Does Visual Impairment Affect Mobility Over Time? The Salisbury Eye Evaluation Study

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Purpose. To determine if the odds of mobility disability increases at a different rate among visually impaired (VI) as compared with nonvisually impaired (NVI) over an 8-year period.

Methods. A total of 2520 Salisbury Eye Evaluation Study participants were followed 2, 6, and 8 years after baseline. VI was defined as best-corrected visual acuity worse than 20/40, or visual field of approximately less than 20°. Self-reported difficulty with three tasks was assessed at each visit: walking up 10 steps, walking down 10 steps, and walking 150 feet. Generalized estimating equation models included a 6-year spline, and explored differences in mobility difficulty trajectories by including an interaction between VI status and the spline terms. Odds ratios (OR) and 95% confidence intervals (CI) compared mobility difficulty for each task by VI status.

Results. At baseline, the VI were significantly more likely to report difficulty mobility tasks than the NVI ($OR_{difficultywalkingup10steps} = 1.37$, CI: 1.02–1.80; $OR_{difficultywalkingdown10steps} = 1.55$, CI: 1.16–2.08; $OR_{difficultywalking150feet} = 1.50$, CI: 1.10–2.04). The trajectory of mobility disability did not differ by VI status from baseline to the 6-year visit. However, the difference between the VI and NVI declined at the 8-year visit, which may be due to loss of VI participants at risk of developing mobility difficulty.

Conclusions. The VI were more likely to report mobility disability than the NVI, but the trajectory of mobility disability was not steeper among the VI as compared to the NVI over the study period.

Keywords: visual impairment, mobility, disability

Difficulty with mobility is the most commonly reported physical disability among older adults in the United States.[1] Among those aged 65 years and older, approximately 32% (11.1 million) report difficulty with walking three city blocks and 30% (10.5 million) report difficulty climbing a flight of stairs.[1] The risk of mobility disability increases with age; for every decade of life after age 65, the likelihood of mobility disability increases 2-fold.[2] Older adults with mobility difficulties may represent a subset of the population at higher risk for more advanced disabilities, as mobility disability often leads to difficulties with more complex tasks, such as with activities of daily living (ADLs).[3–5] Understanding the underlying causes of mobility disability may help to mitigate the progression of disability among older adults.

Of the reasons for physical disability occurring at older ages, chronic health conditions are the most common.[1,5] Visual impairment is one condition shown to be associated with functional difficulty, and is estimated to cause physical disability among 3.3% of US adults.[1] Research has begun to examine the impact of vision loss on mobility, and indicates that the visually impaired (VI) have slower walking speeds, more falls, and report more mobility difficulty than their nonvisually impaired (NVI) counterparts.[6–11]

However, the impact of visual impairment on mobility has not been fully examined. Previous studies have been largely cross-sectional and thus unable to assess the impact of visual impairment on mobility over time.[6–11] It is unclear if visual impairment exacerbates mobility declines as people age. Understanding this relationship may help to determine intervention strategies aimed at improving functioning in the VI.

The aim of this research was to examine the longitudinal association between visual impairment and mobility disability in the Salisbury Eye Evaluation (SEE) Study, a longitudinal cohort study of older US adults followed over 8 years with the intent to assess changes in vision and mobility. Our a priori hypothesis was that the trajectory of mobility disability would increase at a greater rate among the VI, as compared with the NVI over this study period.

Methods

The Institutional Review Board of the Johns Hopkins School of Medicine approved this research, and informed consent was obtained for all participants according to the Declaration of Helsinki.

Study Population

The SEE study is a population-based longitudinal study that began in 1993 and included 2520 residents of Salisbury, Maryland, aged 65 years and older at baseline. The intention of establishing this cohort was to examine the impact of visual impairment on functional status in a population-based cohort of

Table 1. Baseline Characteristics by VI Status: The SEE Study

Demographic Characteristics	VI at Baseline, 169 (7%)	NVI at Baseline, 2351 (93%)	*P* Value*
Age, y, *n* (%)			
65–69	28 (16.6)	752 (32.0)	
70–74	42 (24.9)	793 (33.7)	
75–79	38 (22.5)	516 (22.0)	
≥80	61 (36.1)	290 (12.3)	<0.01
Female, *n* (%)	103 (61.0)	1355 (57.6)	0.40
White, *n* (%)	96 (56.8)	1758 (74.8)	<0.01
Current/former smoker, *n* (%)	98 (58.0)	1416 (60.6)	0.77
BMI, *n* (%)			
<18.5 (underweight)	7 (4.1)	45 (1.9)	
18.5–24.9 (normal)	52 (30.8)	655 (27,9)	
≥25 (overweight/obese)	110 (65.1)	1651 (70.2)	0.16
MMSE Score, mean (SD)	25.2 (3.3)	27.3 (2.5)	<0.01
Comorbid conditions, *n* (%)			
Depressive symptoms	30 (1.8)	206 (8.9)	<0.01
Diabetes	74 (43.8)	702 (29.9)	<0.01
Number of other health conditions, *n* (%)			
0	21 (12.4)	246 (10.5)	
1	37 (21.9)	565 (24.0)	
2	41 (24.3)	679 (28.9)	
≥3	70 (41.4)	861 (36.6)	0.39

* Age-adjusted *P* values.

adults 65 years and older.[8] Possible participants were identified from the Health Care Financing Administration Medicare Database. The recruitment and eligibility criteria of the SEE study have been previously described.[8] Clinic visits occurred at baseline, as well as 2, 6, and 8 years after baseline.

Visual Impairment

Visual impairment was categorized as a binary variable using visual acuity and visual field data. Distance visual acuity was measured for each eye using a standard forced choice procedure with an Early Treatment for Diabetic Retinopathy Study chart.[12] For these analyses, best-corrected visual acuity in the better-seeing eye was used.

Visual fields were measured using a Humphrey single intensity (24 dB) full field (60°) screen (Humphrey Field Analyzer; Carl Zeiss Meditec, Dublin, CA). Monocular visual fields were measured, but from these data binocular visual fields were be estimated from the composite of the more sensitive of the visual field locations from each eye.[13] The composite binocular visual field was scored as number of points missed (out of a possible 96 points) on the visual field exam. The visual fields were separated into three areas: the central (56 points), upper peripheral (18 points), and lower peripheral fields (22 points). The central field measured in the SEE corresponds to approximately 20° of visual field.

Visual impairment was defined as best corrected distance visual acuity worse than 20/40 in the better-seeing eye or missing all of the points in the upper and lower peripheral fields of the visual field test. This visual acuity cut point corresponds to the American Association of Ophthalmology categorization of visual impairment, which defined impairment as best-corrected distance visual acuity of worse than 20/40 in the better-seeing eye,[14] and the ICD-10 categorization defines impairment as less than 20° of visual field.[15] Visual impairment was analyzed as a time-varying covariate, allowing individuals to change between NVI and VI or between VI to NVI at each study visit.

Mobility Disability

Our primary outcome of interest was mobility disability. In the SEE study, a questionnaire adapted from questionnaires developed by Nagi[16] and Rosow and Breslau[17] was used to assess difficulty with three mobility tasks: walking up 10 steps, walking down 10 steps, and walking 150 feet. The lead-in for each question asked was, "By yourself, that is without help from another person or special equipment, do you have any difficulty with ..." The response to this question was a scale of difficulty that included the following possible choices: "no difficulty," "a little difficult," "moderate difficulty," "extreme difficulty," and "cannot perform activity for health or physical reasons." Using the Center for Disease Prevention and Controls definition of disability, we collapsed these responses into a binary variable ("no difficulty" or "any difficulty/unable to complete the mobility task").[1]

Other Covariates

In addition to the variables described above, the SEE study included age, sex, and self-designated race (white or black). The baseline values of these covariates were used in the analysis. Previous research has indicated that the risk of both visual impairment and disability increases nonlinearly with age.[8] To capture this nonlinear association, age at baseline was categorized as: 65 to 69, 70 to 74, 75 to 79, and ≥80 years.

We also examined the following covariates as time-varying: body mass index (BMI), smoking status, number of comorbid condition, presence of diabetes, the presence of depressive symptoms, and Mini-Mental State Examination (MMSE) score. The values of these covariates for an individual were allowed to change at each study visit. BMI was calculated as weight (kg) divided by height (m) squared measured at each visit, and was categorized into three groups: underweight (<18.5), normal weight (18.5 to <25), and overweight/obese (≥25). Smoking status was assessed via self-report and categorized as never smoker and current/former smoker.

Comorbid conditions are known to negatively impact mobility.[18,19] Therefore, participants were asked questions about their comorbidities using the lead in "has a doctor ever told you that you have. . ." The conditions asked about include: arthritis, hip fracture, back problem, heart attack or myocardial infarction, angina or chest pain, congestive heart failure, intermittent claudication pain in the legs, high blood pressure, emphysema, asthma after age 50, stroke, Parkinson's disease, cancer or malignancy, and vertigo or Meniere's disease. For these analyses, we categorized the number of comorbid conditions as: 0, 1, 2, or 3+ comorbid conditions.

As diabetes can lead to visual impairment as well as mobility disability, this comorbid condition was examined separately from the comorbidity covariates described above. The presence of diabetes was recorded if hemoglobin A1C values were above 7% or if a doctor had ever told the participant that they had diabetes. The presence of depressive symptoms was assessed using the seven-item depressive symptom subscale of the General Health Questionnaire.[20,21] This scale was designed to identify severe depressive symptoms in the general public. An individual is categorized as having depressive symptoms if they respond "yes" to one or more of the seven questions about worthlessness, suicidal thoughts, and hopelessness. Cognitive status was determined using the MMSE.[22] Scores on this test can range from 0 to 30, and cognitive impairment is suggested by scores less than or equal to 23.

Table 2. Characteristics by VI Status and Study Visit: The SEE Study

	Baseline, $n = 2520$		2-Year Visit, $n = 2240$		6-Year Visit, $n = 1504$		8-Year Visit, $n = 1250$	
	VI, 169 (7%)	NVI, 2351 (93%)	VI, 249 (11%)	NVI, 1989 (89%)	VI, 185 (12%)	NVI, 1252 (88%)	VI, 139 (11%)	NVI, 1107 (89%)
Visual impairment classification,* *n* (%)								
Visual acuity impairment†	114 (67.5)	NA	199 (79.9)	NA	153 (82.7)	NA	126 (90.1)	NA
Visual field impairment‡	65 (38.5)	NA	71 (28.5)	NA	36 (19.5)	NA	27 (19.4)	NA
Change in visual impairment status, *n* (%)								
Incident VI	NA	NA	132 (53.0)	NA	77 (41.6)	NA	36 (25.9)	NA
Change from VI to NVI	NA	NA	30 (12.0)	NA	24 (13.0)	NA	27 (19.4)	NA
Ophthalmic measures, mean (SD)								
Visual acuity, logMAR	0.46 (0.03)	−0.01 (0.002)	0.57 (0.03)	0.02 (0.002)	0.67 (0.04)	0.03 (0.003)	0.52 (0.03)	0.03 (0.003)
No. of points missed on central visual field	23.5 (1.5)	3.0 (0.1)	18.7 (1.2)	2.7 (0.1)	18.3 (1.6)	2.7 (0.2)	24.9 (1.8)	3.9 (0.2)
Mobility disability, *n* (%)								
Difficulty walking up 10 steps	87 (53.1)	761 (33.2)	132 (55.0)	747 (38.3)	120 (67.4)	585 (45.4)	71 (53.6)	460 (42.9)
Difficulty walking down 10 steps	61 (37.2)	487 (21.2)	110 (45.8)	489 (25.1)	107 (60.1)	451 (35.2)	66 (48.9)	358 (33.4)
Difficulty walking 150 feet	54 (32.0)	320 (13.6)	94 (37.8)	390 (19.6)	100 (54.1)	352 (26.7)	53 (38.1)	258 (23.2)

NA, not applicable.
* Not mutually exclusive categories.
† Visual acuity impairment defined as best-corrected distance visual acuity worse than 20/40 in the better-seeing eye.
‡ Visual field impairment defined as missing all of the points in the upper and lower peripheral fields of the visual field test.

Statistical Analysis

Univariate analyses were used to compare the distribution of potential confounders by visual impairment status at baseline. We obtained *P* values from χ^2 for categorical variables or *t*-tests for continuous variables comparing the VI with the NVI. Since visual impairment status was used as a time-varying covariate, we examined how the number of participants with visual impairment and nonvisual impairment changed by study visit, including the percentage of incident VI. We also determined the mean visual acuity (logMAR) and mean number of central visual field points missed by visually impairment status and study visit.

Generalized estimating equation (GEE) models were used to account for the correlation between the repeated measures.[23] Three separate regression models were run, one for each of the mobility outcomes: difficulty walking up 10 steps, difficulty walking down 10 steps, and difficulty walking 150 feet. From these models, odds ratios (OR) and 95% confidence intervals (CI) were estimated comparing the odds of reporting difficulty with each of these tasks among the VI to the odds among the NVI using an exchangeable working correlation structure. Our initial models included covariates that were significantly associated with visual impairment status from our univariate analyses. The most parsimonious statistical model was determined based on comparison of model fit using the quasi-likelihood under the independence model criteria.[24] In addition to visual impairment status and time since baseline (in years), our final models included baseline age categories, sex, and race, as well as time-varying values for smoking status, BMI categories, number of comorbid conditions categories, the presence of depressive symptoms, and the presence of diabetes. We modeled years since baseline using spline terms with a knot at the 6-year visit.

For each outcome, we included interaction terms between visual impairment status and the spline time covariates, which would allow for the slope to differ between the VI and NVI over each section of the spline. This allowed us to test our primary hypothesis that the change in the odds of reporting mobility disability over the study period differed between the VI and the NVI.

To check for emmigrative selection bias, we modeled the odds of being lost to follow-up compared with the odds of not being lost to follow-up at each study visit after baseline. These models included covariates for visual impairment status as well as the other covariates in our primary analyses from the visit prior to dropout. We ran three sets of models, one set for each of the mobility disability outcomes and included these variables as predictors of being lost to follow-up (i.e., three sets of models, with each set including one type mobility disability as a predictor of being lost to follow-up), and an interaction term between mobility disability and visual impairment status. This interaction term was included to determine if there was differential loss to follow-up of VI and disabled participants after adjusting for our other observed covariates.

We also ran sensitivity analyses where the visual acuity criteria used to define visual impairment was shifted from best-corrected distance visual acuity worse than 20/40 to acuity worse than 20/60, as this alternate cut point is the visual acuity criteria used for the ICD-10.[15] However, our results were similar our primary analyses and the inferences were unchanged, and only results from the primary analyses are presented.

All data were analyzed using statistical software (STATA Statistical Software: Release 12.1; STATA Corp., College Station, TX; and SAS; SAS, Inc., Cary, NC).

Results

Participant Characteristics

This study included 169 (7%) participants who were categorized as VI at baseline and 2351 (93%) who were not VI at baseline. Compared with those who were not VI, baseline VI participants were significantly older. After adjusting for age, the VI were also more likely to be black, had a lower MMSE score,

Table 3. Longitudinal Association Between Mobility Disability and VI Status: The SEE Study

	Reported Difficulty Walking Up Stairs				Reported Difficulty Walking Down Stairs				Reported Difficulty Walking 150 Feet			
	Model 1a*		Model 1b†		Model 2a*		Model 2b†		Model 3a*		Model 3b†	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Years since baseline												
Spline 1, baseline to year 6	1.14	1.11–1.16	1.13	1.10–1.16	1.19	1.16–1.22	1.17	1.15–1.21	1.21	1.18–1.24	1.20	1.16–1.23
Spline 2, year 6 to year 8	0.99	0.93–1.05	1.03	0.97–1.10	0.99	0.93–1.06	1.02	0.96–1.11	0.95	0.88–1.02	0.99	0.91–1.07
VI status												
NVI	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
VI	1.33	1.09–1.62	1.37	1.02–1.80	1.56	1.27–1.91	1.55	1.16–2.08	1.61	1.33–1.96	1.50	1.10–2.04
VI status × spline 1												
NVI	—	—	REF	REF	—	—	REF	REF	—	—	REF	REF
VI	—	—	1.03	0.95–1.11	—	—	1.03	0.95–1.11	—	—	1.06	0.98–1.14
Visual impairment status × spline 2												
NVI	—	—	REF	REF	—	—	REF	REF	—	—	REF	REF
VI	—	—	0.73	0.60–0.90	—	—	0.80	0.65–0.98	—	—	0.75	0.61–0.92
Baseline age, y												
65–69	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
70–74	1.16	0.99–1.37	1.16	0.98–1.36	1.39	1.15–1.68	1.39	1.15–1.68	1.42	1.15–1.75	1.42	1.15–1.77
75–79	1.76	1.46–2.12	1.76	1.46–2.12	2.25	1.83–2.76	2.24	1.82–2.75	2.34	1.88–2.95	2.38	1.90–2.99
≥80	2.05	1.63–2.59	2.04	1.62–2.57	2.44	1.91–3.11	2.42	1.89–3.08	3.35	1.57–4.36	3.33	2.55–4.36
Sex												
Male	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Female	2.04	1.76–2.36	2.05	1.77–2.36	1.97	1.68–2.31	1.98	1.69–2.33	1.75	1.47–2.09	1.78	1.49–2.13
Race												
White	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Black	1.71	1.46–2.00	1.71	1.46–2.00	1.26	1.06–1.49	1.26	1.06–1.49	1.75	1.46–2.10	1.75	1.46–2.10
Smoking status at baseline												
Never	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Current/former	1.20	1.04–1.38	1.20	1.04–1.38	1.00	0.89–1.17	1.00	0.85–1.17	1.27	1.07–1.51	1.27	1.07–1.52
BMI at baseline												
<18.5, underweight	1.72	1.13–2.62	1.71	1.13–2.59	1.89	1.29–2.77	1.86	1.27–2.71	2.33	1.50–3.61	2.23	1.44–3.47
18.5–25, normal	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
≥25, overweight or obese	1.49	1.30–1.70	1.47	1.29–1.68	1.42	1.23–1.64	1.40	1.21–1.62	1.44	1.22–1.69	1.44	1.22–1.69
No. comorbid conditions at baseline												
0	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
1	1.36	1.21–1.54	1.37	1.21–1.55	1.35	1.2–1.5	1.34	1.17–1.54	1.32	1.14–1.55	1.33	1.14–1.55
2	1.66	1.45–1.90	1.69	1.48–1.94	1.51	1.3–1.8	1.51	1.31–1.76	1.65	1.39–1.95	1.64	1.38–1.93
≥3	2.52	2.17–2.92	2.54	2.19–2.95	2.33	1.99–2.72	2.34	2.00–2.74	2.95	2.46–3.53	2.90	2.42–3.48

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TABLE 3. Continued

	Reported Difficulty Walking Up Stairs				Reported Difficulty Walking Down Stairs				Reported Difficulty Walking 150 Feet			
	Model 1a*		Model 1b†		Model 2a*		Model 2b†		Model 3a*		Model 3b†	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Depressive symptoms at baseline												
No	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Yes	1.65	1.38–1.98	1.67	1.39–2.00	2.03	1.69–2.45	2.06	1.70–2.49	1.92	1.56–2.35	1.92	1.56–2.36
Diabetes at baseline												
No	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Yes	1.28	1.14–1.44	1.29	1.15–1.45	1.21	1.06–1.38	1.22	1.06–1.40	1.47	1.26–1.72	1.48	1.27–1.73

REF, reference group.
* Model a: models time since baseline using a spline term with a knot at the 6-year visit.
† Model b: includes interaction between time spline terms and visual impairment status.

and were more likely to have diabetes and report depressive symptoms than the NVI (Table 1).

At the 2-year visit, 249 SEE participants (11%) were classified as VI, 185 (12%) at the 6-year visit, and 139 (11%) at the 8-year visit (Table 2). The mean visual acuity (in logMAR) increased over time among the VI from 0.46 logMAR at baseline to 0.67 logMAR at the 6-year study visit, indicating worsening vision in this group. However, the mean acuity at the 8-year visit was not statistically significant from the 6-year mean ($P = 0.182$).

The proportion of participants reporting mobility difficulty increased at each study visit. From baseline to the 6-year study visit, a higher percentage of VI reported difficulty with all three mobility tasks than NVI (Table 2). However, from the 6-year visit to the 8-year visit, a decline in the percentage of VI reporting difficulty with mobility tasks was observed.

Multivariate Analyses

In our multivariate analyses, the odds of the NVI reporting mobility disability compared with not reporting mobility disability were significantly higher for each year between baseline and the 6-year study visit (Table 3: models 1a, 2a, and 3a). However, ORs for the second half of the time spline was not significant, suggesting no difference in the rate of change between 6- and 8-year visits. In these models, the odds of reporting mobility disability were significantly greater for the VI compared with the NVI for all three mobility outcomes, after adjusting for all other covariates.

To determine if the trajectory of mobility disability differed, we include interaction terms between visual impairment status and each of the time spline terms (Table 3: models 1b, 2b, and 3b). For each mobility outcome, the interaction between visual impairment status and the first spline term (baseline to the 6-year visit) was not statistically significant, indicating there was no difference in the trajectory of reporting disability over this time by visual impairment status. However, from the 6-year visit to the 8-year visit the interaction term was significant for all outcomes, and the OR of these terms was below 1.0. This suggests that the difference in the odds of reporting mobility disability between the VI and NVI was reduced at the 8-year visit, compared with the 6-year visit.

The interaction model was used to compare the odds of reporting mobility disability in the VI to the NVI for the first 6 years and the last 2 years and for each outcome (Table 4). The ORs in the first segment of the time spline (from baseline to the 6-year visit) indicate the VI were significantly more likely to report mobility disability, although the trajectory of decline was similar in both groups. From the 6- to the 8-year visit, there was no statistically significant difference in reporting disability between the VI and NVI.

Other factors were significantly related to mobility disability over time and include baseline age, sex, race, as well as BMI, the number of other comorbid conditions, and the presence of depressive symptoms and diabetes. These results were largely unchanged in the models including an interaction between visual impairment status and the time splines.

Losses to Follow-up

We examined the effect of potential differential losses to follow-up by both visual impairment status and disability status. We modeled the odds of being lost to follow-up at each study visit after baseline. From baseline to the 2-year visit, the VI were not more likely to be lost at the 2-year visit than the NVI, and participants reporting disability were not more likely to be lost than those not reporting disability for any of the three mobility tasks (Table 5). From the 2-year to

Table 4. Association Between Mobility Disability and VI Status From Baseline to the 6-Year Visit and From the 6- to the 8-Year Visit: The SEE Study

	Reported Difficulty Walking Up Stairs*		Reported Difficulty Walking Down Stairs*		Reported Difficulty Walking 150 Feet*	
	OR	95% CI	OR	95% CI	OR	95% CI
Baseline to 6-year visit						
NVI	REF	REF	REF	REF	REF	REF
VI	1.6	1.2–2.1	1.9	1.5–2.4	1.9	1.5–2.5
6-year to 8-year visit						
NVI	REF	REF	REF	REF	REF	REF
VI	1.0	0.7–1.5	1.3	0.9–1.8	1.1	0.8–1.6

REF, reference group.

* OR resulting from the addition of the covariates for visual impairment, each segment of the time spline, and the interaction between visual impairment status and each segment of the time spline, adjusted for baseline age, sex, race, smoking status, BMI categories, category of number of comorbidities, report of depressive symptoms, and presence of diabetes.

the 6-year visit, participants reporting disability at the 2-year visit were more likely to be lost to follow-up at the 6-year visit than participants who did not report mobility disability, but there was no difference by visual impairment status (Table 5).

From the 6-year to the 8-year visit, the VI were significantly more likely to be lost to follow-up than the NVI for the models including stair climbing and stair descent disability (Table 5). But the VI were not significantly more likely to be lost than the NVI for the model including difficulty walking 150 feet. Additionally, participants reporting disability were significantly more likely to be lost to follow-up than those not reporting disability for each of the mobility tasks (Table 5). The interactions between visual impairment and each of the three outcomes were not significant, suggesting there was no differential loss to follow-up of the VI who were also disabled.

Table 5. Cross-Section Logistic Regression Determining Predictors of Losses to Follow-up at Each Study Visit: The SEE Study

	Baseline to 2-Year Visit*		2-Year to 6-Year Visit*		6- to 8-Year Visit*	
	OR	95% CI	OR	95% CI	OR	95% CI
Model 1: difficulty walking up stairs						
VI status						
NVI	REF	REF	REF	REF	REF	REF
VI	0.9	0.4–2.0	1.3	0.9–2.1	2.3	1.2–4.7
Mobility disability						
No difficulty walking up stairs	REF	REF	REF	REF	REF	REF
Difficulty walking up stairs	1.4	1.0–1.8	1.5	1.2–1.8	2.2	1.5–3.1
Visual impairment × mobility disability						
NVI and no difficulty walking up stairs	REF	REF	REF	REF	REF	REF
VI and has difficulty walking up stairs	1.0	0.4–2.7	0.8	0.4–1.5	0.6	0.2–1.4
Model 2: difficulty walking down stairs						
VI status						
NVI	REF	REF	REF	REF	REF	REF
VI	0.9	0.4–1.7	1.1	0.8–1.7	2.0	1.1–3.7
Mobility disability						
No difficulty walking down stairs	REF	REF	REF	REF	REF	REF
Difficulty walking down stairs	1.3	0.9–1.8	1.5	1.1–1.9	1.8	1.2–2.5
VI × mobility disability						
NVI and no difficulty walking down stairs	REF	REF	REF	REF	REF	REF
VI and has difficulty walking down stairs	1.0	0.4–2.9	1.0	0.5–2.0	0.7	0.3–1.6
Model 3: difficulty walking 150 feet						
VI status						
NVI	REF	REF	REF	REF	REF	REF
VI	0.5	0.2–1.3	0.9	0.6–1.5	1.5	0.7–3.1
Mobility disability						
No difficulty walking 150 feet	REF	REF	REF	REF	REF	REF
Difficulty walking 150 feet	1.4	1.0–2.1	1.6	1.2–2.2	1.9	1.3–2.9
VI × mobility disability						
NVI and no difficulty walking 150 feet	REF	REF	REF	REF	REF	REF
VI and has difficulty walking 150 feet	1.4	1.0–2.0	1.3	1.0–1.6	1.0	0.7–1.3

REF, reference group.

* Adjusted for age at baseline, sex, and race, as well as smoking status, BMI categories, category of number of comorbidities, report of depressive symptoms, and presence of diabetes at prior study visit.

Discussion

The results from this study indicated that from baseline to the 6-year visit, the VI were more likely to have mobility difficulty than the NVI. But, there was no evidence that the trajectory was different among the VI, compared with the NVI. This was contrary to our a priori hypothesis that the trajectory of mobility disability would be steeper among the VI as compared to the NVI over the 8-year study period.

Our results also indicated that for this study population, the odds of reporting of mobility disability over time were not linear. In fact, we observed that the percentage of individuals (both VI and NVI) reporting mobility disability did not continue to increase after the 6-year visit. Additionally, the difference in the odds of reporting mobility disability between the VI and NVI was no longer significant by the 8-year study visit. These findings were unexpected.

Therefore, we examined the possibility that we were observing a "healthy survivor" bias, meaning participants who were disabled and VI were preferentially lost to follow-up. We found no evidence of differential loss of the VI from baseline to the 6-year visit, suggesting the absence of a difference in the trajectory was not due to emmigrative selection bias. However, we observed that from the 6- to the 8-year visits the VI were more likely to be lost to follow-up than the NVI, and the disabled were more likely to be lost than the nondisabled. The interaction between visual impairment and disability was not significant, indicating that individuals who were VI and disabled were not more likely to be lost and suggesting the absence of differential loss to follow-up of these individuals. While it is possible that these cross-sectional models were not powered to detect this interaction at the last study visit, unadjusted analyses did not indicate a differential loss of VI and disabled participants (data not shown). Despite this result, we cannot rule out the possibility that the decline in mobility disability from the 6- to the 8-year visits was a result of loss to follow-up of VI participants who were at greatest risk of developing mobility disability. Overall, we found no indication that similarity of the mobility disability trajectory between the VI and NVI was due to emmigrative selection bias.

Our observation of no difference in mobility disability trajectory by visual impairment status was surprising. Previous cross-sectional studies reported that the VI are more likely to have mobility difficulty than the NVI,[6–11] and as a result we expected this difference would increase over time. But our observed difference in the odds of reporting mobility disability by visual impairment status at baseline may suggest that this difference occurs early in the process of visual loss, and possibly before the accumulation of other comorbid conditions. However, in the SEE study comorbidities were common. At baseline, over 30% of the NVI and more than 40% of the VI had three or more comorbid conditions. Further research including younger populations with few comorbidities would be needed to test this hypothesis. It is also possible that over time, the VI develop compensatory strategies to reduce their mobility difficulty, but we could not examine that hypothesis. At the time of the study, Salisbury, Maryland, did not have a low vision rehabilitation program.

In addition to visual impairment, other factors in our regression model were associated with the report of mobility disability. We found that individuals reporting mobility disability were more likely to be of older age, female sex, black race, past or current smokers, under- or overweight (based on BMI), have one or more comorbid conditions, report depressive symptoms, and have diabetes. These results were expected, as the covariates examined in this study were chosen based on our review of relevant literature that identified these factors as potential confounders of the association between visual impairment status and mobility disability.[2,18,25–34]

Our results may have implications for low vision rehabilitation efforts. These efforts should include improvement of mobility, such as with the use of assistive devices and mobility and orientation training. However, the inclusion of mobility training in low vision rehabilitation settings is infrequent. In a survey of over 1000 US low vision rehabilitation clinics, only 28.7% of the polled programs offered mobility and orientation training.[35] We found that the negative impact of visual impairment on mobility disability largely remains as people age, and believe this result emphasizes the importance of including mobility training as a part of low vision rehabilitation efforts.

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