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OLDER FALLERS WITH SELF-REPORTED DIZZINESS HAVE HIGH LEVELS OF ANXIETY AND DEPRESSION AND ADOPT A STIFFENING STRATEGY WHEN EXPOSED TO OPTOKINETIC STIMULI

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Abstract: *Background: Objective:* Many people with dizziness can develop visual dependence, an over-reliance on vision for spatial orientation. Specific visual environments including optokinetic visual stimuli can elicit feelings of disequilibrium and is known to result in increases in postural instability in patients with anxiety and vestibular dysfunction. Our study aims to investigate dizziness and postural sway in various visual conditions in a group of older people referred to a falls clinic. *Design:* We investigated postural sway in six visual conditions in a group of older people referred to a falls clinic with and without self-reported dizziness. *Setting:* South Australian Movement Analysis Centre, Repatriation General Hospital, South Australia. *Participants:* 100 adults (41 male) with a mean age of 82 years (range 66-94 years) participated. *Measurements:* We collected data on self-reported dizziness, space and motion discomfort, anxiety, depression and fear of falls. Postural sway, measured by Centre of Pressure (CoP) path length, was assessed with eyes open, eyes closed and when exposed to two linear and two rotating types of optokinetic stimuli (OKS). *Results:* 36 participants (36%) reported suffering dizziness. These participants had significantly higher levels of anxiety and depression, and demonstrated significantly shorter CoP path lengths for all six balance conditions compared to those without dizziness ($p<0.05$). The "forward" OKS, however, induced relatively greater sway in the dizzy participants. *Conclusions:* These findings suggest that dizziness is common in older fallers and that it contributes to a stiffening strategy to maintain standing balance. Vestibular rehabilitation using OKS for older fallers with dizziness warrants investigation in further research studies.

Key words: Dizziness, anxiety, depression, fallers, balance.

Introduction

Dizziness is a frequent complaint in older people, with a prevalence ranging between 10% (1, 2) and 30% (3, 4). Dizziness symptoms can be debilitating and lead to reduced quality of life (5), self-reported functional disability (6), poor health (4), depression (4, 7), fear of falling and restricted participation in social activities (8). Further, findings from a recent meta-analysis of 74 prospective studies indicate dizziness/vertigo is an important risk factor for falls in older community-dwelling people (9).

Vestibular dysfunction is a common cause of dizziness and many people with this condition can develop visual dependence and describe symptoms of imbalance and/or dizziness that can be elicited by specific visual conditions. This particular phenomenon has also been described as 'Space and Motion Discomfort' (SMD) (10). SMD can be triggered by many situations with complex visual flows; i.e. when walking along a supermarket aisle, being a passenger in a vehicle, or when exposed to open spaces, crowds or heights.

Full field visual motion has been shown to increase sway responses in patients suffering with 'visual vertigo' (11). In a study of postural control and spatial orientation, participants with 'visual vertigo' and bilateral labyrinthine loss were found to be destabilized more by a rotating visual stimulus compared to healthy controls (12). Increased roll vection or visual field dependence has also been shown to be a significant discriminator between older fallers and non-fallers (13).

Related studies have also shown that people with anxiety, a condition often co-occurring with dizziness, are more likely to be influenced by dynamic visual stimuli. For example, it has been found that patients with anxiety disorders swayed significantly more compared to

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controls when exposed to visually induced postural sway. Further, within the anxious group, those with SMD swayed more than those without SMD, suggesting that a self-report of SMD identifies those people who are sensitive to optic flow (14).

No studies have investigated whether older fallers who report dizziness are also more likely to be anxious, suffer from SMD and/or be affected by linear and rotating visual fields. This information could greatly assist with the clinical management of this group. The primary objectives of this study therefore were to determine the prevalence of dizziness in a group of elderly fallers, to determine whether dizziness is associated with space and motion discomfort, anxiety, depression and fear of falling, and investigate whether self-reported dizziness influences postural sway under static and dynamic visual conditions.

Methods

Participants

100 adults (41 male) with a mean age of 82 years (range 66-94 years) who attended the outpatient Falls Clinic at the Repatriation General Hospital, Adelaide, South Australia were recruited for the study. 84 participants reported one or more falls in the previous year and the remaining 16 were referred for investigation of balance problems. Participants were excluded if they were unable to stand unassisted for 60 seconds. The study was approved by the Flinders Human Research Ethics Committee (FHREC) and participants provided written informed consent before participating in the study.

Assessments

Self reported number of falls in the past year and self reported dizziness were recorded. Questionnaires completed by the participants included;

- The Goldberg Anxiety and Depression Scale (GAD). A 50% chance of clinically important disturbance in anxiety and depressive symptoms can be defined as scale scores >5 and >2 respectively (15). The GAD has been validated as self-rating scale (16). It has previously been used as a continuous measure in other research studies involving older people (17, 18).
- The Situational Characteristics Questionnaire Part II measures space and motion discomfort (SMD). It includes 9 situations for which participant rate how uncomfortable they feel from 0-3. Situations include aerobic exercise, rolling over in bed, closing eyes in the shower, looking up at tall buildings, leaning far back in a chair, reading a newspaper close to the face, riding on a roller coaster, dancing, as well as degree of discomfort as the day progresses (19). The presence of SMD can be defined as a scale score > 2 (20).
- The Falls Efficacy Scale – International (FES-I) 16 part questionnaire (21). An elevated fear of falling of high concern was defined as a FES-I score > 23 (22).

Standing balance

Standing balance tests were conducted barefoot with feet positioned comfortably apart so that each foot was positioned on one of two adjacent force platforms (AMTI, Watertown, MA). Up to two standing balance trials, each of 30 seconds duration, were recorded for each of six conditions including two roll vection stimuli and two linear optic flow stimuli. The six conditions were: eyes open with no visual stimuli (EO), eyes closed (EC), forwards optic flow (FW), backwards optic flow (BW), clockwise roll vection (CW), and counter-clockwise roll vection (CCW). Visual stimuli were projected onto a hemi-spherical immersadome positioned 0.6m in front of the participant. Participants were instructed to look at the centre of the projected video image. Each participant attempted each condition twice, completing up to 12 standing balance trials, with the order of conditions randomised across the trials.

During each standing trial, centre of pressure (CoP) data was acquired from each force platform at 100Hz using Nexus v1.4 software (Vicon, Oxford, UK). Mean sway parameter values were calculated for each participant who completed two trials of each condition. The resultant antero-posterior (AP) and medio-lateral (ML) CoP data from the two force platforms was calculated and filtered using a General Cross Validation Woltring Spline filter. The first two seconds of data from each trial was discarded before calculating the following the CoP trajectory path length (CoP path length, mm). The Rhomberg quotient (ratio of sway EC: sway EO) was calculated to assess the effect of eye closure on sway and a range of other kinetic quotients (BW,FW,CW,CCW / EO) were calculated to assess the destabilising effect of the optokinetic stimuli.

Statistical Analysis

Differences between non-multiple fallers (0-1) and multiple fallers (2+) were analysed using Chi Square for categorical variables and independent sample t-tests for normally distributed continuous variables. For continuous variables with skewed distributions, data were normalised and all parametric analyses were conducted on normalised data. SPSS version 19 was used for all analyses.

Results

Prevalence and correlates of dizziness

36 participants reported dizziness. Of these, 15 (42%) and 29 (81%) had 50% chance of a clinically important disturbance in anxiety and depression respectively. The FES-I was introduced late into the study. 47 of the 66 participants (71%) who completed the FES-I had a high level of concern about falling when undertaking activities of daily living. The dizzy participants scored significantly higher on the Goldberg Anxiety (p=0.016) and Depression (p=0.010) scales (table 1).

Table 1
Comparisons of dizzy and non-dizzy elderly fallers

	Dizzy (n=36)	Non-Dizzy (n=63)	Total (n=99)	P
Age	82.42 (4.9)	82.6 (6.9)	85.5 (6.2)	.897
Male (%)*	15 (41.6%)	26 (41.3%)	41	.970
Mean Falls in last year	2.58 (1.56)	2.53 (1.42)	2.56 (1.47)	.887
Goldberg – Anxiety	3.08 (2.72)	1.75 (2.54)	2.23 (2.68)	.016
Goldberg – Depression	4.17 (2.52)	2.84 (2.34)	3.32 (2.48)	.010
Sit_Q_II	7.87 (6.88)	5.68 (5.44)	6.07 (6.06)	.087
FES-I**	30.55 (7.86)	28.28 (10.83)	28.97 (10.02)	.402

All values are mean (SD) except *number (%) male; **FES-I Dizzy n=20, Non-Dizzy n=46

Dizziness and Sway

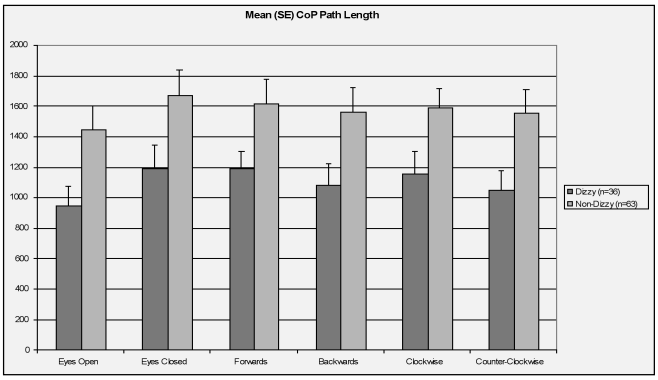
Of the 100 participants, 1 person was unable to complete the questionnaires due to time restraints. The dizzy group had significantly shorter CoP path lengths than the non-dizzy group in all conditions (p<0.05) (figure 1). No significant differences were found between the groups for Romberg's quotients (EC/EO sway). The dizzy group had higher kinetic quotients than the non-dizzy group for all optokinetic conditions with a significant increase for the path length in the FW condition (table 2).

Table 2
Quotient of each condition over Eyes Open for the group and for dizzy and non-dizzy participants

	Condition Quotient over Eyes Open	Dizzy Mean (SE)	Non-Dizzy Mean (SE)
CoP Path length	EC	1.34 (0.09)	1.27 (0.05)
	FW	1.45 (0.10)	1.22 (0.04)*
	BW	1.17 (0.05)	1.12 (0.03)
	CW	1.23 (0.06)	1.18 (0.04)
	CCW	1.16 (0.04)	1.15 (0.03)

* Non-dizzy significantly less than Dizzy (p<0.05)

Figure 1
Sway pathlength in dizzy and non-dizzy elderly fallers



Discussion

The prevalence of self-reported dizziness in this study (36%) is higher than prevalence rates previously reported for general populations of older people (23, 24), which is likely due to the current study population being at increased risk of falls. We found that dizziness was significantly associated with higher levels of anxiety (p=0.016) and depression (p=0.010), which is consistent with other studies that have also showed that dizziness in older people is associated with reduced quality of life (25).

A previous large epidemiological study has shown an association between self reported dizziness and depression (2). Our study also supports this finding although it remains unclear as to the direction of causality. Depression is likely to be major contributor to a downward decline in health associated with reduced activity. These findings suggest that measures of dizziness and depression should be included in fall risk assessments, with intervention strategies aimed at targeting both conditions.

Participants with self-reported dizziness had significantly shorter CoP path length than those without dizziness, which may be attributed to a increased stiffening for balance control. Increased muscle co-activation at the ankle in standing has been shown to increase the elderly, particularly in those with low balance ability (26). This 'stiffening strategy' has been observed in response to a postural threat (standing on the edge of a raised platform) in both young and older people (27). Postural sway has also been shown to reduce in elderly participants when performing a visual searching task as well as in people with dizziness when performing a mental task (28, 29). It has been previously found that OKS does not increase sway amplitude in vestibular patients (30).

Kinetic quotients measure changes in sway during the OKS conditions relative to the participant's sway with EO. The OKS conditions had a destabilising effect on all participants as indicated by all OKS/EO quotient ratios greater than 1. The quotient results show that while the

'stiffening strategy' remained, the FW condition did have a significant destabilising effect on balance in dizzy subjects. This effect of destabilisation when exposed to OKS has also been found in studies involving people with anxiety (14, 31), vestibular disorders, 'visual vertigo' and in those with labyrinthine dysfunction (31). It is therefore likely that the shorter path length we observed in elderly fallers with dizziness may be due to a combination of increased fear, anxiety and the destabilising postural threat associated with OKS stimulation in these standing conditions.

We acknowledge that this study has certain limitations. First, the measure of dizziness relied on self-report, and no formal diagnosis of dizziness was made. This may have obscured relationships for dizziness sub-types as Kanter and colleagues have demonstrated marked differences in sway for people with different diagnoses of dizziness (32). Second, it was assumed that in OKS conditions the immersadome occupied the participants' visual fields. It is possible that participants used peripheral visual cues (reference points outside the immersadome) while undertaking the tests. However, this would only have diminished the OKS effects and it is unlikely this would have differentially influenced either the dizzy or non-dizzy group.

In summary, our findings indicate that dizziness is common in elderly fallers and is associated with higher levels of anxiety and depression. The dizzy group appear to adopt a 'stiffening strategy' for standing balance, yet relative to their own sway, exposure to visual motion has a greater destabilising effect when compared to those without dizziness.

There is emerging evidence that vestibular rehabilitation is efficacious for patients suffering with SMD-type symptoms such as agoraphobia (33) and resolving aspects of visual dependence in balance with the use of visual-vestibular conflict and optokinetic stimulation is becoming an intervention strategy within vestibular rehabilitation (12, 33-35). For example, visually induced sway in healthy controls can be improved with graded exposure to visual stimulation (36) and simulator based rehabilitation can assist vestibular rehabilitation in patients with refractory dizziness (35). Wide field of view screens and virtual reality systems are also now being considered for this type of therapy (34, 37). Increased muscle co-activation for postural control in the elderly has also been shown to reduce following balance training (38). These therapies may prove to be efficacious for older people with dizziness at risk of falls and warrant investigation in further research studies.

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