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Quantifying Fall-Related Hazards in the Homes of Persons with Glaucoma

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Objective: To characterize fall-related hazards in the homes of persons with suspected or diagnosed glaucoma, and to determine whether those with worse visual field (VF) damage have fewer home hazards.

Design: Cross-sectional study using baseline (2013–2015) data from the ongoing Falls in Glaucoma Study (FIGS).

Participants: One-hundred seventy-four of 245 (71.0%) FIGS participants agreeing to the home assessment.

Methods: Participants' homes were assessed using the Home Environment Assessment for the Visually Impaired (HEAVI). A single evaluator assessed up to 127 potential hazards in 8 home regions. In the clinic, binocular contrast sensitivity (CS) and better-eye visual acuity (VA) were evaluated, and 24-2 VFs were obtained to calculate average integrated VF (IVF) sensitivity.

Main Outcome Measures: Total number of home hazards.

Results: No significant visual or demographic differences were noted between participants who did and did not complete the home assessment ($P > 0.09$ for all measures). Mean age among those completing the home assessment ($n = 174$) was 71.1 years, and IVF sensitivity ranged from 5.6 to 33.4 dB (mean = 27.2 dB, standard deviation [SD] = 4.0 dB). The mean number of items graded per home was 85.2 (SD = 13.2), and an average of 32.7 (38.3%) were identified as hazards. IVF sensitivity, CS, and VA were not associated with total home hazards or the number of hazards in any given room ($P > 0.06$ for all visual measures and rooms). The bathroom contained the greatest number of hazards (mean = 7.9; 54.2% of graded items classified as hazardous), and the most common hazards identified in at least 1 room were ambient lighting <300 lux and exposed light bulbs. Only 27.9% of graded rooms had adequate lighting. IVF sensitivity, CS, and VA were not associated with home lighting levels ($P > 0.18$ for all), but brighter room lighting was noted in the homes of participants with higher median income ($P < 0.001$).

Conclusions: Multiple home fall hazards were identified in the study population, and hazard numbers were not lower for persons with worse VF damage, suggesting that individuals with more advanced glaucoma do not adapt their homes for safety. Further work should investigate whether addressing home hazards is an effective intervention for preventing falls in this high-risk group. *Ophthalmology 2016;■:1–10 © 2016 by the American Academy of Ophthalmology*

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Falls are a leading cause of injury and death among older adults[1] and occur in one third of adults over the age of 65 annually.[2,3] Ten percent to 20% of falls cause serious injuries such as fractures or head trauma,[4] and up to 40% of those who fall will restrict their activities of daily living, leading to a decline in physical activity and social interactions.[5] Falls can occur as a confluence of intrinsic factors (e.g., age, sex, prior fall history, medical comorbidities, medications, muscle weakness, sensory changes) and extrinsic factors (e.g., the home environment),[6] with extrinsic risk factors serving as ideal targets of interventions, given that they are more easily modifiable, sometimes at low cost. The home environment represents a particularly important factor, given that the majority of falls occur in or near the home,[7–9] and because home modifications can effectively reduce fall rates.[10]

Glaucoma is associated with an increased risk of falls[11–13] owing to visual field (VF) loss and poor contrast sensitivity (CS).[14–18] As the population ages, glaucoma-related falls and disability will become an increasing burden on society.[19,20] The home environment is particularly relevant to falls in glaucoma patients, who report significant fear of falling,[21] are increasingly home-bound at greater levels of VF damage,[22] and are more likely to encounter difficulty with environmental hazards owing to impaired hazard perception.

Hazards identified through home assessments have been associated with increased fall risk, though prior assessments have not been tailored to individuals with visual limitations.[23–27] Importantly, most home assessments do not adequately measure lighting conditions (wattage, placement, window coverings), color contrast, visual distractions, or

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glare.[28] Awareness of home lighting hazards is crucial for patients with visual impairment,[29,30] as poor lighting and environmental contrast are associated with more falls and difficulty with mobility.[31,32] No studies have characterized home fall hazards among patients with glaucoma, nor have they explored if homes are less hazardous at greater levels of VF loss, which would suggest environmental adaptation as visual impairment progresses and fall risk increases.

Here, we use a validated home assessment tool to identify fall-related hazards in the homes of individuals with suspected or diagnosed glaucoma. To explore the hypothesis that individuals with more advanced glaucoma adapt their environment, we examine the relationship between the number of home hazards and the adequacy of home lighting across patients with varying degrees of VF loss. We also identify the most common home fall hazards in glaucoma patients, which will help guide the creation of targeted interventions to prevent falls in this at-risk population.

Methods

Participants

Study participants were recruited from patients presenting to the Johns Hopkins Wilmer Eye Institute glaucoma clinic. Eligible patients (1) were ≥60 years of age (or due to turn 60 during the study period), (2) had a chart diagnosis of primary open-angle glaucoma, primary angle-closure glaucoma, pseudoexfoliation glaucoma, pigmentary glaucoma, or glaucoma suspect, and (3) were able to perform VF testing. Patients were excluded if they had worse than 20/40 vision in either eye owing to any disease other than glaucoma, were confined to a bed or wheelchair, were hospitalized in the last month, or lived >60 miles from Baltimore. Additionally, data were collected for 1 week on all glaucoma clinic patients likely to have met study inclusion criteria to determine representativeness of the recruited sample. The Falls in Glaucoma Study (FIGS) protocol was approved by the Johns Hopkins Institutional Review Boards, and all subjects signed written informed consent authorizing all study procedures.

Procedures

All FIGS participants underwent a comprehensive baseline examination to assess visual function, including visual acuity (VA), Humphrey 24-2 VFs performed on an HFA-2 machine (Carl Zeiss Meditec, Dublin, CA), and contrast sensitivity as measured by the Mars Letter Contrast Sensitivity Test (Mars Perceptrix Corporation, Chappaqua, NY). Better-eye VA and binocular Mars CS were analyzed as the logarithm of the minimum angle of resolution (logMAR)[33] and logarithm contrast sensitivity units, respectively. Average sensitivity (in dB) across visual field points was calculated for the integrated VF (IVF), which was used as the primary metric for VF loss, given that mean deviation (MD) values vary for the same sensitivity across different age groups.[34,35] Points from the right and left eye VFs were integrated using the maximum sensitivity between the 2 eyes. Exponentiated sensitivity points were averaged to calculate a mean value for the integrated field, which was then relogged to produce the mean sensitivity of the integrated field. To determine cut points for classifying glaucoma severity using IVF sensitivity, a regression analysis was first performed for IVF total sensitivity and better-eye MD for all patients with visual field data (n = 241) to calculate approximate IVF sensitivities for various MD values. IVF sensitivity cutoffs were then set at >28 dB, 23−28 dB, or <23 dB, respectively, corresponding to Hodapp-Anderson-Parrish values of MD ≥−6 dB, −6 to −12 dB, and ≤−12 dB.[36] Normal mean IVF sensitivity in older patients is roughly 31 dB.

All FIGS participants were asked about sociodemographic characteristics and living arrangements, including home type, home ownership, and housing occupancy. Participants also provided information on current medications and comorbid medical conditions from a list of 15 diseases (arthritis, broken or fractured hip, back problems, history of heart attack, history of angina/chest pain, congestive heart failure, peripheral vascular disease, high blood pressure, diabetes, emphysema, asthma, stroke, Parkinson disease, cancer other than skin cancer, and history of vertigo or Menière disease).[37] Depressive symptoms were assessed using the Geriatric Depression Scale, with scores of greater than 6/15 classified as positive for depression.[38] Cognitive status was evaluated using the Mini-Mental State Examination for the visually impaired (MMSE-blind).[39] Median income was estimated from American Community Survey data provided by the United States Census Bureau.[40]

Participants underwent a home visit to characterize fall hazards unless they declined or were unable to coordinate a visit. Study participants were instructed not to tidy any rooms before evaluation of the home. For lighting measurements, participants were asked to set the lighting and window coverings of each room to reflect typical conditions when in use. Home visits were conducted year-round by a single trained evaluator (R.M.) and were restricted to daytime hours.

Measures

The Home Environment Assessment for the Visually Impaired (HEAVI) evaluates 46 distinct items, each in up to 8 areas of the home (total of 127 hazards): (1) entryway, (2) living room, (3) dining room, (4) kitchen, (5) bedroom, (6) bathroom, (7) stairs, and (8) hallway. The HEAVI is designed to be completed in 1 hour and does not require prior training in home evaluation or modification. The living room and dining room were not evaluated if infrequently used (<1 hour daily); all other rooms were evaluated unless not present or declined by the participant. A prior validation sample demonstrated a strong correlation between the number of hazards identified by the grader used in this study and an occupational therapist (V.G.) with expertise in modifying homes (Swenor BK, Yonge AV, Goldhammer V, et al. Evaluation of a home assessment tool designed to quantify home-related hazards in the visually impaired. In submission.).

Table 1 summarizes the items evaluated and lists the potential rooms where each item might be assessed. Items graded as "Yes" were classified as a hazard; items graded as "No" or "Not assessed" were not. Light intensity indoors and outdoors was measured in lux using a digital light meter (Dr. Meter model LX1330B; Hisgadget Inc, Union City, CA). Friction was measured using a digital slip meter (American Slip Meter model 825; American Slip Meter Inc, Englewood, FL). Size and distance measurements were rounded to the nearest half-inch (e.g., height of stair risers, width of doorway).

Statistical Analyses

Differences between participants who did or did not complete the home assessment were evaluated using chi-square analyses for categorical values and Mann-Whitney *U* tests for continuous variables. Continuous measures within the home assessment were dichotomized for analysis based on publicly available guidelines.[41−44] Hazards were first calculated as the number and percentage (among graded items) of hazards for each room and the full home. We then identified the most common hazards by calculating