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Visual risk factors for falls in older people

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Abstract

Poor vision reduces postural stability and significantly increases the risk of falls and fractures in older people. Most studies have found that poor visual acuity increases the risk of falls. However, studies that have included multiple visual measures have found that reduced contrast sensitivity and depth perception are the most important visual risk factors for falls. Multifocal glasses may add to this risk because their near-vision lenses impair distance contrast sensitivity and depth perception in the lower visual field. This reduces the ability of an older person to detect environmental hazards. There is now evidence that maximising vision through cataract surgery is an effective strategy for preventing falls. Further randomised controlled trials are required to determine whether individual strategies (such as restriction of use of multifocal glasses) or multi-strategy visual improvement interventions can significantly reduce falls in older people. Public health initiatives are required to raise awareness in older people and their carers of the importance of regular eye examinations and use of appropriate prescription glasses.

Keywords: *vision, accidental falls, aged*

Introduction

Impaired vision can have substantial adverse effects on the ability to read, enjoy recreational pastimes and undertake activities of daily living [1–3]. Several studies, published during the past 15 years, have also shown that impaired vision adversely affects postural stability and increases the risk of falling in older people. This article reviews this body of research that has examined (i) the role vision plays in maintaining balance, (ii) visual impairments that predispose older people to falls, (iii) the effects of inappropriate glasses on vision and falls and (iv) the efficacy of visual improvement interventions for preventing falls.

Vision and balance

Vision plays an important role in stabilising balance by providing the nervous system with continually updated information regarding the position and movements of body segments in relation to each other and the environment. When people stand with their eyes closed, postural sway increases by 20–70% [4–7]. It has also been found that moving visual fields can induce a powerful sense of self-motion, and misleading visual cues induce significant increases in sway [8]. We have found that poor performances in tests of distant contrast sensitivity and stereopsis (a measure of depth perception) were independent predictors of increased sway in older people [9]. This suggests that the accurate perception of visual stimuli and depth plays an important role in providing a visual reference frame for the stabilisation of the body relative to its surroundings.

Vision and falls and fractures

Many studies of the risk of falls in older people have included measures of visual impairment as a possible risk factor. Standard tests of visual acuity have been most commonly used to measure vision; however, published findings have been inconsistent with regard to whether impaired visual acuity increases the risk of falls. On the one hand, there are several reports that indicate impaired distant visual acuity is a risk factor for falls in community-dwelling [10–13] and institutionalised older people [14]. However, other studies have not found this to be the case, particularly when confounding factors such as age are adjusted for [15–19]. Large case-control [20] and prospective studies have also assessed whether reduced visual acuity is a risk factor for hip fractures [21–23]—a serious consequence of falls in older people. Three of these found a significant association [20–22], but the fourth did not [23].

Whereas visual acuity measures fine detail vision, contrast sensitivity tests assess a person's ability to detect edges under low-contrast conditions and may more accurately reflect capacity to detect ground-level hazards. Thus, a loss of edge-contrast sensitivity may predispose older people to trips over obstacles within the home, and outdoor hazards such as steps, kerbs and pavement cracks and misalignments. In a series of studies, we have found tests of edge-contrast sensitivity, rather than visual acuity, to be more strongly associated with falls [12, 15, 24]. This was also the case in the Blue Mountains Eye Study, which compared the predictive power of a range of visual tests, including visual acuity and visual field size [10]. Reduced contrast sensitivity has also been found to be an important risk factor for multiple falls [25] and fractures [25] in large prospective fracture epidemiology studies.

Reduced depth perception has also consistently been found to be a significant risk factor for falls and fractures. Nevitt *et al.* [11] found that older persons who had poor stereoacuity were at significantly higher risk of suffering recurrent falls, and Cummings *et al.* [23] and Ivers *et al.* [20] have reported that poor depth perception was an important risk factor for hip fracture. We have recently found that of nine measures of vision, impaired depth perception was the strongest risk factor for multiple falls in 156 community-dwelling older people [24]. Furthermore, subjects with good vision in both eyes had the lowest rate of falls, whereas subjects with good vision in one eye but only moderate or poor vision in the other had elevated falling rates—equivalent to those with moderate or poor vision in both eyes Figure 1. This suggests that the ability to judge distances accurately and perceive spatial relationships is important for negotiating and avoiding obstacles and hazards in the environment. Further support for impaired depth perception being a risk factor for falls also comes from a study by Felson *et al.* [21], who found that older persons who had good vision in one eye, but only moderately good vision in the other, had an elevated hip fracture risk.

Ivers *et al.* [10] found that visual field loss, although not as important as contrast sensitivity and visual acuity, was an independent risk factor for falls. Klein *et al.* [13] also reported that visual field loss was associated with both multiple falls and fractures in the Beaver Dam Eye Study. By contrast, Nevitt *et al.* [11] reported no significant association between visual field loss and recurrent falls, and Glyn *et al.* [26] found that visual field loss was only weakly associated with falls in patients attending a glaucoma clinic.

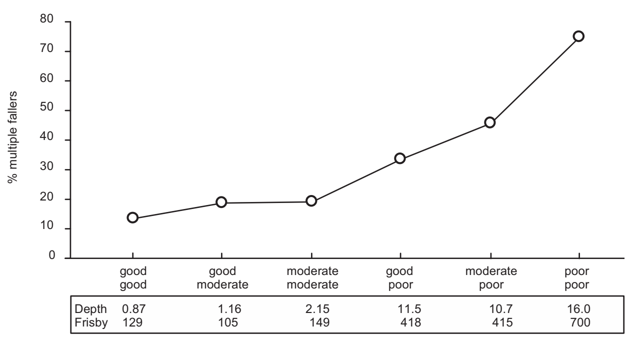

Figure 1. Proportion of subjects who suffered multiple falls classified with respect to visual acuity in left and right eyes. Visual acuity classification expressed as Snellen fractions: good ≤6/7.5; moderate 6/9–6/24; poor ≥6/30 [21]. The depth perception scores relate to errors (measured in cm) subjects made when attempting to align two vertical rods equidistant using the Howard-Dohlman device [34]. Scores of ≥2.4 cm were associated with a 2.26 increased risk of falls (95% CI = 1.24–4.14) [24]. Frisby scores provide a measure of stereoacuity in seconds of arc [35]. Scores of ≥215 s arc were associated with a 1.99 increased risk of falls (95% CI = 1.11–3.59) [24].

Inappropriate glasses

Many older people who wear glasses with outdated prescriptions or no glasses at all would benefit from wearing new glasses with correct prescriptions [3, 27, 28]. This indicates that older people are not aware of their declining vision and/or do not perceive the benefits of regular vision assessments and updated glasses outweigh risks to safety and lifestyle. Reduced access to eye care may also comprise an important barrier for some frail older people.

Irrespective of the correction for distance vision, multifocal (bifocal, trifocal or progressive lens) glasses may pose a significant risk of falling for older people. These glasses have benefits for activities that require changes in focal length, including everyday tasks of driving, shopping and cooking. However, multifocal glasses may predispose older people to falls because viewing the environment through their lower lenses impairs the important visual capabilities (contrast sensitivity and depth perception) for detecting environmental hazards, particularly in unfamiliar environments. When walking, people view the environment at distances approximating two steps ahead [29]. For multifocal wearers, the lower lenses of their glasses (with focal lengths of 0.6 m) blur their lower visual fields, impairing vision at the critical focal distances required for detecting and discriminating floor-level objects (~1.5–2 m).

We recently examined the effects of multifocal glasses on vision and falls in older people [30]. In this prospective cohort study of 156 participants aged 63–90 years, 56% were regular wearers of multifocal glasses. These participants performed significantly worse in distant depth perception and edge-contrast sensitivity tests in conditions which forced them to view test stimuli through the lower segments of their glasses (Figure 2). Multifocal glasses wearers had significantly greater odds of falling in the 1-year follow-up period than non-multifocal glasses wearers (OR = 2.27, 95% CI = 1.04–4.97), when adjusting for age and known physiological risk factors for falls. Multifocal glasses wearers were also more likely to fall when outside their homes (OR = 2.54, 95% CI = 1.19–5.77), and when walking up- or downstairs (P<0.001).

Visual interventions for preventing falls

As visual loss is often correctable in older people [3, 27, 28], simple intervention strategies such as regular eye examinations, use of correct prescription glasses, cataract surgery and the removal of tripping hazards in the home and public places have the potential to prevent falls in older people. Our finding that multifocal glasses is a risk factor for falls in community-dwelling older people [30] indicates that the use of single-lens distance glasses instead of multifocal glasses in higher-risk situations such as negotiating stairs, walking outside the home and using public transport may also reduce the risk of falling.

Two randomised controlled trials have evaluated the efficacy of discrete visual interventions as a strategy of preventing falls [31]. The first involved 1090 subjects aged 70 years and over and used a factorial design to assess the independent and combined effects of interventions aimed at vision improvement, home hazard reduction and group exercise. The visual improvement intervention comprised

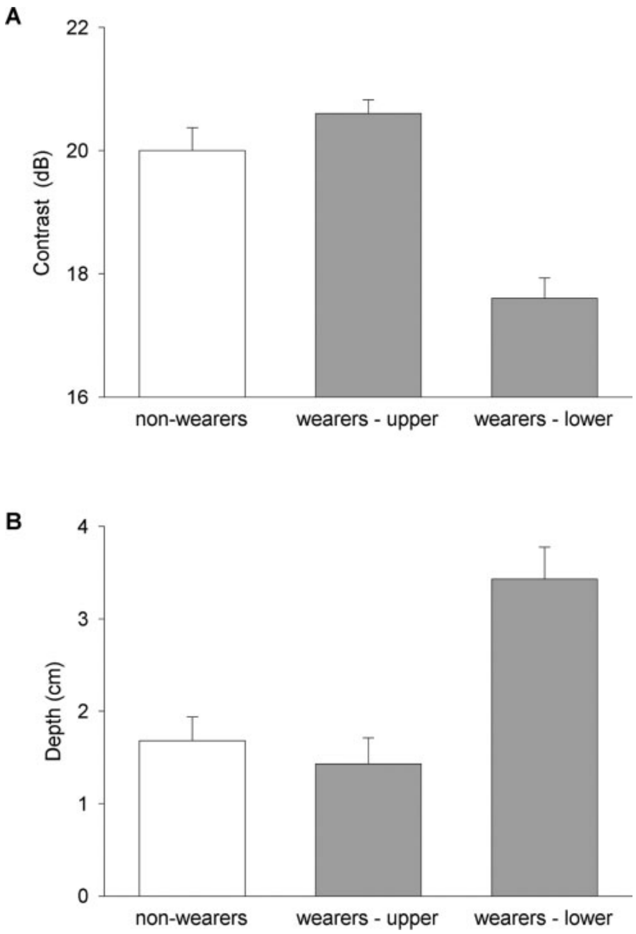

Figure 2. Mean contrast sensitivity (panel a) and depth perception (panel b) test scores for subjects wearing their usual glasses if applicable. For the multifocal glasses wearers (n = 87), two scores are given: for the upper and lower glasses segment viewing conditions. The 'non-wearers' group comprised 67 subjects wearing single-lens distance glasses and two subjects wearing no glasses. These data show that the multifocal wearers had vision comparable to non-wearers when looking through their upper glasses segments, but significantly worse vision when looking through their lower glasses segments. Error bars indicate 1 standard error.

a referral to the participant's usual eye-care provider if the participant had impaired vision (poor visual acuity, decreased stereopsis and/or reduced field of view) and he or she was not already receiving treatment for this problem. The eye-care provider was also given the screening assessment results. Those randomised to the visual intervention had an estimated reduction of 4.4% in the annual rate of falls (rate ratio for time to first fall = 0.89, 95% CI = 0.75–1.04), but this did not reach statistical significance.

The second trial examined the effects of cataract surgery with lens implantation on falls, fractures and health status in 306 women aged ≥70 years [32]. Subjects were randomised to either expedited (~4 weeks) or routine (12-month wait) surgery. Vision, visual disability, physical activity levels, anxiety, depression, balance confidence and handicap improved significantly in the operated group at the 6-month retest and over the 12 months of follow-up, the rate of falling in the operated group was reduced by 34% compared with the controls (incedent rate ratio = 0.66, 95% CI = 0.45–0.96). Although the number of cases were few—four subjects in the operated group (3%) and 12 (8%) in the control group—this trial also demonstrated that an intervention for preventing falls can be effective in reducing fractures (P = 0.04).

In a recent multifactorial randomised controlled trial intervention for preventing falls, we included an intervention aimed at maximising vision in 620 community-dwelling people aged ≥75 years [33]. Participants randomised to the intervention with impaired visual acuity, contrast sensitivity and/or depth perception were referred to an eye-care specialist and were provided with new glasses as required. In addition, these participants were counselled to wear single-lens glasses (as opposed to multifocal glasses) when walking outside the home and underwent cataract surgery if indicated. Visual assessments were performed at baseline and at the 6-month time-point of the study to determine whether the intervention resulted in vision improvements. We found that in the participants randomised to the visual intervention, high and low contrast, visual acuity and edge-contrast sensitivity were maintained or were better at the follow-up assessment. In comparison, participants not randomised to this intervention demonstrated poorer scores in the visual tests, which may reflect age-related declines and use of non-optimal glasses. Table 1 summarises the baseline and retest scores for the visual test measures for the intervention and control groups.

Conclusions

Vision makes an important contribution to balance, and impaired vision is a significant independent risk factor for falls and fractures in older people. Reduced ability to detect low contrast hazards, judge distances and perceive spatial relationships appears to be the major visual impairment associated

Table 1. Baseline and retest scores for visual acuity and edge-contrast sensitivity tests for the intervention and control groups

	Intervention (n = 64)		Control (n = 69)	
Test variable	Baseline mean (SD)	6-month retest mean (SD)	Baseline mean (SD)	6-month retest mean (SD)
Visual acuity high (MAR)	1.4 (0.5)	1.3 (0.6)***	1.3 (0.5)	1.7 (2.0)
Visual acuity low (MAR)	2.7 (1.4)	2.7 (1.6)**	3.0 (3.6)	3.7 (4.9)
Edge-contrast sensitivity (dB)	17.8 (1.9)	18.5 (2.3)*	18.3 (2.5)	18.0 (2.8)

Vision improved in the intervention subjects over the trial period and deteriorated in the controls. Differences between intervention and control groups at retest adjusting for baseline scores: *P<0.05, **P<0.01, ***P<0.001. MAR – Minimum angle of letter segments resolvable in minutes of arc (1.00 is equivalent to Snellen 6/6 vision). dB – decibels (ranging from 1 – poor vision to 24 – good vision).

with falls. Multifocal glasses may add to the risk of falls because in older people near-vision lenses impair distance contrast sensitivity and depth perception in the lower visual field, reducing their ability to detect environmental hazards. There is now evidence that maximising vision through cataract surgery is an effective strategy for preventing falls. Further randomised controlled trials are required to determine whether individual strategies (such as restriction of use of multifocal glasses) or multi-strategy visual improvement interventions can significantly reduce falls in older people. Public health initiatives are required to raise awareness in older people and their carers of the importance of regular eye examinations and use of appropriate prescription glasses. Many older people may also benefit from wearing only single-lens glasses when walking. This would appear to be particularly important when walking up- or downstairs and in unfamiliar settings outside the home.

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