The Impact of Reduced Vision on Falls for Community-Dwelling Older People: A Literature Review

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ABSTRACT

Aim: To explore detailed studies and reveal the complex relationships between the elements of vision and falls risk for community-dwelling older people.

Method: A thematic literature review was conducted of detailed studies published in a 10-year period and their direct references that reported on reduced vision as a risk factor for falls for community-dwelling older people.

Results: Seven publications were analysed based on the elements of vision they reported, including visual acuity, contrast sensitivity including low contrast visual acuity, depth perception and visual field. The literature suggests that contrast sensitivity including low contrast visual acuity is more informative regarding falls risk in this population, than the other elements of vision.

Conclusion: The relationship between reduced vision and falls for community-dwelling older people is an important and complex one. The lack of standard methods of assessing vision in falls research creates an opportunity to further explore vision as a risk factor for falls in this group.

Keywords: vision, falls, community-dewlling, older people

INTRODUCTION

Falls are a major health issue and the main reason for trauma related hospital admission in people aged 65 years and older.[1,2] Each year, between 30 and 44 percent of older people living in the community experience a fall,[3,4] and the consequences are costly. In 2001, the estimated total health cost of fall-related injuries in Australia was reported to be $500 million; a cost projected to reach approximately $1,375 million by the year 2051 if no further action is taken to prevent falls in older age.[5]

Falls in older people are multifactorial, resulting from the interaction between risk factors specific to the faller and the faller's environment. For older people, reduced vision has been reported in the literature to be a significant independent risk factor for falls in this population.[6] This literature review explores detailed studies of reduced vision (visual acuity, contrast sensitivity including low contrast visual acuity, depth perception and visual field) and reveals the complex relationships between reduced vision and falls risk for community-dwelling older people, defined as people who live at home or independently in a retirement village.

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BACKGROUND

A fall can be defined as 'an unexpected event in which the participant comes to rest on the ground, floor or lower level'.[7] Prevention of Falls Network Europe (ProFaNe) developed and recommended this definition due to the sizeable variation in definitions found in the studies reviewed by ProFaNe.[8] Consistent definitions are important for achieving consistent outcomes.

Recent Australian studies report that around 43 percent of older people living in the community (ie living at home or independently in a retirement village) have one or more falls each year.[3,7,9] Around 10 percent of older people fall at least once when in hospital,[10,11] and around 50 percent of older people living in residential aged care facilities fall at least once each year.[12,13]

For older people, risk factors for falling reported in the literature include advancing age, female gender, history of falls, medication use, medical conditions such as Parkinson's disease and stroke, reduced vision, impaired

gait, balance problems and hazards in the home, such as obstructed walkways, low bed height and upturned floor rug edges.[4,14-19,20,21] Also, the risk of falling is increased significantly when an older person has multiple risk factors compared to having no risk factors for falling (Chi-square = 62.7, P<0.001).[4]

The visual system plays an important role in keeping an older person on their feet. Along with other systems the visual system detects changes in balance.[22] Reduced vision that includes visual acuity, contrast sensitivity, depth perception and visual field, when reported in the literature is not always associated with falls in older people. The various elements of vision chosen to represent reduced vision and the different methods of measurement make it difficult to draw strong conclusions about the relationship between impaired vision and falls for older people.

Falls are costly to the individual, community and the health system. When community-dwelling older people experience a fall, the cost to the individual is often more than a financial one and this personal cost is an important factor to consider. The personal cost or consequences of falling for older people who live in the community are many, and include injury,[18,19,21,23-27] functional decline,[4,28] nursing home placement,[29] developing a fear of falling,[4,24,30] and in some cases death.[25,28,29]

To assist with effective falls prevention, falls risk assessment tools have been developed based on established risk factors. As multiple factors contribute to falls in older age, it is important to use a falls risk assessment tool which covers more than one risk factor for falling. Although the use of a single risk factor such as history of falls in the previous 12 months is a strong predictor of future falls,[31] this method is limited. Such a method of falls risk assessment does not allow for the investigation of additional risk factors, such as vision for example, which may be modifiable and therefore lead to the prevention of future falls. The aim of this literature review was to explore detailed studies and reveal the complex relationships between the elements of vision and falls risk for community-dwelling older people.

METHOD

A thematic literature review was conducted of detailed studies published in a period of 10 years and their direct references that reported on reduced vision as a risk factor for falls in older people. Limited to publications that featured the complex relationship between vision and falls risk in older people living in the community, seven publications were chosen for this review, the details of which are summarised in Tables 1, 2 and 3.

OUTCOMES

Visual acuity

Visual acuity allows for the appreciation of fin detail in daily activities. De Boer et al[32] included reduced visual acuity as a risk factor for falls in a prospective cohort study of 1,509 older adults (55-85 years of age). Participants were asked to record all falls over a 3-year period. In this study a fall was defined as an unintentional change in position resulting in coming to rest at a lower level or on the ground. The authors measured visual acuity using a non-quantitative method of a self-report of the ability to recognise faces at 4 metres with their glasses (Table 1). The authors reported that at the vision level of 'much difficulty or can't see' there was no association with

Table 1. Visual acuity and falls

Element of visual function	Method of assessment (both eyes open)	Level of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Visual acuity	Self-report of ability to recognise faces at 4 metres with own glasses	Much difficulty or can't see	Age-adjusted HR 1.45 (0.97-2.15) Not associated	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)
	Retro illuminated Snellen chart at 6 metres with own glasses	6/12 or worse	Age-adjusted RR 1.3 (0.8-2.2) females RR 1.3 (0.6-2.8) males Not associated	Faller	Campbell et al 1989[14] (1-year follow-up period)
	Retro illuminated Early Treatment of Diabetic Retinopathy (ETDRS) chart	Per line missed	Age-adjusted OR 1.01 (0.98-1.05) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Snellen style chart with own glasses	6/9 or worse	Age/sex-adjusted PR 2.1 (1.3-3.4) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (previous 12 months)
	Snellen style chart at 4 metres with own glasses	6/10 or worse	Age-adjusted RR 1.59 (0.85-2.98) Not associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Corrected visual acuity details described elsewhere	6/15 or worse	Unadjusted RR 1.5 (1.2-2.1) Associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Self-report of ability to read small print in the newspaper	Much difficulty or can't see	Age-adjusted HR 1.20 (0.89-1.62) Not associated	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio. Faller ≥ 1 fall, Recurrent faller ≥ 2 falls. p<0.05 signifies statistical significance

falls (age-adjusted hazard risk 1.45, 95% CI 0.97-2.15).[32]

Campbell et al[14] included reduced visual acuity as a potential risk factor for falls, defined in the study as any accidental contact with the ground, in a sample of community-dwelling older people. The 12-month prospective study included 761 participants (465 females and 296 males) aged 70 years and older, with no mean age reported. Unlike de Boer et al[32] Campbell et al[14] used the 'gold standard' retro illuminated vision chart at 6 metres, the participants wore their best-corrected spectacles and their vision was tested with both eyes open. At the cut-off visual acuity level of 6/12 or worse, there was no association with falls in either female or male participants (Table 1). Lord and Dayhew[9] conducted a 12-month prospective falls risk study in a sample of 156 (99 females and 57 males) community-dwelling older people (mean age 76.5 years, standard deviation 5.1). A fall was defined in the study as any event which resulted in unintentional contact with the ground excluding major events such as stroke. At the cut-off visual acuity level of 6/10 or worse, Lord and Dayhew[9] also reported that there was no association with falls in their study (relative risk 1.59, 95% CI 0.85-2.98) (Table 1). Unlike Campbell et al,[14] Lord and Dayhew[9] excluded some fall types. Although both studies reported no association between reduced visual acuity and falls, having inconsistent definitions across studies makes comparisons difficult.

More recently, Freeman et al[15] included reduced visual acuity as a potential risk factor for falls defined in the study as unintentionally coming to rest on the ground or other level. The 2,375 participants were aged 65 years and over were followed up for 20 months in a prospective falls risk study. Neither the proportion of females and males, nor the mean age were reported. Similar to Campbell et al,[14] Freeman et al[15] also used a retro illuminated vision chart. At the visual acuity level of 'number of lines missed on the vision chart', there was no association with falls (age-adjusted odds ratio 1.01, 95% CI 0.98-1.05) (Table 1). Importantly, Freeman et al[15] used a similar definition of a fall to that used by Campbell et al,[14] strengthening the findings as it is likely that the two studies were measuring a similar outcome. Despite the similar definition of a fall being used, the time-period over which the data was collected was not; Freeman et al[15] 20 months and Campbell et al[14] 12 months. Differences in methods used across studies also make comparisons difficult.

In a prospective falls study by Nevitt et al,[18] 325 community-dwelling older people (266 females and 59 males) were followed up for 12 months. Participants were aged 60 years and over with most (43%) aged between 70 and 79 years of age. A fall was defined in the study as a fall resulting in contact with the floor or a chair or other lower object like a stair. 'Near falls' where the participants caught themselves before landing on the floor, or falls caused by major events such as being hit by a vehicle, were excluded. Reduced visual acuity was associated with an increased risk of multiple falls when the visual acuity was 6/15 or worse (unadjusted for age: relative risk 1.5, 95% CI 1.2-2.1) (Table 1). This result suggests that the level of visual acuity associated with an increased risk of falls may in fact be worse than suggested by Lord and Dayhew (6/10 or worse) who used a similar definition of a fall, although this association may have been lost when age-adjusted.

The Blue Mountains Eye Study conducted by Ivers et al[33] is a population-based survey with retrospective falls collection, in which 4,433 eligible residents took part. The participants were aged 49 years and over (35% aged 60 to 69 years) and 1,877 were female.[33] The authors of this study reported that visual acuity of 6/9 or worse was significantly associated with recurrent falls, defined as any fall which resulted in landing on the ground or on the floor.[33] Only limited details of the method of testing visual acuity were included in the publication making it unclear if the gold standard method was used (Table 1). Also, the retrospective recall of falls data may have led to a misreporting of falls and therefore an underestimation or overestimation of the association between visual acuity and falls in their study.

Contrast sensitivity

Unlike visual acuity which allows for the appreciation of fine detail, contrast sensitivity assists a person to safely mobilise. Contrast sensitivity is the ability to distinguish between an object and its background. It allows a person to negotiate kerbs and uneven foot paths by allowing them to detect the difference in surface positions when the contrast is low; that is, when one surface is similar in shade to the other.

De Boer et al,[32] Ivers et al[33] and Lord and Dayhew[9] reported that reduced contrast sensitivity at low levels of contrast, was significantly associated with an increased risk of falling (Table 2). Contrast sensitivity was measured in these three studies using similar methods and these methods required the participant to identify the orientation of a single line or set of lines at different levels of contrast.

Freeman et al[15] also included contrast sensitivity as a risk factor for falls and reported that at low levels of contrast it was not associated with an increased risk of falls (Table 2). The authors used a Pelli-Robson chart to measure contrast sensitivity, which unlike the method

used by the authors mentioned above, required the participant to identify same size letters at decreasing levels of contrast. There is no research evidence showing measures of contrast sensitivity using the Pelli-Robson test are equivalent to measures using the line orientation style test. As the population studied by Freeman et al[15] was similar to that studied by the authors previously mentioned, the difference in method may explain the difference in results, highlighting the importance of using standard methods of assessment.

Lord and Dayhew[9] reported that reduced low contrast visual acuity using a vision chart where the letters are of 10% contrast which is very close in shade to the background (Figure 1), had a strong association with multiple falls (relative risk 2.08, 95% CI 1.17-3.71, at 6/18 or worse) in their study (Table 2). This level of association was similar to that reported between reduced contrast sensitivity and multiple falls in the same study (relative risk 1.93, 95% CI 1.01-3.68, at ≤ 6/18 decibels of contrast sensitivity) (Table 2). It is then likely that these two tests are measuring the same thing.

Lord and Dayhew[9] also reported that reduced low contrast visual acuity was associated with multiple falls in their study and that reduced visual acuity was not (relative risk 1.59, 95% CI 0.85-2.98 at 6/10 or worse) (Table 1), suggesting that having good contrast sensitivity may be more important than having good visual acuity in preventing falls in older people. As the cut-off for visual acuity as a risk factor for falls in the low contrast visual acuity test was different than that of the visual acuity test in this study, it is unclear if the reported association between low contrast visual acuity and falls, is due to the use of the low contrast visual acuity test or the cut-off levels.

Tiedemann et al[34] included low contrast visual acuity in the development and validation study of the QuickScreen© falls risk assessment tool. The QuickScreen© is one of a few falls risk assessment tools that includes an assessment of vision, an important risk factor for falls in older people not routinely or properly assessed. The authors conducted a study on four large cohorts (three falls risk studies and one falls prevention study) of community-dwelling older people aged 65 years and over. In all four studies the participants reported the number of falls over a period of 12 months and the definition of a fall in the study was similar to that used by Lord and Dayhew[9] and Nevitt et al,[18] excluding some fall types.

Tiedemann et al[34] used the same low contrast visual acuity chart as Lord and Dayhew[9] where the letters are of 10% contrast and very close in shade to the background (Figure 1). The authors reported that this measure of vision was associated with multiple falls at a cut-off of 2.3

Table 2. Contrast sensitivity, depth perception and falls

Elements of visual function	Method of assessment (both eyes open)	Definition of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Contrast sensitivity	VCTS-6000-1 chart for near	Impaired at low level frequencies	Age-adjusted HR 1.75 (1.17-2.60) Significant association	Recurrent fallers	de Boer et al 2004[32] (3-year follow-up period)
	Pelli-Robson Chart	At 0.3 log unit correct	Age-adjusted OR 0.96 (0.86-1.07) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Vectorvision CSV-1000 chart	At 6 cycles per degree	Age/sex-adjusted PR 1.2 (1.1-1.3) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (1-year follow-up period)
	Not described	Not described	No details Not associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Melbourne Edge Test (distance)	≤ 18 decibels contrast sensitivity	Age-adjusted RR 1.93 (1.01-3.68) Significant association	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Low contrast visual acuity (visual acuity at 10% contrast)	6/18 or worse	Age-adjusted RR 2.08 (1.17-3.71) Associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Low contrast visual acuity (visual acuity at 10% contrast)	2.3 MAR Between 6/12 and 6/15	Age-adjusted RR 1.64 (1.21-2.21) Significant association	Recurrent fallers	Tiedemann et al 2010[34] (1-year follow-up period)
Depth perception	Howard-Dohlman apparatus	≥ 2.4 cm	Age-adjusted RR 2.26 (1.24-4.14) Associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)
	Randot Circles test	> 457 seconds of arc (no depth perception)	Age-adjusted OR 1.10 (0.94-1.28) Not associated	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Described elsewhere	≥ 200 seconds of arc at 40 cms	Unadjusted RR 1.6 (1.2-2.6) Associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio, MAR minimum angle resolution. Recurrent faller ≥ 2 falls. p<0.05 signifies statistical significance

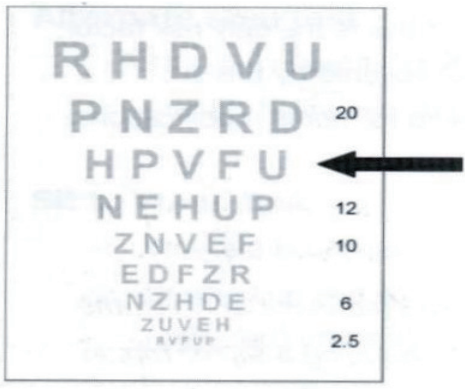

Figure 1. Balance systems low contrast (10%) acuity chart© (sample only). Reprinted from QuickScreen© by the Prince of Wales Medical Research Institute (POWMRI) 2007, p 10. Copyright 2007 by NeuRA. Reprinted with permission.

MAR (relative risk 1.64, 95% CI 1.21-2.21) (Table 2). Although statistically significant, the association was not as strong as reported by Lord and Dayhew[9] in their study.

Depth perception

Like contrast sensitivity, depth perception is another important element of vision which assists a person to safely mobilise as it allows a person to judge distances, and safely negotiate stairs and uneven walking surfaces.[6] Depth perception as a risk factor for falls was included in studies by Freeman et al,[15] Lord and Dayhew[9] and Nevitt et al.[18] Freeman et al[15] reported that reduced depth perception was not associated with falls in their study, which is inconsistent with the findings reported by Lord and Dayhew[9] and Nevitt et al[18] (Table 2). As the sampled populations were quite similar, this inconsistency may be due to the use of the Randot Circles test by Freeman et al.[15] This test has been reported to yield a high number of false negatives and may have misrepresented the association between depth perception and falls.[15] Despite the variation in method of assessment, older people who have reduced contrast sensitivity and depth perception have almost twice the risk of falling than those with less or no visual deficits (Table 2). These two elements of vision, when reduced, appear to be more useful indicators of falls risk than visual acuity for this population.

Visual fields

Visual field loss, as detected by either a full visual field assessment or a screening is not often considered as a potential risk factor for falls in older people. Nevitt et al[18] reported no association between visual field loss and falls in their sample, with the type of visual field loss not being detailed. Lord and Dayhew[9] also reported no association between visual field loss and falls in their sample, when measuring lower visual field. The method used by Nevitt et al[18] was detailed elsewhere and the method used by Lord and Dayhew[9] was a non-standard method of visual field assessment; that is, not translatable to usual measurement systems. Ivers et al[33] did use a standard method of visual field assessment (Table 3) and reported that the people in their study with central visual field loss were one-and-a-half times more likely to fall in a 12-month period than those with a normal central visual field. Also, in this particular study, central visual field loss was a stronger indicator of falls risk than reduced contrast sensitivity (Table 2).

Freeman et al[15] also used a standard method of visual field assessment (Table 3) and reported that visual field loss increases the risk of falls (odds ratio 1.08, 95% CI 1.03-1.13). Unlike the study by Ivers et al,[33] the falls data in the study by Freeman et al[15] was collected prospectively and the authors included measures of central, peripheral and total visual field. When Freeman et al[15] included central and peripheral visual field in a multiple regression model along with visual acuity, contrast sensitivity and depth perception, only peripheral visual field remained statistically significant, suggesting that peripheral visual field loss may be a more important risk factor for falls. These variations reinforce the need

Table 3. Visual field and falls

Element of visual function	Method of assessment	Level of visual impairment	Risk or Ratio (95% CI)	Faller type	Author
Visual field	Humphrey 81-point 60-degree screening each eye	At 10 points missing	Age-adjusted OR 1.08 (1.03-1.13) Significant association	Recurrent fallers	Freeman et al 2007[15] (20-month follow-up period)
	Humphrey 76 point 30-degree screening each eye	At 5 points missing	Age/sex-adjusted PR 1.5 (1.2-2.6) Significant association	Recurrent fallers	Ivers et al 1998[33] Retrospective (previous 12 months)
	Not described	Not described	No details Not associated	Recurrent fallers	Nevitt et al 1989[18] (1-year follow-up period)
	Binocular visual field angle from eye height to a target on the floor	≤ 60 degrees	Age-adjusted RR 1.25 (0.63-2.48) Not associated	Recurrent fallers	Lord & Dayhew 2001[9] (1-year follow-up period)

HR hazard risk, RR relative risk, PR prevalence ratio, OR odds ratio, MAR minimum angle resolution. Recurrent faller ≥ 2 falls. $p<0.05$ signifies statistical significance

for vision risk factors for falling to be investigated using detailed assessments with standard methods.

DISCUSSION

There is general agreement, that in comparison to other elements of vision, visual acuity is not a useful indicator of falls risk for community-dwelling older people.[9,14,15,32] Although Nevitt et al[18] reported that reduced visual acuity was associated with an increased falls risk in their study. Interestingly, it was at a more reduced level of visual acuity than usually seen in the literature.[9,14] Therefore, this finding is worthy of further investigation as visual acuity testing is often available in clinical settings.

Contrast sensitivity and low contrast visual acuity which are functionally similar elements of vision, are on the other hand consistently reported to be associated with an increased risk of falls in older people.[3,9,32,34] The ability to perceive depth, as with contrast sensitivity, assists with safe mobility. Therefore, the reported association between reduced depth perception and an increased risk of falls is understandable. In studies where findings have differed, the methods of measuring these elements of vision have also differed and perhaps explain the lack of association reported. Visual field is not commonly investigated as a risk factor in falls research.

When this element of vision has been included and tested using standard measures, the association between a reduced visual field and an increased risk of falls for community-dwelling older people is statistically significant[15,33] and a more useful indicator of falls risk than reduced contrast sensitivity and depth perception.[15,33]

CONCLUSION

The relationship between reduced vision and falls for community-dwelling older people is an important and complex one. Despite vision being an important risk factor for falls in older people it is not routinely or properly assessed. The elements of vision included in falls research include the well-known elements of visual acuity, contrast sensitivity, depth perception and visual field and more recently a less known element of low contrast visual acuity which combines visual acuity and contrast sensitivity.

The literature does suggest that although the elements of visual function such as depth perception and visual field are significant indicators of falls risk, contrast sensitivity including low contrast visual acuity is more informative regarding falls risk in this population. Despite this, the lack of standard methods of assessing vision in falls research offers the ongoing opportunity to further explore vision as a risk factor for falls for community-dwelling older people.

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