairment (n)	(6,059)	(10,378)	(19,776)	(18,033)	(16,801)	(18,613)	(17,071)	(15,957)	(20,270)	(18,935)
Vision	0.276	0.141	0.236	0.223	0.261	0.209	0.247	0.227	0.238	0.236
impairment (n)	(775)	(502)	(1,299)	(1,219)	(1,091)	(1,190)	(1,091)	(985)	(1,378)	(1,350)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty taking medications										
No vision	0.054	0.015	0.030	0.031	0.033	0.032	0.035	0.039	0.037	0.037
impairment (n)	(5,786)	(9,621)	(18,707)	(17,244)	(16,573)	(18,399)	(16,998)	(15,921)	(20,122)	(18,814)
Vision	0.223	0.126	0.176	0.187	0.199	0.183	0.203	0.183	0.190	0.184
impairment (n)	(794)	(493)	(1,292)	(1,246)	(1,139)	(1,231)	(1,132)	(1,034)	(1,393)	(1,369)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty managing money										
No vision	0.071	0.021	0.039	0.040	0.043	0.039	0.042	0.044	0.059	0.055
impairment (n)	(5,759)	(10,151)	(19,155)	(17,450)	(16,176)	(17,865)	(16,331)	(15,211)	(19,576)	(18,356)
Vision	0.329	0.162	0.272	0.259	0.289	0.222	0.256	0.228	0.263	0.252
impairment (n)	(700)	(475)	(1,216)	(1,088)	(985)	(1,039)	(972)	(870)	(1,244)	(1,242)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Difficulty with any IADL										
No vision	0.169	0.074	0.110	0.107	0.112	0.113	0.119	0.123	0.137	0.136
impairment (n)	(6,192)	(10,439)	(20,015)	(18,271)	(16,974)	(18,839)	(17,283)	(16,151)	(20,567)	(19,094)
Vision	0.570	0.388	0.504	0.491	0.542	0.467	0.515	0.470	0.514	0.485
impairment (n)	(826)	(516)	(1,356)	(1,293)	(1,168)	(1,267)	(1,155)	(1,048)	(1,416)	(1,393)
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mean IADL count										
No vision	0.325	0.113	0.194	0.195	0.209	0.193	0.210	0.219	0.246	0.252
impairment (n)	(6,192)	(10,439)	(20,015)	(18,271)	(16,974)	(18,839)	(17,283)	(16,151)	(20,567)	(19,094)
Vision	1.366	0.795	1.201	1.123	1.231	1.024	1.167	1.049	1.166	1.192
impairment (n)	(826)	(516)	(1,356)	(1,293)	(1,168)	(1,267)	(1,155)	(1,048)	(1,416)	(1,393)
p-value	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Caregiving received										
Mean count of helpers										
No vision	1.684	1.754	2.192	1.850	1.640	1.672	1.668	1.694	1.827	1.809
impairment (n)	(854)	(374)	(1,539)	(2,029)	(2,093)	(2,267)	(2,221)	(2,166)	(2,832)	(2,639)
Vision	1.731	1.884	2.365	2.057	1.820	1.783	1.845	1.859	2.100	1.983

impairment (n)	(402)	(121)	(512)	(667)	(676)	(678)	(645)	(533)	(727)	(706)
p-value	0.429	0.322	0.026	0.001	0.0001	0.011	0.0001	0.0009	<0.0001	0.0004
Average days paid help										
No vision impairment (n)	18.461 (216)	15.261 (48)	18.155 (367)	19.900 (298)	18.463 (313)	17.115 (326)	18.222 (346)	17.606 (370)	17.852 (480)	17.906 (454)
Vision impairment (n)	18.864 (112)	18.664 (18)	19.191 (153)	20.151 (132)	17.561 (142)	18.411 (128)	19.468 (122)	20.219 (101)	20.271 (160)	18.314 (161)
p-value	0.742	0.324	0.284	0.808	0.421	0.252	0.252	0.032	0.011	0.669
Average hours paid help										
No vision impairment (n)	5.446 (209)	3.011 (47)	4.593 (360)	5.388 (294)	5.811 (309)	5.611 (320)	5.750 (341)	5.441 (364)	5.277 (469)	5.959 (436)
No. no vision impairment										
Vision impairment (n)	5.488 (110)	7.237 (19)	5.831 (152)	5.654 (129)	5.968 (142)	6.461 (121)	5.844 (121)	6.109 (101)	5.417 (149)	4.949 (161)
p-value	0.953	0.038	0.050	0.668	0.814	0.238	0.889	0.363	0.796	0.031
Average days unpaid help										
No vision impairment (n)	17.909 (757)	13.673 (315)	14.495 (1,286)	18.265 (1,837)	18.116 (1,786)	17.528 (1,943)	14.524 (1,156)	18.629 (1,853)	16.802 (2,483)	16.811 (2,304)
Vision impairment (n)	18.327 (360)	18.515 (107)	15.747 (427)	19.078 (605)	19.192 (581)	18.683 (561)	16.443 (423)	18.019 (467)	17.371 (656)	17.851 (612)
p-value	0.588	0.0003	0.046	0.141	0.060	0.041	0.004	0.33	0.267	0.049
Average hours unpaid help										
No vision impairment (n)	3.651 (727)	3.183 (309)	3.350 (1,253)	3.634 (1,788)	3.931 (1,736)	3.876 (1,879)	3.153 (1,127)	4.105 (1,793)	3.526 (2,421)	3.532 (2,245)
Vision impairment (n)	3.952 (351)	3.895 (103)	3.754 (414)	4.565 (574)	5.146 (556)	4.912 (540)	3.718 (412)	4.888 (450)	4.007 (628)	4.089 (590)
p-value	0.358	0.174	0.106	0.0008	<0.0001	0.0003	0.023	0.015	0.029	0.011

Note: n represents number of respondents with and without vision impairment who provided a response for the outcome during each wave; p-values are testing differences in proportion or differences in mean between vision impairment group and no vision impairment group, within each wave.

Table 5. Multivariable logistic regression comparing odds of living in a nursing home in vision impaired* individuals to individuals with no vision impairment

	Odds ratio¥	**Standard error**	**95% confidence interval**
Year			
1998	1.08	0.29	(0.64, 1.84)
2006	1.09	0.30	(0.64, 1.86)
2012	1.22	0.30	(0.76, 1.97)

*Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair
¥Odds ratio adjusted for degree of educational attainment as a categorical variable, gender, race/ethnicity, household wealth as a categorical variable, household income as a categorical variable, marital status dichotomized as married/partnered or not married, cognitive status as a categorical variable, age as a continuous variable, and indicator variables for presence of eight comorbidities

Table 6. Multivariable logistic regression comparing odds of difficulty with any ADL in vision impaired* individuals to individuals with no vision impairment

	Odds ratio¥	**Standard error**	**95% confidence interval**
Year			
1998	2.57	0.22	(2.16, 3.05)
2006	2.37	0.22	(1.97, 2.84)
2012	2.31	0.22	(1.92, 2.77)

*Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair
¥Odds ratio adjusted for degree of educational attainment as a categorical variable, gender, race/ethnicity, household wealth as a categorical variable, household income as a categorical variable, marital status dichotomized as married/partnered or not married, cognitive status as a categorical variable, age as a continuous variable, and indicator variables for presence of eight comorbidities

Table 7. Multivariable logistic regression comparing odds of difficulty with any IADL in vision impaired* individuals to individuals with no vision impairment

	Odds ratio¥	**Standard error**	**95% confidence interval**
Year			
1998	3.78	0.35	(3.15, 4.53)
2006	3.94	0.38	(3.26, 4.76)
2012	3.49	0.34	(2.89, 4.22)

*Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair
¥Odds ratio adjusted for degree of educational attainment as a categorical variable, gender, race/ethnicity, household wealth as a categorical variable, household income as a categorical variable, marital status dichotomized as married/partnered or not married, cognitive status as a categorical variable, age as a continuous variable, and indicator variables for presence of eight comorbidities

Table 8. Adjusted* odds ratio of nursing home residence estimated from mixed-effect logistic regression (n=107,888)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)** [†]
Vision impairment[‡] (reference: no vision impairment)	1.37	0.021	[1.05, 1.78]
Highest education level (reference: less than high school)			
High school diploma or equivalent	2.22	<0.001	[1.63, 3.01]
Completed college	3.44	<0.001	[2.15, 5.51]
Graduate degree	3.37	<0.001	[1.79, 6.34]
Degree unknown or some college	(dropped)		
Male (reference: female)	1.11	0.496	[0.83, 1.48]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	0.36	<0.001	[0.24, 0.54]
Hispanic	0.10	<0.001	[0.05, 0.20]
Other	0.44	0.120	[0.15, 1.24]
Not obtained	(dropped)		
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.23	<0.001	[0.18, 0.30]
$31,000-$69,000	0.15	<0.001	[0.10, 0.22]
$69,000-$212,000	0.14	<0.001	[0.10, 0.20]
>$212,000	0.12	<0.001	[0.08, 0.17]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.75	0.248	[0.46, 1.22]
$227,000-$458,000	0.82	0.793	[0.19, 3.55]
>$458,000	0.38	0.478	[0.03, 5.60]
Married/partnered (reference: not married/partnered)	0.22	<0.001	[0.16, 0.30]
Cognition (reference: high cognitive function)			
Moderate cognitive function	3.38	0.004	[2.26, 5.04]
Low cognitive function	21.55	<0.001	[13.56, 34.25]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	0.70	0.004	[0.55, 0.89]
Diabetes	2.09	<0.001	[1.58, 2.77]
Cancer	1.27	0.107	[0.95, 1.69]
Lung disease	1.28	0.125	[0.93, 1.77]
Heart condition	1.07	0.542	[0.85, 1.35]
Stroke	3.21	<0.001	[2.42, 4.24]
Psychiatric disease	3.39	<0.001	[2.58, 4.47]
Arthritis	1.00	0.997	[0.77, 1.30]
Age[¥]	1.25	<0.001	[1.22, 1.28]

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for nursing home residence

[‡]Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio comparing odds for an additional year of age

Table 9. Adjusted* odds ratio of difficulty performing ≥1 ADL estimated from mixed-effects logistic regression (N=108,043)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)** [†]
Vision impairment[‡] (reference: no vision impairment)	2.96	<0.001	[2.71, 3.24]
Highest education level (reference: less than high school)			
High school diploma or equivalent	0.78	<0.001	[0.71, 3.24]
Completed college	0.72	<0.001	[0.63, 0.83]
Graduate degree	0.64	<0.001	[0.54, 0.77]
Degree unknown or some college	1.28	0.563	[0.55, 2.99]
Male (reference: female)	0.84	<0.001	[0.78, 0.91]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	1.18	0.002	[1.07, 1.32]
Hispanic	1.40	<0.001	[1.22, 1.59]
Other	1.11	0.415	[0.86, 1.43]
Not obtained	0.75	0.771	[0.10, 5.39]
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.59	<0.001	[0.54, 0.63]
$31,000-$69,000	0.46	<0.001	[0.41, 0.51]
$69,000-$212,000	0.39	<0.001	[0.36, 0.44]
>$212,000	0.37	<0.001	[0.33, 0.41]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.82	<0.001	[0.75, 0.90]
$227,000-$458,000	0.66	0.005	[0.50, 0.88]
>$458,000	0.61	0.050	[0.37, 1.00]
Married/partnered (reference: not married/partnered)	0.81	<0.001	[0.76, 0.87]
Cognition (reference: high cognitive function)			
Moderate cognitive function	1.58	<0.001	[1.48, 1.69]
Low cognitive function	3.14	<0.001	[2.80, 3.52]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	1.17	<0.001	[1.10, 1.25]
Diabetes	1.59	<0.001	[1.48, 1.72]
Cancer	1.39	<0.001	[1.28, 1.50]
Lung disease	2.05	<0.001	[1.88, 2.24]
Heart condition	1.61	<0.001	[1.50, 1.71]
Stroke	3.18	<0.001	[2.90, 3.50]
Psychiatric disease	2.31	<0.001	[2.14, 2.50]
Arthritis	3.42	<0.001	[3.19, 3.67]
Age[¥]	1.05	<0.001	[1.04, 1.05]

ADLs measured were dressing, walking across a room, bathing, eating, using the toilet, and getting in/out of bed

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for difficulty performing ≥1 ADL

[‡]Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio for an additional year of age

Table 10. Adjusted* odds ratio of difficulty performing ≥1 IADL estimated from mixed-effects logistic regression (N=108,043)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)** [†]
Vision impairment[‡] (reference: no vision impairment)	4.02	<0.001	[3.70, 4.37]
Highest education level (reference: less than high school)			
High school diploma or equivalent	0.79	<0.001	[0.73, 0.86]
Completed college	0.74	<0.001	[0.65, 0.84]
Graduate degree	0.69	<0.001	[0.58, 0.82]
Degree unknown or some college	2.02	0.072	[0.94, 4.35]
Male (reference: female)	0.94	0.129	[0.88, 1.02]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	1.08	0.127	[0.98, 1.20]
Hispanic	1.13	0.062	[0.99, 1.28]
Other	1.28	0.041	[1.01, 1.62]
Not obtained	0.11	0.125	[0.01, 1.86]
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.60	<0.001	[0.55, 0.64]
$31,000-$69,000	0.46	<0.001	[0.41, 0.51]
$69,000-$212,000	0.42	<0.001	[0.38, 0.46]
>$212,000	0.37	<0.001	[0.33, 0.41]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.82	<0.001	[0.74, 0.91]
$227,000-$458,000	0.85	0.273	[0.63, 1.14]
>$458,000	0.92	0.739	[0.55, 1.52]
Married/partnered (reference: not married/partnered)	0.88	<0.001	[0.82, 0.94]
Cognition (reference: high cognitive function)			
Moderate cognitive function	1.93	<0.001	[1.79, 2.08]
Low cognitive function	5.96	<0.001	[5.31, 6.69]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	1.11	0.001	[1.04, 1.19]
Diabetes	1.31	<0.001	[1.21, 1.41]
Cancer	1.25	<0.001	[1.15, 1.36]
Lung disease	1.71	<0.001	[1.57, 1.86]
Heart condition	1.59	<0.001	[1.49, 1.70]
Stroke	2.64	<0.001	[2.41, 2.89]
Psychiatric disease	2.86	<0.001	[2.65, 3.09]
Arthritis	1.67	<0.001	[1.56, 1.79]
Age[¥]	1.04	<0.001	[1.04, 1.04]

IADLs measured were preparing meals, grocery shopping, using the phone, taking medications, managing money

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for difficulty performing ≥1 IADL

[‡]Vision impairment includes responses of poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, good, or fair

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio for an additional year of age

Table 11. Sensitivity analysis with adjusted* OR of nursing home residence estimated from mixed-effects logistic regression (N=107,888)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)**[†]
Vision impairment[‡] (reference: no vision impairment)	1.21	0.069	[0.99, 1.49]
Highest education level (reference: less than high school)			
High school diploma or equivalent	2.22	<0.001	[1.63, 3.01]
Completed college	3.45	<0.001	[2.16, 5.52]
Graduate degree	3.38	<0.001	[1.79, 6.37]
Degree unknown or some college	(dropped)		
Male (reference: female)	1.10	0.514	[0.82, 1.47]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	0.36	<0.001	[0.24, 0.53]
Hispanic	0.10	<0.001	[0.05, 0.20]
Other	0.43	0.118	[0.15, 1.24]
Not obtained	(dropped)		
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.23	<0.001	[0.18, 0.30]
$31,000-$69,000	0.15	<0.001	[0.10, 0.22]
$69,000-$212,000	0.14	<0.001	[0.10, 0.20]
>$212,000	0.12	<0.001	[0.08, 0.17]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.75	0.249	[0.46, 1.22]
$227,000-$458,000	0.84	0.810	[0.19, 3.59]
>$458,000	0.37	0.466	[0.02, 5.45]
Married/partnered (reference: not married/partnered)	0.22	<0.001	[0.16, 0.29]
Cognition (reference: high cognitive function)			
Moderate cognitive function	3.38	<0.001	[2.26, 5.04]
Low cognitive function	21.68	<0.001	[13.63, 34.47]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	0.70	0.004	[0.55, 0.89]
Diabetes	2.09	<0.001	[1.58, 2.77]
Cancer	1.27	0.105	[0.95, 1.69]
Lung disease	1.29	0.118	[0.94, 1.78]
Heart condition	1.07	0.552	[0.85, 1.35]
Stroke	3.22	<0.001	[2.43, 4.26]
Psychiatric disease	3.42	<0.001	[2.60, 4.51]
Arthritis	1.00	0.979	[0.77, 1.29]
Age[¥]	1.25	<0.001	[1.22, 1.28]

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for nursing home residence

[‡]Vision impairment includes responses of fair and poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, or good

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio for an additional year of age

Table 12. Sensitivity analysis with adjusted* odds ratio of difficulty performing ≥1 ADL estimated from mixed-effects logistic regression (N=108,043)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)** [†]
Vision impairment[‡] (reference: no vision impairment)	2.19	<0.001	[2.07, 2.32]
Highest education level (reference: less than high school)			
High school diploma or equivalent	0.81	<0.001	[0.74, 0.88]
Completed college	0.77	<0.001	[0.67, 0.87]
Graduate degree	0.69	<0.001	[0.58, 0.82]
Degree unknown or some college	1.28	0.566	[0.55, 2.98]
Male (reference: female)	0.83	<0.001	[0.76, 0.90]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	1.14	0.018	[1.02, 1.26]
Hispanic	1.26	<0.001	[1.11, 1.44]
Other	1.11	0.433	[0.86, 1.42]
Not obtained	0.70	0.718	[0.10, 4.96]
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.59	<0.001	[0.55, 0.63]
$31,000-$69,000	0.46	<0.001	[0.41, 0.51]
$69,000-$212,000	0.40	<0.001	[0.36, 0.44]
>$212,000	0.37	<0.001	[0.33, 0.41]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.84	<0.001	[0.76, 0.92]
$227,000-$458,000	0.67	0.006	[0.51, 0.89]
>$458,000	0.60	0.047	[0.36, 0.99]
Married/partnered (reference: not married/partnered)	0.81	<0.001	[0.76, 0.87]
Cognition (reference: high cognitive function)			
Moderate cognitive function	1.55	<0.001	[1.45, 1.65]
Low cognitive function	3.17	<0.001	[2.82, 3.55]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	1.16	<0.001	[1.09, 1.24]
Diabetes	1.58	<0.001	[1.47, 1.71]
Cancer	1.39	<0.001	[1.28, 1.50]
Lung disease	2.03	<0.001	[1.87, 2.22]
Heart condition	1.59	<0.001	[1.49, 1.70]
Stroke	3.14	<0.001	[2.86, 3.44]
Psychiatric disease	2.29	<0.001	[2.12, 2.47]
Arthritis	3.39	<0.001	[3.16, 3.63]
Age[¥]	1.05	<0.001	[1.04, 1.05]

ADLs measured were dressing, walking across a room, bathing, eating, using the toilet, and getting in/out of bed

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for difficulty performing ≥1 ADL

[‡]Vision impairment includes responses of fair and poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, or good

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio for an additional year of age

Table 13. Sensitivity analysis with adjusted* odds ratio of difficulty performing ≥1 IADL estimated from mixed-effects logistic regression (n=108,043)

Covariate	**Odds ratio**[†]	**p-value**	**95% confidence interval (CI)** [†]
Vision impairment[‡] (reference: no vision impairment)	2.60	<0.001	[2.45, 2.75]
Highest education level (reference: less than high school)			
High school diploma or equivalent	0.82	<0.001	[0.75, 0.89]
Completed college	0.79	<0.001	[0.69, 0.89]
Graduate degree	0.74	0.001	[0.62, 0.88]
Degree unknown or some college	1.94	0.09.	[0.89, 4.21]
Male (reference: female)	0.93	0.056	[0.86, 1.00]
Race/ethnicity (reference: non-Hispanic white/Caucasian)			
Non-Hispanic Black/African-American	1.04	0.472	[0.94, 1.15]
Hispanic	1.00	0.975	[0.88, 1.13]
Other	1.27	0.049	[1.00, 1.60]
Not obtained	0.10	0.116	[0.01, 1.75]
Total non-housing wealth (reference: less than $1,000)			
$1,000-$31,000	0.60	<0.001	[0.55, 0.64]
$31,000-$69,000	0.46	<0.001	[0.41, 0.51]
$69,000-$212,000	0.42	<0.001	[0.38, 0.47]
>$212,000	0.37	<0.001	[0.33, 0.42]
Total household income (reference: <$74,000)			
$74,000-$227,000	0.83	<0.001	[0.75, 0.92]
$227,000-$458,000	0.88	0.384	[0.65, 1.18]
>$458,000	0.95	0.853	[0.58, 1.58]
Married/partnered (reference: not married/partnered)	0.87	<0.001	[0.81, 0.94]
Cognition (reference: high cognitive function)			
Moderate cognitive function	1.89	<0.001	[1.75, 2.03]
Low cognitive function	5.96	<0.001	[5.31, 6.69]
Presence of chronic condition (reference: absence of chronic condition)			
High blood pressure	1.10	0.003	[1.03, 1.18]
Diabetes	1.30	<0.001	[1.21, 1.40]
Cancer	1.26	<0.001	[1.16, 1.36]
Lung disease	1.70	<0.001	[1.56, 1.85]
Heart condition	1.59	<0.001	[1.49, 1.70]
Stroke	2.60	<0.001	[2.37, 2.85]
Psychiatric disease	2.84	<0.001	[2.63, 3.06]
Arthritis	1.65	<0.001	[1.54, 1.77]
Age[¥]	1.04	<0.001	[1.04, 1.04]

IADLs measured were preparing meals, grocery shopping, using the phone, taking medications, managing money

*Adjusted for age at wave, highest education attained, gender, race/ethnicity, household wealth, household income, marital status, cognition, presence/absence of eight comorbidities, and wave indicator

[†]Beta coefficients and confidence limits from the model were exponentiated to obtain the odds ratio and corresponding 95% CI for difficulty performing ≥1 IADL

[‡]Vision impairment includes responses of fair and poor or a voluntary response of legally blind in response to the question “Is your eyesight excellent, very good, good, fair, or poor using glasses or corrective lenses as usual?” rather than a response of excellent, very good, or good

¥Treated as a continuous variable, beta coefficient and confidence limits exponentiated to obtain odds ratio for an additional year of age

References:

1. Prevent Blindness America. *Vision Problems in the U.S.*; 2008.
2. Congdon N, O'Colmain B, Klaver CCW, et al. Causes and prevalence of visual impairment among adults in the United States. *Arch Ophthalmol*. 2004;122(4):477-485. doi:10.1001/archopht.122.4.477.
3. Rein DB, Zhang P, Wirth KE, et al. The economic burden of major adult visual disorders in the United States. *Arch Ophthalmol*. 2006;124(12):1754-1760. doi:10.1001/archopht.124.12.1754.
4. Crews JE, Jones GC KJ. Double Jeopardy: The Effects of Comorbid Conditions among Older People with Vision Loss - JVIB - Special Supplement. *J Vis Impair Blind*. https://www.afb.org/jvib/jvib001307.asp. Accessed July 9, 2015.
5. Cummings SR, Nevitt MC, Browner WS, et al. Risk factors for hip fracture in white women. *N Engl J Med*. 1995;332(12):767-773.
6. Cugati S, Cumming RG, Smith W, Burlutsky G, Mitchell P, Wang JJ. Visual Impairment, Age-Related Macular Degeneration, Cataract, and Long-term Mortality. *Arch Ophthalmol*. 2015;125(7):917-924.
7. Wang JJ, Mitchell P, Simpson JM, Cumming RG, Smith W. Visual Impairment, Age-Related Cataract, and Mortality. *Arch Ophthalmol*. 2015;119(8):1186-1190.
8. Christ SL, Zheng DD, Swenor BK, et al. Longitudinal Relationships Among Visual Acuity, Daily Functional Status, and Mortality. *JAMA Ophthalmol*. 2014;132(12):1400. doi:10.1001/jamaophthalmol.2014.2847.
9. Cimarolli VR, Jopp DS. Sensory impairments and their associations with functional disability in a sample of the oldest-old. *Qual Life Res*. 2014;23(7):1977-1984. doi:10.1007/s11136-014-0657-0.
10. Jette AM, Branch LG. Impairment and Disability. *J Chronic Dis*. 1985;38(1):59-65.
11. Lam BL, Christ SL, Zheng DD, et al. Longitudinal relationships among visual acuity and tasks of everyday life: The salisbury eye evaluation study. *Investig Ophthalmol Vis Sci*. 2013;54(1):193-200. doi:10.1167/iovs.12-10542.
12. Lee PP, Smith JP, Kington RS. The associations between self-rated vision and hearing and functional status in middle age. *Ophthalmology*. 1999;106(2):401-405. doi:10.1016/S0161-6420(99)90082-9.
13. Lee P, Smith JP, Kington R. The relationship of self-rated vision and hearing to functional status and well-being among seniors 70 years and older. *Am J Ophthalmol*. 1999;127(4):447-452. doi:10.1016/S0002-9394(98)00418-8.
14. 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. http://onlinelibrary.wiley.com/doi/10.1111/j.1532-5415.2004.52554.x/full.
15. Rubin GS, Roche KB, Prasada-Rao P FL. Visual Impairment and Disability in Older Adults. *Optom Vis Sci*. 1994;71(12):750-760.
16. Rubin GS, Bandeen-Roche K, Huang GH, et al. The association of multiple visual impairments with self-reported visual disability: SEE project. *Investig Ophthalmol Vis Sci*. 2001;42(1):64-72.
17. Sloan FA, Ostermann J, Brown DS, Lee PP. Effects of changes in self-reported vision on cognitive, affective, and functional status and living arrangements among the elderly. *Am J Ophthalmol*. 2005;140(4). doi:10.1016/j.ajo.2005.01.019.
18. Hung WW, Ross JS, Boockvar KS, Siu AL. Recent trends in chronic disease, impairment and disability among older adults in the United States. *BMC Geriatr*. 2011;11(1):47. doi:10.1186/1471-2318-11-47.
19. West SK, Rubin GS, Broman AT, Munoz B, Bandeen-Roche K, Turano K. How does visual impairment affect performance on tasks of everyday life? The SEE Project. *Arch Ophthalmol*. 2002;120(June 2002). doi:10.1097/00132578-200210000-00023.
20. Hong T, Mitchell P, Burlutsky G, Fong CSU, Rochtchina E, Wang JJ. Visual Impairment and subsequent use of support services among older people: Longitudinal findings from the Blue Mountains Eye Study. *Am J Ophthalmol*. 2013;156(2):393-400. doi:10.1016/j.ajo.2013.04.002.
21. Klein BEK, Moss SE, Klein R, Lee KE, Cruickshanks KJ. Associations of visual function with physical outcomes and limitations 5 years later in an older population: The Beaver Dam Eye Study. *Ophthalmology*. 2003;110(4):644-650. doi:10.1016/S0161-6420(02)01935-8.
22. Frick KD, Gower EW, Kempen JH, Wolff JL. Economic impact of visual impairment and blindness in the United States. *Arch Ophthalmol*. 2007;125(4):544-550. doi:10.1001/archopht.125.4.544.

23. Schmier JK, Halpern MT, Covert D, Delgado J, Sharma S. Impact of visual impairment on use of caregiving by individuals with age-related macular degeneration. *Retina*. 2004;26(9):1056-1062. doi:10.1097/01.iae.0000254890.48272.5a.
24. Horowitz A, Brennan M, Reinhardt JP. Prevalence and Risk Factors for Self-Reported Visual Impairment Among Middle-Aged and Older Adults. *Res Aging*. 2005;27(3):307-326. doi:10.1177/0164027504274267.
25. Ortman JM, Velkoff VA, Hogan H. *An Aging Nation: The Older Population in the United States*. Vol P25-1140. Washington, DC; 2014. census.gov.
26. Health and Retirement Study, AHEAD/HRS Core public use dataset. Produced and distributed by the University of Michigan with funding from the National Institute on Aging (grant number NIA U01AG009740). Ann Arbor, MI, (2015).
27. Berger S, Porell F. The association between low vision and function. *J Aging Health*. 2008;20(5):504-525.
28. Walsh EG, Wu B, Mitchell JB, Berkmann LF. Cognitive function and acute care utilization. *J Gerontol B Psychol Sci Soc Sci*. 2003;58(1):S38-S49.
29. RAND Core Income and Wealth Imputation Files, Version N. Produced by the RAND Center for the Study of Aging, with fundig from the National Institute on Aging and the Social Security Administration. Santa Monica, CA (October 2014).
30. Hu FB, Goldberg J, Hedeker D, Flay BR, Pentz M a. Comparison of population-averaged and subject-specific approaches for analyzing repeated binary outcomes. *Am J Epidemiol*. 1998;147(7):694-703. doi:10.1093/oxfordjournals.aje.a009511.
31. Hedeker D. *Generalized Linear Mixed Models*. John Wiley & Sons, Ltd. doi:10.2307/2348554.
32. Gardiner JC, Luo Z, Roman LA. Fixed effects, random effects and GEE: What are the differences? *Stat Med*. 2009;28(15):221-239. doi:10.1002/sim.
33. StataCorp. Stata Statistical Software: Release 13. 2013.
34. Chou CF, Frances Cotch M, Vitale S, et al. Age-related eye diseases and visual impairment among U.S. adults. *Am J Prev Med*. 2013;45(1):29-35. doi:10.1016/j.amepre.2013.02.018.
35. Tanna AP, Kaye HS. Trends in self-reported visual impairment in the United States: 1984 to 2010. *Am Acad Ophthalmol*. 2012;119(10):2028-2032. doi:10.1016/j.ophtha.2012.04.018.
36. Hidalgo JL-T, Martínez IP, Bravo BN, Pretel FA, Ferrer AV, Verdejo MAL. Visual function versus visual acuity in older people. *Ophthalmic Epidemiol*. 2009;16(4):262-268. doi:10.3109/09286580902999397.
37. McGwin G, Khoury R, Cross J, Owsley C. Vision impairment and eye care utilization among Americans 50 and older. *Curr Eye Res*. 2010;35(6):451-458. doi:10.3109/02713681003664931.
38. Aartolahti E, Häkkinen A, Lönnroos E, Kautiainen H, Sulkava R, Hartikainen S. Relationship between functional vision and balance and mobility performance in community-dwelling older adults. *Aging Clin Exp Res*. 2013;25(5):545-552. doi:10.1007/s40520-013-0120-z.

Appendix A: Number of waves for which a respondent provided a core interview, by entry cohort

	Cohort					
Number of waves	HRS	AHEAD	CODA*	WB*	EBB†	MBB‡
1	802	1,204	186	137	428	574
2	718	1,078	219	134	1,449	4,550
3	774	984	202	132	333	
4	646	791	204	144	388	
5	698	711	211	131	2,360	
6	842	641	244	186		
7	1,040	627	234	309		
8	1,177	424	926	1,614		
9	5,663	925				
Total	12,360	7,385	2,426	2,787	4,958	5,124

*CODA and WB cohorts eligible to be interviewed for max of 8 waves
†EBB cohort eligible to be interviewed for max of 5 waves
‡MBB cohort eligible to be interviewed for max of 2 waves
AHEAD: Asset and Health Dynamics among the Oldest Old (born 1923 or earlier); CODA: Children of the Depression Era (born 1924-1930); EBB: Early Baby Boomer (born 1954-1959); HRS: Health and Retirement Study (born 1931-1941); MBB: Mid-Baby Boomer (born 1960-1965)

Appendix B. Follow-up time by entry cohort

Cohort	Max waves eligible for follow-up	Total eligible sample	Total sample providing ≥1 core interview	Mean (SD) number of waves of follow-up	Median (IQR) number of waves of follow-up	N providing only 1 core interview	N providing complete follow-up
HRS	9	13,782	12,360	7.84 (1.89)	9 (7-9)	802	5,663 (45.8%)
AHEAD	9	8,538	7,385	6.08 (2.46)	6 (4-9)	1,204	925 (12.5%)
CODA	8	2,457	2,426	6.68 (1.85)	8 (6-8)	186	926 (38.2%)
WB	8	2,838	2,787	7.28 (1.45)	8 (7-8)	137	1,614 (57.9%)
EBB	5	5,061	4,958	4.21 (1.25)	5 (4-5)	428	2,360 (47.6%)
MBB	2	5,304	5,124	1.94 (0.24)	2 (2-2)	574	4,550 (88.8%)

AHEAD: Asset and Health Dynamics among the Oldest Old (born 1923 or earlier); CODA: Children of the Depression Era (born 1924-1930); EBB: Early Baby Boomer (born 1954-1959); HRS: Health and Retirement Study (born 1931-1941); MBB: Mid-Baby Boomer (born 1960-1965)