Activity Limitation due to a Fear of Falling in Older Adults with Eye Disease

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Purpose. To examine whether patients with age-related macular degeneration (AMD), glaucoma, or Fuchs corneal dystrophy report limiting their activity due to a fear of falling as compared with a control group of older adults with good vision.

Methods. We recruited 345 patients (93 with AMD, 57 with Fuchs, 98 with glaucoma, and 97 controls) from the ophthalmology clinics of Maisonneuve-Rosemont Hospital (Montreal, Canada) to participate in a cross-sectional study from September 2009 until July 2012. Control patients who had normal visual acuity and visual field were recruited from the same clinics. Participants were asked if they limited their activity due to a fear of falling. Visual acuity, contrast sensitivity, and visual field were measured and the medical record was reviewed.

Results. Between 40% and 50% of patients with eye disease reported activity limitation due to a fear of falling compared with only 16% of controls with normal vision. After adjustment for age, sex, race, number of comorbidities, cognition, and lens opacity, the Fuchs groups was most likely to report activity limitation due to a fear of falling (odds ratio [OR] = 3.07; 95% confidence interval [CI], 1.33–7.06) followed by the glaucoma group (OR = 2.84; 95% CI, 1.36–5.96) and the AMD group (OR = 2.42; 95% CI, 1.09–5.35). Contrast sensitivity best explained these associations.

Conclusions. Activity limitation due to a fear of falling is very common in older adults with visually impairing eye disease. Although this compensatory strategy may protect against falls, it may also put people at risk for social isolation and disability. (*Invest Ophthalmol Vis Sci.* 2012;53:7967–7972) DOI: 10.1167/iovs.12-10701

Falls are an important public health problem for older adults. The direct effects of falls can include serious injuries, nursing home admission, and death.[1,2] In addition, the indirect effects of falls are also important and may include a fear of falling leading to a limitation in activities that are both necessary and enjoyable for healthy independent living.[3–5] Population-based studies of older adults indicate that activity limitation due to a fear of falling is common.[6] For example, a study of 1064 community-dwelling adults living in New Haven, Connecticut who were 72 years of age and older found that 19% reported activity limitation due to a fear of falling.[6] Risk factors that have been identified include comorbidity, depression, worse lower limb strength, impaired vision, and contrast sensitivity.[6–8]

To our knowledge, no studies have yet examined the relationship between eye disease and activity limitation due to a fear of falling. Ramulu et al.[9] recently reported that glaucoma patients have a greater fear of falling than controls; however, they did not assess activity limitation due to a fear of falling. Likewise, the Beaver Dam eye study reported a relationship between worse visual acuity and the development of a fear of falling, but they did not assess activity limitation due to a fear of falling or its relationship with eye disease.[10]

Our goal was to determine whether patients with age-related eye disease are more likely to limit their activities due to a fear of falling. We chose three eye diseases with different profiles of vision loss (age-related macular degeneration [AMD], Fuchs corneal dystrophy, and glaucoma) and hypothesized that eye diseases with primarily peripheral vision loss (glaucoma) would lead to greater activity limitation due to a fear of falling than eye diseases with primarily central vision loss (AMD and Fuchs). We believed that this would be true because of prior research, which found compromised balance in glaucoma patients[11,12] and other studies that have demonstrated the importance of visual field in the risk of falls.[13,14]

Methods

Study Population

The patients in this study were recruited from the ophthalmology clinics of Maisonneuve-Rosemont Hospital, which is located in Montreal, Quebec, Canada. The recruitment period was from August 2009 to July 2012. Each morning, members of the research team reviewed the list of incoming patients for the day to find potentially eligible participants for the study. Eligibility criteria included age of 65 years or older and visual and cognitive criteria to be described below.

For the groups with AMD or Fuchs corneal dystrophy, the patients were required to have the disease in both eyes and to have visual acuity worse than 20/40 in each eye. For the glaucoma group, the patients were required to have bilateral disease and to have visual field mean deviation worse than –4 dB in the worse eye. All glaucoma types were included in the study, although almost everyone had primary open-

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angle glaucoma (85%). The three groups with eye disease were allowed to have other eye diseases, which may have also impaired vision. However, a person was not included if he/she met the visual inclusion criteria for multiple groups (e.g., AMD and Fuchs).

To be in the control group, participants had to have visual acuity better than 20/40 in both eyes and visual field mean deviation better than −4 dB in both eyes. Controls were allowed to have other eye diseases as long as they met the above visual criteria. In the control group, 66% of the patients did not have any current eye disease, whereas 15% had early cataract, 4% had early AMD, 5% had ocular hypertension, 3% had blepharitis, and 7% had another condition. People who had received eye surgery, laser, or an intravitreal injection in the last 3 months were enrolled after a 2- to 3-month delay so that their activities would not be affected by their recovery. Furthermore, each participant had to score 10 or higher on the Mini-Mental State Examination blind version (MMSE-blind) to exclude those with moderate to severe cognitive impairment.[15] The Blind Version, with a total score of 22 rather than 30, was chosen for this study because it excludes items that directly or indirectly rely on vision and is thus more valid when applied to patients with visual problems.

In all, 608 patients were considered eligible for the study after review of their hospital files. Among these potential study subjects, 413 (68%) accepted the invitation, 165 (27%) refused, and 30 (5%) were unable to answer the questions because of language barriers, hearing problems, or cognitive problems. Of those 413 who accepted our invitation to be in the study, 345 met vision and cognitive eligibility criteria after testing. Written informed consent was obtained from all participants. The ethics committee of Hôpital Maisonneuve-Rosemont approved this research project, which also conformed to the tenets of the Declaration of Helsinki.

Data Collection

Data collection sessions lasted from 60 to 90 minutes. During this period of time, a trained member of the research team administered the questionnaire to the patient. Afterward, the participant performed vision tests.

Mobility

Patients were asked to report any fall that occurred during the past year, with a fall defined as unintentionally coming to rest on the ground or some other level.[16] They were also asked if they limited their daily activities because of a fear of falling (yes, no). The Life Space Assessment (LSA) was given to measure the spatial extent of participants in a given month.[17,18] The LSA takes into account the frequency of going to different life space levels (bedroom, driveway, within neighborhood, outside neighborhood but within town, out of town) and whether assistance was required to get to those levels. A composite life space score (range: 0–120) is calculated that combines information on the life space level, the degree of independence, and the frequency. Higher scores indicate greater life space. The reliability and construct/criterion validity of this questionnaire have been published.[17] Balance was assessed using the one-legged balance test in which the person is asked to stand on the leg of choice with eyes open for up to 30 seconds.[19] We defined failure of this test as being unable to hold the stand for at least 5 seconds on the first trial. People who cannot stand for 5 seconds on one leg are at an increased risk of having an injurious fall.[19]

Health

The patient was asked to report a physician diagnosis of 13 chronic conditions (e.g., diabetes, arthritis). A sum of the total number of chronic conditions was used to indicate comorbidity, as has been done in previous research.[20] The MMSE-blind was used to evaluate the cognitive function of each patient.[15] This instrument has a maximum score of 22 and higher scores indicate better cognitive performance. Depression was assessed by using the Geriatric Depression Scale with 15 items, using a cutoff of 5 to indicate depression.[21,22]

Vision and Eye Disease

Binocular habitual visual acuity was measured using the ETDRS (Early Treatment Diabetic Retinopathy Study) chart with illuminated light box at 2 meters or at 1 meter if the participant could not read any letters at 2 meters.[23,24] Letter-by-letter scoring was performed with scores at 2 meters converted to scores at 1 meter by adding 15. Scores were converted to logMAR (logarithm of the minimum angle of resolution). Contrast sensitivity was measured using the Pelli–Robson chart at 1 meter for each eye.[25] Forced-choice letter-by-letter scoring procedures were used until a participant read all three letters of a triplet incorrectly. Log contrast sensitivity was then calculated. Visual field was measured using frequency-doubling technology (Humphrey FDT Perimeter; Carl Zeiss Meditec, Jena, Germany) with full threshold N-30 testing in each eye.[26] The FDT measures 30° horizontally and 24° vertically. The patients' medical records were reviewed and further details on their eye disease and any coexisting eye disease (such as lens opacity) was recorded. Those who could not perform the FDT test because of advanced eye disease had their last visual field exam results taken from the medical record.

Primary Outcome

Our primary outcome for this analysis was reported activity limitation due to a fear of falling, which was examined as a dichotomous variable.

Statistical Analyses

In preliminary analyses, those with and without eye disease were compared. Global differences were tested using ANOVA, χ^2 tests, or Fisher's exact tests, as appropriate. Those who did and did not report activity limitation due to a fear of falling were also compared. Differences were tested using Student's *t*-tests, χ^2 tests, or Fisher's exact tests. Logistic regression was then used to adjust for potentially confounding factors such as age, sex, race, cognitive status, the number of comorbid conditions, and lens opacity. The fully adjusted model included the aforementioned variables, which were chosen because of their perceived importance to mobility and activity limitation due to a fear of falling.

In a secondary analysis, we then assessed the importance of potential mediators by entering each of them separately into the fully adjusted model according to the methods of Baron and Kenny.[27] Briefly, a variable is a mediator if it is in the causal pathway and the addition of the mediator to the regression model leads to a relationship that is reduced and no longer statistically significant. Depression was assessed as a mediator because it is possible that eye disease, especially AMD, causes depression, which may then cause people to limit their activities.[28,29] There may also be a more complicated feedback loop such that eye disease causes activity limitation, which causes depression, which then causes more activity limitation.

We then examined each of the three measures of visual function (visual acuity, contrast sensitivity, and visual field) in separate models to determine which measure mediated the largest portion of the relationship between each eye disease and the outcome. A value of $P < 0.05$ was considered to be statistically significant. Analyses were done using commercial data analysis and statistical software (Stata Version 11.0; Stata Software, College Station, TX).

Results

Among the 345 eligible patients for this study, 93 (27%) had AMD, 57 (17%) had Fuchs' corneal dystrophy, 98 (28%) had glaucoma, and 97 (28%) were in the control group. Table 1 compares the three groups with eye disease to the control group with good vision. Those with eye disease were older

Table 1. Description of Groups with and without Eye Disease

Factor	AMD Mean (SD) or % ($n = 93$)	Fuchs Mean (SD) or % ($n = 57$)	Glaucoma Mean (SD) or % ($n = 98$)	Controls Mean (SD) or % ($n = 97$)	*P* Value*
Age, y	83 (6)	79 (7)	77 (8)	73 (5)	<0.01
Sex					
Male	24%	16%	43%	41%	<0.01
Female	76%	84%	57%	59%	
Ethnicity					
Caucasian	100%	100%	89%	98%	<0.01
African descent	0%	0%	11%	2%	
Binocular visual acuity, logMAR	0.72 (0.40)	0.62 (0.32)	0.31 (0.31)	0.04 (0.06)	<0.01
Log contrast sensitivity in worse eye	0.63 (0.52)	0.73 (0.46)	0.86 (0.55)	1.70 (0.17)	<0.01
Visual field in better eye, MD	−2.87 (3.73)	−2.94 (3.73)	−9.71 (6.40)	0.51 (2.05)	<0.01
MMSE-blind (max 22)	19.03 (2.64)	19.68 (2.38)	19.21 (2.83)	20.68 (1.39)	<0.01
Depressed	42%	27%	28%	7%	<0.01
Comorbidity score	3.2 (1.9)	2.6 (1.7)	2.6 (1.6)	2.0 (1.5)	<0.01
Lens opacity in eye	34%	26%	27%	15%	0.028

* *P* values were derived from ANOVA tests for continuous variables and χ^2 or Fisher's exact tests for categorical variables, as appropriate. Column percentages are given.

than the control group ($P < 0.01$). People with AMD and Fuchs were more likely to be females than the control group ($P < 0.01$). Those with glaucoma were more likely to be of African descent than the controls ($P < 0.01$). As expected, those with eye disease had worse visual acuity, contrast sensitivity, and visual field than the control group ($P < 0.01$). Those with eye disease had worse cognitive scores, were more likely to be depressed, and had higher comorbidity scores than the control group ($P < 0.01$). They were also more likely to have a lens opacity ($P = 0.03$).

We also compared those who did and did not report activity limitation due to a fear of falling in Table 2. Between 40% and 50% of patients with eye disease reported activity limitation due to a fear of falling compared with only 16% of controls with normal vision ($P < 0.01$). People who reported activity limitation due to a fear of falling were older, were more likely to be females, had worse vision, were more likely to be depressed, and had greater comorbidity ($P < 0.05$). There were no statistically significant differences in cognitive status between those who did and those who did not report activity limitation due to a fear of falling, although it was borderline ($P = 0.05$). Those who reported activity limitation due to a fear of falling actually did report falling more in the last year, reported much smaller life space, and were much more likely to fail the one-legged balance test than those who did not report activity limitation due to a fear of falling ($P < 0.01$).

Table 2. Description of Those by Report of Activity Limitation due to a Fear of Falling

Factor	Limit Activity due to a Fear of Falling, Mean (SD) or % ($n = 132$)	Do Not Limit Activity due to a Fear of Falling, Mean (SD) or % ($n = 213$)	*P* Value*
Eye disease group			
AMD	51%	49%	<0.01
Fuchs	49%	51%	
Glaucoma	42%	58%	
Control	16%	84%	
Age, y	81 (7)	76 (7)	<0.01
Sex			
Male	29%	71%	0.02
Female	43%	57%	
Ethnicity			
Caucasian	38%	62%	0.57
African descent	46%	54%	
Binocular visual acuity, logMAR	0.54 (0.45)	0.31 (0.34)	<0.01
Log contrast sensitivity in worse eye	0.70 (0.59)	1.20 (0.57)	<0.01
Visual field in better eye, MD	−5.8 (6.3)	−3.0 (5.7)	<0.01
MMSE-blind (max 22)	19 (3)	20 (2)	0.05
Depressed	66%	34%	<0.01
Comorbidity score	3 (2)	2 (2)	<0.01
Lens opacity in eye	47	53	0.06
Life space	42 (24)	62 (23)	<0.01
Fell in last year	44%	23%	<0.01
Failed balance test	67%	41%	<0.01

* *P* values were derived from *t*-tests for continuous variables and χ^2 or Fisher's exact tests for categorical variables, as appropriate. Row percentages are given.

Table 3. Multiple Logistic Regression Models Showing Adjusted Relationship between Eye Disease and Activity Limitation due to a Fear of Falling and the Impact of Including Contrast Sensitivity in the Model

	Activity Limitation due to a Fear of Falling			
	Model 1		Model 2	
Factor	OR	95% CI	OR	95% CI
Eye disease group				
Controls	1.00		1.00	
AMD	2.42	1.09 to 5.35	0.91	0.34 to 2.48
Fuchs	3.07	1.33 to 7.06	1.18	0.43 to 3.27
Glaucoma	2.84	1.36 to 5.96	1.25	0.50 to 3.12
Age, per 1 y	1.07	1.03 to 1.11	1.04	1.00 to 1.09
Sex				
Male	1.00		1.00	
Female	1.56	0.89 to 2.74	1.69	0.94 to 3.06
Ethnicity				
Caucasian	1.00		1.00	
African ethnicity	1.35	0.36 to 5.06	1.42	0.36 to 5.58
MMSE-blind, per 1 unit	0.99	0.89 to 1.10	1.03	0.92 to 1.15
Comorbidity score, per 1 condition	1.17	1.02 to 1.36	1.25	1.07 to 1.46
Lens opacity	1.66	0.95 to 2.88	1.77	1.00 to 3.15
Log contrast sensitivity, per 0.1 unit			0.88	0.83 to 0.93

In adjusted analyses shown in Table 3, Model 1, people with AMD, Fuchs, and glaucoma were more likely to report activity limitation due to a fear of falling compared with the control group. The Fuchs group was most likely (odds ratio [OR] = 3.07; 95% confidence interval [CI], 1.33–7.06) followed by the glaucoma group (OR = 2.84; 95% CI, 1.36–5.96) and the AMD group (OR = 2.42; 95% CI, 1.09–5.35). Other variables associated with activity limitation due to a fear of falling included older age and a greater number of comorbidities ($P < 0.05$).

Depression was not included in the final regression model because of concerns that it was a mediator of the relationship between eye disease and activity limitation due to a fear of falling. When we did include depression in the model, AMD was no longer statistically significantly associated with activity limitation due to a fear of falling (OR = 1.78; 95% CI, 0.77–4.11). The relationships with Fuchs and glaucoma were reduced but still statistically significant (OR = 2.66; 95% CI, 1.11–6.40 and OR = 2.37; 95% CI, 1.10–5.11, respectively). People with depression were much more likely to report activity limitation due to a fear of falling (OR = 3.53; 95% CI, 1.93–6.44).

We then examined whether visual acuity, contrast sensitivity, or visual field explained the largest part of the association between each eye disease and activity limitation due to a fear of falling. The inclusion of contrast sensitivity in the worse eye resulted in the largest reduction in the odds ratios for all three eye diseases. The reduced odds ratios were all <1.3 and were no longer statistically significant (Table 3, Model 2). Contrast sensitivity in the worse eye explained more of the relationships than contrast sensitivity in the better eye (data not shown). In contrast, when visual acuity was added to Model 1, AMD was no longer statistically significant (OR = 1.7; 95% CI, 0.65–4.59) but glaucoma and Fuchs corneal dystrophy were still statistically significant (data not shown). When visual field was added to Model 1, all three eye diseases were still statistically significant (data not shown). Therefore, contrast sensitivity best explained the relationships between the three eye diseases and activity limitation due to a fear of falling.

In sensitivity analyses, we excluded the six people with secondary glaucoma since they may have had vision loss from other diseases. The inferences were unchanged because the odds ratio for glaucoma was still statistically significant (OR = 2.59; 95% CI, 1.22–5.52).

Discussion

We previously reported that none of the eye diseases of interest in this study population was associated with falls in the last year.[11] However, this does not mean that the issue of falling is not a problem in this study population. Indeed, the literature shows that fear of falling can increase the risk of subsequent falls even in the absence of previous falls.[5] In our study, between 40% and 50% of older adults with visually limiting eye disease reported limiting their activities due to a fear of falling compared with only 16% of adults with normal vision. It is possible that this activity limitation is a very effective compensatory strategy to reduce the risk of falling,[30] although there may be both immediate and long-term costs to independence, health, and happiness. For example, the InCHIANTI study of older adults in Italy found that activity restriction due to a fear of falling was an independent predictor of subsequent disability 3 years later, even after adjustment.[31]

We had hypothesized that eye diseases that mainly affected peripheral vision (glaucoma) would have stronger relationships with activity limitation due to a fear of falling than eye diseases primarily affecting central vision (AMD and Fuchs). Our hypothesis was not entirely correct. All the odds ratios were between 2.4 and 3.0, with the highest odds ratio in the Fuchs group and the lowest odds ratio in the AMD group. It was true that the odds ratio in the glaucoma patients was higher than the odds ratio in the AMD patients. However, the odds ratio for the Fuchs patients was the highest of all and the Fuchs patients in our study had compromised visual acuity and contrast sensitivity but fairly normal visual field. We conclude that activity limitation due to a fear of falling is a fairly equally used compensatory strategy for all three patient groups in our study.

The measure of visual function that predominantly described the relationship between eye disease and activity limitation due to a fear of falling was contrast sensitivity. Once we adjusted for contrast sensitivity in the worse eye, the odds ratios for each eye disease decreased to near 1.0. Deshpande et al.[7] also found that contrast sensitivity was associated with activity limitation due to a fear of falling in the InCHIANTI population-based study of older adults in Tuscany, Italy, although only in those with depression. There is a vast literature discussing the importance of contrast sensitivity to mobility outcomes such as postural sway[32,33] and falls,[14,32,34] which may influence activity limitation due to a fear of falling.

Our rate of activity limitation due to a fear of falling in our control population was very similar to what was reported in a population-based study of older adults done in New Haven, Connecticut. Sixteen percent of our controls reported activity limitation due to a fear of falling, whereas 19% of the New Haven population-based sample reported activity limitation due to a fear of falling.[6] This reassures us that our control group, despite being recruited from a clinic, is representative of the general population of older adults.

Strengths of this study include the examination and comparison of people with different eye diseases representing different profiles of vision loss, the measurement of visual

acuity, contrast sensitivity, and visual field, and the inclusion of many potential confounding factors in the analysis. A limitation of this study is its cross-sectional design, which does not allow us to assess the temporality of an eye disease diagnosis and the onset of the limitation of activities due to a fear of falling. Our assessment of activity limitation due to a fear of falling was based on a self-reported answer to a single question. However, the group who reported limiting activities due to a fear of falling also reported much smaller life space, were much more likely to fall in the last year, and performed much worse on the one-legged balance test than those who did not limit activities, which helps to validate this question. By asking a single question, though, we were unable to separately assess activity restriction due to fear of falling from activity restriction due to other reasons. Further research will be needed to determine which activities are restricted due to fear of falling in people with eye disease. Prior research has indicated that activities that cause a high degree of fear of falling include walking outside when slippery, bending down to get something, taking a bath or shower, and taking the stairs.[35]

In conclusion, activity limitation due to a fear of falling is very common in older adults with visually impairing eye disease. Although this compensatory strategy may protect against falls, it may also put people at risk for social isolation and subsequent disability.[31] This knowledge is relevant to older patients with eye disease and their families, to physicians caring for older patients with eye disease, and to those providing low vision rehabilitation services. We should strive to keep older adults with eye disease as mobile as safely possible to help prevent morbidity associated with a sedentary lifestyle, mobility disability, and mortality.[36]

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