Older adults with visual disabilities and fear of falling associated with activities of daily living

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Abstract: Although fear of falling is a risk factor for a fall and a leading cause of injury, morbidity, and mortality among older adults, there has been lack of attention to older adults with visual disabilities. This study aimed to examine fear of falling associated with activities of daily living in those with visual disabilities. A total of 18 older adults with visual disabilities completed a 10-point Likert type scale to measure fear of falling and elaborated on their ratings during exit interviews. The ratings and exit interviews were analysed via descriptive statistics and inductive content analysis, respectively. Fear of falling was negatively correlated with length of residence in the current home. The content analysis helped to identify barriers and facilitators to reducing fear of falling and fall risks, which were documented under 14 themes for home environments, six themes for outside the home, and six themes for general cases.

Keywords: older adults; visual disability; fear of falling; activities of daily living; home.

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1 Introduction

Older adults are vulnerable to falls and fall-related injuries. The US Census Bureau reported that the number of Americans aged 65 and over in 2016 was 49.2 million and more than half (28.7 million) were aged 65 to 74. All older population age groups (65 and over) struggle with serious difficulty walking or climbing stairs (Roberts et al., 2018). There is ample evidence to suggest that falls are a leading cause of both fatal and non-fatal injuries among older adults in the USA (National Council on Aging, 2018). In 2014, 30% of older Americans (age 65 and over) experienced a fall at least once, which is equivalent to approximately 29 million falls, causing 7 million injuries and 27,000 deaths

(Bergen et al., 2016). A fall often leads to serious injuries, physical deterioration, and often institutionalisation (Iglesias et al., 2009; Keene et al., 1993), which would be more often observed in older adults as they tend to have greater bone fragility and poorer protective reflexes (Dhital et al., 2010). Hip fracture is the most serious injury in that more than 95% of hip fractures are caused by falling (Hayes et al., 1993). In general, the majority of fallers with a hip fracture could not return to the level of activity of daily living where they used to show before the fracture (Abdelhafiz and Austin, 2003). Over 20% of fallers with a hip fracture are relocated from their own home to a nursing home while only 24% remain as mobile as they used to be before the fracture (March et al., 1999). There are accumulating evidence to suggest that hip fractures are linked to poor vision (e.g., reduced visual acuity, contrast sensitivity, and visual field) (de Boer et al., 2004; Ivers et al., 2000; Loriaut et al., 2014; Coleman et al., 2009).

As a fall-related injury is considered as one of the most expensive medical conditions in the aging population (Centers for Disease Control and Prevention, 2016a), older adults at an increased risk of having a fall are concerned about financial burden for treating fall-related injuries and loss of independence (Bailly et al., 2014; Tan et al., 2016; Black et al., 2011). A recent report indicates that the medical costs for falls among older adults totalled $35 billion in 2012, which is projected to increase to over $101 billion by 2030 (Houry et al., 2016). There is a detailed report (Florence et al., 2018) that provides medical costs of fatal and non-fatal falls in older adults (aged 65 and older during 2015) in the USA. For fatal falls, overall medical spending was approximately $754 million while for non-fatal falls, Medicare paid $28.9 billion, Medicaid paid $8.7 billion, and private and other payers paid $12 billion. Medical costs of non-fatal falls among older adults in 2015 consist of $12.9 billion for hospital expenditures (i.e., 4.4%), $10.8 billion for health professional's expenditures (i.e., 5.7%), $2.1 billion for prescription drug expenditures (i.e., 2%). Medical spending by older adults vary depending on treatment settings; for example, they spent mostly on hospitalised injuries ($12 billions), followed by injuries treated in emergency rooms and outpatient clinics and doctor's offices ($3 billions) (Stevens et al., 2006). There were individual differences between elderly groups, e.g., the highest percentage of hospitalisation costs was observed in people aged 75–84 while the highest percentage of emergency room costs was observed in people aged 85 and over (Stevens et al., 2006).

A combination of aging and poor vision is likely to put older adults with visual disabilities at an increased risk of falls. In 2014, an estimated 2.8 million older Americans (aged 65 and over) reported severe visual impairments (Centers for Disease Control and Prevention, 2016b). The prevalence of visual impairments becomes more significant as aging proceeds further – e.g., 4.5% for those aged 65 to 74 has visual impairments; 7.2% for those 75 to 84; and 15.8% for those 85 and older (Roberts et al., 2018). It is well documented that vision plays a critical role in stabilisation of human posture, and poor vision is likely to increase the risk of falls (Lin and Lee, 2019; Dhital et al., 2010). There is ample evidence to suggest that there is a strong correlation between visual disability and falls, especially among community-dwelling older adults (Ivers et al., 1998; Lord and Dayhew, 2001; Ramrattan et al., 2001; Coleman et al., 2004). Impaired vision would more than double the risk for falls (National Academies of Sciences, Engineering and Medicine, 2017). For instance, a state-based, telephone survey of community-dwelling older adults (aged ≥ 65 years) in the USA reported that nearly half (46.7%) of the respondents with visual disabilities experienced a fall in the previous year as compared to 27.7 % of those without visual disabilities (Crews et al., 2016). A systematic review

study (Legood et al., 2002) argued that as compared to older adults without visual impairments, their peers with visual impairments are 1.7 times more likely to fall and 1.9 times more likely to have multiple falls. Vision can be impaired for a variety of reasons including age-related macular degeneration, glaucoma, and cataracts, all of which are associated with falls. For example, age-related macular degeneration affects central and reading vision, leading to a distorted view and difficulty recognising one's face (Dhital et al., 2010). An empirical study (Radvay et al., 2007) found that two thirds of older participants with age-related macular degeneration showed visuomotor and balance deficits, resulting in an increased risk of falls. Older women with age-related macular degeneration showed a combination of impaired balance and slower reaction time as compared to their peers without age-related macular degeneration, which would contribute to a higher risk of falling, e.g., a fall risk index score (3.20) of those with age-related macular degeneration was significantly greater than that (1.21; $p < .001$) of their peers without age-related macular degeneration (Szabo et al., 2008). Visual field refers to how wide of an area an individual can see, which is measured in degrees. A visual field test is typically conducted when glaucoma is suspected. When visual acuity, contrast sensitivity, visual field, and stereoacuity were tested after adjustment for demographic and health variables, visual field loss was found to be the primary determinant increasing the risk of falls (Freeman et al., 2007). Haymes et al. (2007) revealed that older patients with glaucoma and mid field defects were over three times more likely to have fallen in the previous year than the control group of people without glaucoma. People with cataracts have cloudy areas in the lens of the eye. A number of studies (Ivers et al., 1998; McCarty et al., 2002) reported a higher risk of falls among people with cataract as compared to their peers without cataract. The World Health Organization (2007) views low visual acuity as one of significant risk factors for falls and fall-related injuries.

Fear of falling has substantial impacts on the quality of life. Fear of falling is defined as an individual's cautious concern about falling (Tinetti and Powell, 1993). Both people with and without a history of falls experience fear of falling (Lee et al., 2018). Fear of falling is viewed as a risk factor for a fall and a leading cause of injury, morbidity, and mortality (Hadjistavropoulos et al., 2011). For example, fear of falling can lead to reductions in various activities on a daily basis (Tinetti and Powell, 1993); an increased risk of falling especially among older populations (Wijlhuizen et al., 2007; Lee et al., 2019; Smith et al., 2016); and poor emotional health (e.g., depression and anxiety) (Painter et al., 2012; van Haastregt et al., 2008). It is well documented that the aging population is likely to develop fear of falling (Legters, 2002; Murphy et al., 2003), which would be influenced by various factors including chronic dizziness, impaired balance and gait, a sedentary lifestyle, anxiety, lack of emotional support, and a history of falls (Murphy et al., 2003). The adverse effects of fear of falling on falls and fall-related injuries have received much attention in the gerontology and safety research area; yet, there is still lack of understanding of fear of falling among older adults who have visual disabilities. The primary aim of this study is to advance understanding of the degree to which older adults with visual disabilities develop fear of falling and to explore facilitators and barriers to reducing fear of falling and fall risk.

2 Methods

2.1 Participants

A convenience sampling method helped to invite 19 older adults with visual disabilities across North Carolina in the USA (see Table 1). It is recommended that sample sizes for qualitative studies generally run at least 15 participants (Marshall et al., 2013), 5 to 50 participants (Dworkin, 2012), 10 participants (Sandelowski, 1995), and 12 participants (Boddy, 2016). The sample size of this research is believed to be adequate for the data analysis. Research participants should speak English, be 65 years old or older, and have visual disabilities [i.e., visual acuity level worse than 20/70 (World Health Organization, 2008)]. Approval for this study was obtained from the Institutional Review Board (IRB). By referring to the study by Voss et al. (2004), participants who lost their sight before they reached 11 years of age were considered as people with early-onset visual disabilities. The majority of participants were female (79%), European-American (63%), retired (68%), and visually impaired after 11 years of age (79%).

Table 1 Characteristics of the participants

Participants	*n = 19*
Visual acuity	
Between 20/70 and 20/200	2
Between 20/200 and 20/400	10
Between 20/400 and 20/1200	1
Less than 20/1,200, but has light perception	1
No light perception at all	5
Duration of visual disabilities (years)	27.37 ± 23.24
Onset of visual disabilities (years) a	
Early onset (n = 4)	6.75 ± 6.24
Late onset (n = 15)	55.67 ± 22.84
Age (years)	72.74 ± 8.16
Gender	
Male	4
Female	15
Race/ethnicity	
African-American	7
European-American	12
Marital status	
Married	6
Not married	4
Widow/widower	3
Divorced	6

Note: [a]Participants with early-onset visual disabilities are those who lost their sight before they reached 11 years of age.

Source: Voss et al. (2004)

Table 1 Characteristics of the participants (continued)

Participants	*n = 19*
Education	
High school or equivalent	6
Bachelors	7
Masters	5
Doctorate	1
Occupation	
Full time	1
Unemployed	5
Retired	13
Household income	
<$25,999	7
$26,000–$51,999	7
$52,000–$74,999	2
≥$75,000	2
Declined to say	1
Diagnosed with health conditions	10
Participation in physical exercise	10
Health insurance	
Government funding (Medicaid, Medicare, etc.)	18
Employee	1
History of falls	
Never	6
Once	6
Twice	2
More than twice	5
Years of living in the current home/house	15.63 ± 18.42

Note: [a]Participants with early-onset visual disabilities are those who lost their sight before they reached 11 years of age.

Source: Voss et al. (2004)

2.2 Materials

Fear of falling was measured using the widely-used scale developed by Tinetti et al. (1990). The scale includes 10-items measuring one's fear of falling associated with activities of daily living: *reach into cabinets or closets*, *walk around the house*, *prepare meals not requiring carrying heavy or hot objects*, *get in and out of bed*, *answer the door or telephone*, *get in and out of a chair*, *getting dressed and undressed*, *personal grooming*, and *getting on and off of the toilet*. The scale has adequate internal consistency (Cronbach's $\alpha = .91$). A participant was asked to rate fear of falling on a 10-point Likert type scale. Higher rating indicates higher fear (i.e., lower fall-related self-efficacy).

2.3 Procedures

The research team visited each participant at home and administered the fear of falling scale by reading out loud for the participant. After participants have completed the scale, they were instructed to elaborate on their ratings. The interview was audio-recorded for content analysis. The interview lasted no longer than 60 minutes.

2.4 Data analysis

The data were analysed using the descriptive statistics, the Cronbach's α for internal consistency of the fear of falling scale, and the Spearman's rho test to measure the strength of association between fear of falling and participants' demographic characteristics (e.g., length of time period living in the current home). Statistical analyses were performed using the IBM SPSS Statistics for Macintosh, version 24 (IBM Corp., 2016). The interview data were analysed using inductive content analysis (i.e., open coding, axial coding, and selective coding) (Strauss and Corbin, 1990) via QSR International's NVivo 11 software (QSR International Pty Ltd, 2015). Another coder helped to assess the inter-rater reliability using Cohen's kappa statistic, which resulted in substantial agreement among the raters as the inter-rater reliability was found to be $k = 0.88$ (95% CI: 0.64 to 1.12), $p < 0.05$.

3 Results

The fear of falling scale showed adequate internal consistency (Cronbach's $\alpha = 0.89$). Spearman's rho testing found that fear of falling ($M = 34$, $SD = 21.58$) was negatively correlated with length of residence (years) in the current home ($M = 15.63$, $SD = 18.42$), $r(17) = –.547$, $p < .05$. There was no significant correlation between fear of falling and the other demographic variables.

Participants shared their experience developing fear of falling, ultimately increasing risk of falling and getting injured inside and outside the home on a daily basis under the circumstance of being severely visually impaired and blind. The content analysis resulted in 14 themes that were associated with home environment (i.e., slippery rugs, objects on the floor, reaching into cabinets, rearrangement of household goods, taking shower, knee stiffness, vertigo, walls, hand grab bars, additional indoor-lighting, cognitive map of the house, one story house, a high toilet seat, and hand use); 6 themes for outside the home (i.e., visiting an unfamiliar place, going outside by myself, walking around the neighbourhood, walking a dog, walking through a crowd, and inadequate balance support by a white cane); and 6 themes for general cases including inside and outside the home (i.e., age-related muscle weakness, exercise, health issues, falling safely, vicarious learning from the failures and near-failures of other people, and changes in walking characteristics to protect themselves from falling). Table 2 shows a full list of themes in which older adults with severe visual impairments and blindness develop fear of falling on a daily basis. Those themes were also sorted to identify whether they were barriers or facilitators to reducing fear of falling, contributing to mitigating the risk of falling.

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
Inside the home	Slippery rugs (household goods)	Barrier	*Before I had it [a stool with rubber on the bottom], I had rugs like that in front of my bed. It's moving. I got up, and my foot hit the rug. I slid down the bed.*	As older adults with visual disabilities cannot see clearly (or at all) whether their household goods (e.g., rugs) are stable or slippery, which will increase the likelihood of slips and falls.	Make sure household goods (e.g., slippery rugs) remain securely in place by using various tools such as rubber rug pads, rug grippers, and Velcro straps
	Objects on the floor	Barrier	*Today, my daughter brought the grandkids by, and they took a toy out of the back room and left it in the living room. I almost tripped over that. So, when things are left or kept where I put them, I'm fine, it's no problem. But if they're moved, and I'm not aware of it, it's bad for me.*	Other family members often left some objects on the floor such that an individual with a visual disability is likely to fail to detect the objects. Floors with clutter can cause trips and falls. Visitors and other family members should be educated or informed to keep floors from clutter.	Keep walkways free from clutter to prevent older adults with visual disabilities from tripping and falling
	Reaching into cabinets	Barrier	*I do not climb; I do not reach into a cabinet. Although I have a step stool, I wait for somebody else who might come to get it.*	A certain activity of daily living (e.g., reaching into cabinets) tends to increase fear of falling, probably leading to falls.	Place household goods on the bottom shelf of the cabinet; thus, one with a visual disability can reach out to those objects without using stepstools and ladders, or waiting for someone to help him/her (i.e., loss of independence in activities of daily living)
	Rearranged household goods	Barrier	*The only room that I have a trouble with is the living room, and that's because the furniture sometimes changes positions. You've got to make sure - and my wife knows - to keep stuff out of my normal [walking] path. I don't know that I'll trip.*	Other family members often change the location of household goods (e.g., furniture) without informing one with a visual disability about the change such that one with a visual disability is likely to get interfered with his/her cognitive map of the house, leading to bumping into furniture, which will increase the likelihood of trips and falls.	Avoid relocation of household goods; however, if relocation is necessary, it is critical to inform one with a visual disability about the new location

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities (continued)

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
	Shower (wet surface)	Barrier	*I don't like to do it [shower] if I'm at home by myself. If I want to take a tub bath, I can always sit on the edge of the tub but kind of slide down.*	Due to vision loss, they are concerned about losing balance, falling and getting injured while taking a shower due to wet surfaces.	Equip the bathroom with non-slip mats, grab bars, anti-slip coatings
	Hand grab bar	Facilitator	*I have put safety bars in the shower booth because of that fear [of falling].*	A safety bar in the shower booth/tub helped to reduce fear of falling and mitigate the fall risks.	
	Indoor lighting	Facilitator	*I installed additional lights in the house. Lighting was the biggest thing.*	For those who have residual vision, well-lit rooms are helpful to navigate the space (e.g., walking upstairs and downstairs) and find an obstacle on the floor.	Install additional lights in the home to enhance the visibility
	Cognitive map of the house	Facilitator	*I am comfortable in the living room because I know where everything is. When we first moved into this house, I had a terrible time until I learned my pattern. I lived for about 8 years. So, I got comfortable with a place and I pretty much know where I am going.*	After living long enough to develop a clear cognitive map about his/her home, they feel comfortable walking around.	Offer a detailed tour (with sufficient time) to develop a clear cognitive map of the place Incorporate a sense of touch in the tour session (learning by touch) for people with visual disabilities
	One story house	Facilitator	*My bedroom's downstairs. Thank God. I really don't have to go upstairs. When I was coming down, I thought I was on the last step and then I stepped off and I broke a little toe. I don't like the stairs. I would much rather be on one level.*	As they are afraid of stairs, a home environment without stairs would contribute to reducing fear of falling, leading to mitigating the risk of falling.	Recommend a one-story home environment to avoid stairs
	Getting on and off a toilet – High toilet seat	Facilitator	*I have no problem with getting on and off a toilet because I had high toilets put in.*	The high toilet seat may contribute to safety as it makes rising easier, helping people to reduce the risk of slips and falls.	Install a high toilet seat as the raised toilet is expected to contribute to relieving the knee joints from any added pressure, which will help to reduce fear of falling and mitigate the fall risk

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities (continued)

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
	Getting on and off a toilet – Knee stiffness	Barrier	*When it comes to getting on and off a toilet, I feel fear of falling in the morning as it would be a rough time because it's like your knees are stiff.*	In addition to poor vision, older adults with visual disabilities are concerned about their physical health conditions, increasing fear of falling and the likelihood of falling, e.g., their stiff knees that interfere with getting on and off a toilet.	
	Getting on and off a toilet – Vertigo	Barrier	*Sometimes, I have vertigo [while using the bathroom]. So, that can be an issue. But again, I've tried to be aware of that, and doubly careful. And if it gets bad, I'm just in the bed, or I'm crawling.*	While getting on and off a toilet, older adults with visual disabilities often experience vertigo (i.e., a sensation of spinning dizziness caused by a problem in the part of the inner ear that controls balance) that will cause them to develop fear of falling and increase the risk of fallings in the bathroom.	
	Sense of touch (by hand)	Facilitator	*I just use my hands to feel my way around. I am afraid of falling. If I know there is a step-down coming, I creep to get to it. I am very nervous about walking.*	As they tend to rely on a sense of touch, it would be helpful to install a Braille (or a tactile indicator) that informs them that they are just about to encounter stairs such that they will be physically and cognitively prepared for it.	Place tactile indicators at/near stairs that may cause a trip
	Walls (bump into walls)	Barrier	*I have nothing, except light perception. I was just informed that it is going to continue to go blind completely. I am feeling the walls to walk now, and I am using the walls to guide. So, I am running into walls. I wish that there was a railing or something that I could put my hand against and hold on to the wall. I hate that wall right there. I run into it. Today makes the fifth time I've smacked into that wall.*	When older adults with visual disabilities walk, they tend to touch the wall because they consider the wall as a reference mark. Yet, they often bump into the wall even if it is his/her home.	Install a railing to better guide and to prevent from bumping into the wall

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities (continued)

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
Outside the home	Visiting an unfamiliar place	Barrier	*When it comes to the level of fear of falling, I think the numbers would be much higher out of this house, if we're in someone else's house. I would be much timid. I would take my cane. I have a fear of falling outside. As long as I got my hands on the fence, the gate or something like that, I'm all right anyway.*	Older adults with visual disabilities are comfortable staying in their home as they are familiar with the layout and locations of household goods. But, their fear of falling would increase when they go outside as they are unfamiliar with the place.	Go outside with a white cane or someone when it comes to an unfamiliar place
	Going outside by myself	Barrier	*I am beginning to have a little fear if I go outside by myself. And that makes you worse. I have enough fear to know that I've got to be very careful. So, you need to have someone, so you won't be reckless.*	As they are afraid of falling and being injured outside, they are hesitant to go outside alone.	
	Walking around the neighbourhood (walking path)	Barrier	*I make sure that I have a clear path of where I'm going. That's why I basically I have not walked around in my neighborhood because I'm not sure. My main thing is not to fall.*	They are less likely to walk around in their neighbourhood due to fear of falling as they are not yet familiar with the walking paths in the neighbourhood.	Offer a tour to be familiar with the neighbourhood (e.g., around or near the home) such that he/she can manage to identify and remember reference marks (or obstacles causing trips/falls) and keep on the sidewalk for safety
	Going outside, walking with a dog	Barrier	*I lost balance and fell down. It was when I first got the dog. She was pulling me, and I fell in the middle of the street.*	For those who have a dog and tend to walk with their dog, the fear of falling could be elevated as his/her dog may be stronger to pull him/her down the street and cause him/her to fall.	Walk the dog by taking proper precautions, e.g., using an appropriate leash for the dog's size and physical strength; avoiding allowing the dog to run long distances from the owner, otherwise, he/she can easily lose control, leading to falls

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities (continued)

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
	Walking through a crowd	Barrier	*I was in Walmart with a white cane and somebody did bump me and push me out of the way. I have had somebody almost knock me down. Some store did not have much room to maneuver.*	When older adults with visual disabilities go to a public place (e.g., shopping malls crowded with shoppers), they are likely to be interfered with sighted people (e.g., a cane is kicked by sighted people), leading to increases in fear of falling. In addition to orientation and mobility, the white cane serves as a symbol to indicate that they are visually impaired such that sighted people are encouraged to take care around people carrying it (or offer assistance). However, they experienced sighted people who do not know what the white cane means.	Find someone to accompany one with a visual disability when visiting a crowded place
	Inadequate support by a white cane for balance	Barrier	*I used to walk with a cane, but that was before I fell, then changed it after falling, then they got me the walker for more stability.*	After people lost vision, they used the white cane; however, replaced it with a walker after they fell. The fear of falling makes them pay more attention to stability over visibility. They may need an innovative tool that can serve as both a cane and a walker.	Prepare both a white cane and a walker, but use a walker when beginning feeling that you are losing balance due to muscle weakness (or feel dizzy) such that you can secure your good balance while walking

Table 2 Facilitators and barriers to reducing fear of falling, and relevant recommendations for older adults with visual disabilities (continued)

Themes	*Subthemes*	*Facilitator or barrier*	*Excerpt*	*Descriptions*	*Recommendations*
General (in/outside the home)	Age-related muscle weakness	Barrier	*The fear of falling is always in the back of my mind, and we're working new on the stage; that's building up strength in your legs.*	As people with visual disabilities get older, they are concerned about an age-related loss of muscle mass, muscle strength, and physical function, ultimately leading to a fall incident and injury.	Do multicomponent physical activities (e.g., balance training, aerobic, and muscle-strengthening activities)
	Exercise	Facilitator	*I am working very hard not to do that [falling down]. That is why I do yoga. The yoga is strengthening the muscles, and I do wall-pushups that help to strengthen the knees.*	Older adults with visual disabilities tend to develop a fear of falling induced by their muscle weakness so that they do exercise to mitigate the risk of falling and getting injured.	
	Health issues	Barrier	*I have diabetes and sometimes my blood sugar would drop. For example, I got up in the morning, felt fine, and then I was walking into the bathroom and I just passed out on the floor. I also have low blood pressure and I do pass out.*	Chronic conditions (e.g., diabetes and low blood pressure) could cause them to fall and get injured.	Consult with the healthcare professional to better understand whether and how the chronic conditions affect one's ability to do regular physical activities safely
	Falling safely	Facilitator	*If you fall, you've got to fall frontwards. Never backwards because you don't have anything to help to break the fall. You can break an arm, that's okay; but if you fall backwards, you can break your neck.*	They are interested in learning how to minimise fall-related injuries if a fall were to occur (i.e., mitigation of damages).	Be aware of safe-landing strategies, e.g., squatting, forward fall, elbow flexion, sideway fall, forward rotation, ruck-and-rolling, hand slapping on the ground, relaxed muscle, and stepping
	Vicarious learning from the failures and near-failures of other people	Facilitator	*I just know from experience because that is what happened to my husband. He fell over backwards and hit his head, and that was the beginning of the end. The mantra is, here, in me, is that you just have to be extra careful because you know you've seen the results in people misstep.*	By observing or being informed of others falling down and getting injured, older adults with visual disabilities are likely to increase awareness of the risk of falls, leading to precautions.	Increase self-awareness of the fall risk via various interventions, e.g., fall prevention workshops, fall prevention discussion groups, exercise demonstration, regular vision exams, education for proper use of assistive devices
	Changes in walking characteristics (looking down, slow walking, and shorter steps)	Facilitator	*I'm constantly looking down to see exactly where I'm going, and I very seldom look up. Because I'm having to use my peripheral vision, so I'm not seeing directly in front of me. People would change their walking patterns, like gait speed to slow down or shorter step.*	People take advantage of their residual vision and focus on the near point (e.g., looking down) as they want to find a way to walk safely. Other approaches include slow walking and shorter stride length.	Adjust the walking patterns to enhance the situation awareness and be aware of one's surroundings via keeping eyes (residual vision) and ears open and evaluating what is happening

Participants lived in home environments that included multiple factors causing them to develop fear of falling. For example, they have shared their experiences or concerns about tripping over objects on the floor or bump into household goods (e.g., furniture), and slipping on slippery rugs and a wet surface during taking a shower. As they have lost their vision (or have severely impaired vision), they are more likely to fail to detect those hazardous conditions as compared to their sighted peers, ultimately increasing further the risk of falling. Their fear of falling was also associated with losing balance when reaching into cabinets or when getting on and off a toilet as they feel vertigo or have knee stiffness. On the other hand, they have shared their strategies implemented in the home to overcome the fear of falling and protect themselves from falls and fall-related injuries. They, for instance, installed a safety bar, placed additional lights in the home, spent time developing a clear cognitive map of their house via a sense of touch, relocated household goods in the first floor to avoid stairs, and installed a high toilet seat.

When participants went outside, their fear of falling was associated with various environmental hazards. For example, they avoided going outside if they had no one to go together; were reluctant to visit unfamiliar places even if their caregivers (e.g., sighted family members or friends) could go together; and were less likely to walk their dogs who could be stronger than the owner to pull down the street leading to falling. Participants were more likely to use a white cane outdoor than indoor, and often used it outdoor even if they had a sighted caregiver near them. They typically used a white cane for two purposes:

1 the white cane helped those with visual disabilities to scan their surroundings for obstacles or orientation marks

2 the white cane helped sighted people to recognise those who carry a white cane as a person who is visually impaired.

People who are visually impaired but keep somewhat residual vision may appear to be sighted people; thus, they believed that a white cane would be helpful for sighted people in identifying them as a person with a visual disability and taking appropriate care before bumping into them and falling down.

Regardless of indoors and outdoors, their fear of falling would also be elevated or reduced by several other factors. In addition to their poor visual status, the aging effects contribute to increasing the fear of falling. They were concerned about an age-related loss of muscle mass, muscle strength, and physical function. Participants who were diagnosed with chronic diseases such as diabetes and low blood pressure shared their concerns that those diseases could cause them to pass out, resulting in a fall. Participants implemented their own interventions to prevent them from developing fear of falling, falling and getting injured; for example, they did exercise regularly at home and community centres. As they cannot drive any longer due to vision loss, they tended to obtain transportation supports from family, friends or community organisations in order to attend exercise programs at community centres. They also took hazard mitigations into consideration in order to reduce or minimise fall injuries. For example, they were interested in learning how to minimise fall-related injuries if a fall were to occur. They shared various strategies, e.g., falling forwards (instead of backwards) to protect themselves from hitting the head and fracturing the neck. Other strategies included sideway falling and hand slapping on the ground. They also learned through other persons' experience of falling (i.e., vicarious learning), which helped them maintain or increase awareness of the risk of

falls, leading to precautions on a daily basis. Since they lost their vision, they have changed their walking patterns; for example, they greatly relied on a sense of touch while walking (e.g., touching the wall); and those who had residual vision tended to focus on the near point by constantly looking down as they wanted to find a way to walk safely. Other approaches they took included slow walking and shorter stride length.

4 Discussion

This study contributed to advancing knowledge about fear of falling associated with various activities of daily living among community-dwelling older adults with visual disabilities. This study found the negative correlation between fear of falling and years of living in the current home – e.g., those who lived longer in their home are likely to have a lower level of fear of falling as compared to those who lived shorter in their home. It is also supported by their exit interview in that after living long enough to develop a cognitive map about their house, they feel comfortable walking around. If the questionnaire was, however, designed to examine fear of falling outside the home, their fear of falling would probably be higher as they would feel uncomfortable walking in unfamiliar places. As there are lack of published reports that compared the fall frequency between indoor and outdoor among community-dwelling older adults with visual disabilities, the results of this study can be further discussed by referring to other studies that involved sighted older adults. For example, a research team by Hoang et al. (2017) examined the fear of falling among community-dwelling sighted older adults by using a scale that considered a combination of indoor and outdoor activities. They reported a slightly higher mean score of fear of falling outside the home than in the home. Gazibara et al. (2017) also reported that sighted older community-dwellers fell more often outdoors (76.8%) than indoors (23.2%). Yet, it does not imply that those with visual disabilities would fall more often outside the home than inside as falls are caused by various risk factors such as intrinsic factors (e.g., fear of falling, aging, muscle weakness, gait and balance problems, and chronic conditions) and extrinsic factors (e.g., lack of stair handrails, poor stair design, dim lighting, obstacles hazards, and slippery surfaces) (Centers for Disease Control and Prevention, 2020a, 2020b). For example, numbers of other research studies on falls among sighted people observed that falls occurred frequently both inside and outside the home (Pynoos et al., 2005; Timsina et al., 2017), e.g., 55% of fall injuries occurred inside the home, 23% occurred outside but near the home, and the remaining 22% occurred away from the home.

As the study of Tinetti et al. (1990) used the same scale in measuring fear of falling as this study did, the mean value of each item of the fear of falling scale in this study was compared with that in the study of Tinetti et al. (1990) that included sighted people. All items in this study indicated higher mean values; in other words, fear of falling of participants with visual disabilities in this study was greater than that of sighted people in the study by Tinetti et al. (1990). Thus, it could hypothetically be argued that those with visual disabilities tend to show greater fear of falling as compared to sighted people, associated with activities of daily living in the home; however, other sociodemographic factors that were not covered by this study may lead to different results. As this study did not include sighted older adults to directly compare with their peers with visual disabilities, further research is required to examine empirically the effect of vision loss on

fear of falling between sighted and visually impaired community-dwelling older adults inside and outside the home by controlling other sociodemographic factors to be constant.

Although there are a few published studies focusing on fall risk factors for older adults with visual disabilities, they did not focus on fear of falling (Dhital et al., 2010; Brundle et al., 2015). This study contributed to:

1 advancing knowledge of fear of falling among older adults with visual disabilities both inside and outside the home

2 identifying a set of facilitators and barriers to reducing fear of falling and mitigating the risk of falling.

In the home, their fear of falling was influenced by various barriers and facilitators; for example, the barriers included slippery rugs, objects on the floor, reaching into cabinets, rearranged household goods, shower, knee stiffness, vertigo and walls, while the facilitators included hand grab bars, additional indoor-lighting, cognitive mapping of the house, one story house, a high toilet seat, and hand use. There is evidence suggesting that at least one-third of all falls among older adults are caused by environmental hazards in the home (Tremblay and Barber, 2005; Guimarães et al., 2014; Josephson et al., 1991). The environmental hazards in the home typically refer to slippery surfaces, poor lighting and loose rugs, and the most common environmental hazard for falls in the home is tripping over objects on the floor (Tremblay and Barber, 2005). It is well documented that there are positive relationships between the presence of environmental hazards in the home and falls; for example, Isberner et al. (1998) found that older adults who had a history of falls tended to live in the home where handrails were not equipped and floors were uneven. Older adults living in the home with environmental hazards were more likely to have reported a fall incident in the past three months (Fletcher and Hirdes, 2002). Carter et al. (1997) conducted a home inspection for 425 older adults and uncovered that 80% (n = 542) of homes were exposed to at least one hazard and 39% (n = 164) had more than five hazards (e.g., absence of appropriate grabs and handrails). As older adults with visual disabilities have poor vision (or no light perception at all), it could be argued that older adults with visual disabilities are more likely to be vulnerable to environmental hazards in the home as compared to their peers without visual disabilities.

Outside the home, fear of falling among older adults with visual disabilities was affected by various variables, e.g., visiting an unfamiliar place, going outside alone, walking around the neighbourhood, going out with a dog, walking through a crowd, and inadequate support by a white cane. Carter et al. (1997) contended that the risk factors for outdoor falls would be different from that for indoor falls due to different environmental conditions. Kelsey et al. (2012) also observed different characteristics of falling between indoors and outdoors as indoor falls were more likely to occur among individuals with poor health conditions while outdoor falls were among healthy, active individuals. When older adults with visual disabilities in this study go outside, they were to rely on assistive devices (e.g., a white cane), a service dog, or personal assistance (e.g., holding on to a sighted person's elbow), which are what they are less likely to rely on inside the home. Therefore, their fear of falling outside the home were likely to be induced by a dog and assistive equipment inferred with external environmental conditions (e.g., a failure to detect objects on the ground) or visiting unfamiliar and crowded places (e.g., excessive anxiety due to sighted people ignoring the white cane, overstepping, or inferencing with

manoeuvring a white cane). As this study did not observe older adults with visual impairments while they were outside in the midst of working at their workplace, walking nearby the home, or walking around the community, this study's interview might cause the participants to rely on their retrospective memories about walking outside; thus, actual observations may lead to different results (e.g., different sets of factors leading to fear of falling).

Participants in this study implemented their own strategies to deal with fear of falling and mitigate the risk of falls, e.g., exercise, falling safely, and vicarious learning from the failures (or near-failures) of other people. In the literature, various fall prevention interventions have been introduced for sighted people, including environmental assessment and modification such as placement of additional lighting and handrails; vision assessment and treatment; exercise training; and calcium and vitamin D supplementation (Tricco et al., 2017; Guirguis-Blake et al., 2018). Among those different interventions, exercise is reported to be the most effective approach for sighted people; for example, a meta-analysis study (Guo et al., 2014) incorporating 111 studies (n = 51,551 participants in total) evaluated a number of different fall-prevention interventions (e.g., multiple- and single-component interventions) and found that single exercise interventions contributed to effectively reducing risk of falls among older adults with and without cognitive impairments in institutional or non-institutional settings. However, as previous studies did not test the efficacy of the fall prevention interventions by including older adults with visual disabilities, further research is needed to investigate the effectiveness of those interventions for those with visual disabilities both inside and outside the home. Furthermore, the conventional fall prevention exercise programs were merely designed under the assumption that learners can see the instructional manuals (or the instructors) such that those conventional programs would be challenging for those with visual disabilities to understand and practice exercise. Further research is essential to determine the effectiveness of exercise interventions and to design them to be accessible to those with visual disabilities. Besides exercise interventions, other conventional interventions would also need to be modified, based on evidence, to better accommodate people with visual disabilities at risk of falls because the one-size-fits-all approach would be inadequate. For example, the research team by Foster et al. (2014) tested the effectiveness of a high-contrast highlighter that was placed on the edge of stair threads to improve safety on stairs for people with visual impairments. They found that the highlighter led to a decrease in the number of accidental foot contacts (from 15% to 3%); however, their study was conducted via a simulated vision condition, i.e., younger sighted participants (average of 24.0 ± 4.3 years old) wore cataract simulation goggles and experienced the highlighter. In user studies, blindfolded sighted participants often evaluate assistive technology applications on behalf of their peers with visual disabilities; however, such simulation approach is likely to fail to address needs of those with visual disabilities (Silverman et al., 2015). A fall prevention intervention designed for sighted people should, thus, be tested by people with visual disabilities and/or redesigned to fit those with visual disabilities, as necessary. Pundlik et al. (2015) developed a portable collision warning device for people with peripheral vision loss and observed that the device could reduce the number of collisions (i.e., approximately 37%) in an obstacle course. However, they did not test the device in home environments as they tested it under highly controlled conditions using a 41-metre-long loop-shared course. Their device, as a fall prevention intervention, would still be questionable as to whether people with visual impairments in the home could benefit.

A few limitations may affect this study. This study used the fear of falling scale that was developed by Tinetti et al. (1990), and the scale covered only 10 different activities of daily living in the home. As this study found multiple barriers leading to increases in fear of falling, the inclusion of more various activities of daily living in the scale would result in different results. The fear of falling scale in this study focused on home environments while the participants felt fear of falling both inside and outside the home, and furthermore the correlation analysis indicated that the participants living longer in their home were more likely to show lower fear of falling as compared to those living shorter in their home. As they would be unfamiliar with places outside, their fear of falling outside would be different than inside. Further research is needed to obtain a deeper understanding of fear of falling among older adults with visual disabilities under various contexts. Future research will also be conducted with a larger sample size to examine the recommendations for reducing fear of falling (as presented in Table 2) and to construct a statistical model via regression analysis in order to investigate the relationship between the recommendations and the fear of falling (and/or actual falls) via a longitudinal study (e.g., repeated observations of participants over long periods of time).

5 Conclusions

The present study contributed to advancing knowledge about facilitators and barriers to reducing fear of falling that were associated with aging issues, visual disabilities, or both. Those facilitators and barriers were identified by comprehensively reviewing internal and external environments (e.g., indoor and outdoor), tools that they used on a daily basis (e.g., assistive devices for people with visual disabilities and general household goods), humans (e.g., limitations, capabilities, and preferences), and tasks (e.g., activities of daily living). This study suggested adequate recommendations to handle their fear of falling, eventually leading to mitigating the risk of falls.

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