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ORIGINAL ARTICLE

The association between fear of falling and orthostatic hypotension in older adults

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Abstract

The aim of this study was to determine the relationship between the fear of falling/the degree of fear of falling (FoF) and orthostatic hypotension (OH) in older adults. This cross-sectional study was conducted with 314 older outpatients. If the total score of the Falls Efficacy Scale–International scale was 16–19, 20–27 and ≥ 28, it was assumed that there was low FoF, moderate FoF and high FoF, respectively. OH was evaluated for the 1st (OH1) and 3rd (OH3) minutes, after transitioning from the supine position to standing. Participants were aged 65–93 years (mean age 74.2 ± 8.5 years) and 193 (61.5%) were female. Among the FoF groups, significant differences were found for age, gender, education, marital status, who the patient lived with, the history of falling and hypertension, Timed Up–Go test score and hemoglobin levels ($p < 0.005$). The prevalence of OH1 and OH3 was found to be significantly higher in those with an FoF score of 20 and above than those below 20 ($p < 0.005$). After adjustment for potential confounders, participants who reported a high FoF had higher risk for OH1 and OH3 (OR 2.14, 95% CI 1.14–4.0, $p = 0.017$; and OR 2.72, 95% CI 1.46–5.09, $p = 0.002$, respectively), but those with moderate FoF had no increased risk of having OH compared to low FoF ($p > 0.05$). There is a close relationship between high FoF and OH in older adults. Therefore, when evaluating an older patient with OH, FoF should be evaluated, or FoF should also be questioned in older patients with OH.

Keywords Fear of falling · Orthostatic hypotension · Older

Introduction

Orthostatic hypotension (OH) is common in older adults and its prevalence varies between 20 and 40% depending on the evaluation method or the time elapsed after standing up from the lying position [1]. Insufficiency in arterial baroreflex sensitivity and a decrease in renin–angiotensin aldosterone level as well as its sensitivity may aid in the development of OH in older people [2]. However, neurodegenerative diseases such as Parkinson's disease, diabetes mellitus, malnutrition, frailty, dehydration, or drugs used (such as antihypertensive drugs, levodopa, antidepressants and benzodiazepines), which increase with aging, further increase the possibility of this condition [3–6]. For these reasons, negative clinical problems associated with OH are more common in older people.

In an umbrella review compiling all the latest published observational studies, OH was found to be associated with falling, coronary heart disease, congestive heart failure, stroke, dementia and all-cause mortality [7]. OH may result in decreased physical activity and decreased functionality

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owing to associated symptoms when being active such as dizziness, blackouts, temporary loss of consciousness, weakness, nausea and drowsiness [8, 9]. Therefore, patients may develop fear of being mobilized owing to fear of falling (FoF) that may consequently increase risk of repeated falls over time. However, although the studies carried out so far have shown the relationship of OH with falling, it is not known whether FoF, which is as important as falls in geriatric practice, is associated with OH [10].

The aim of this study was to determine the relationship between FoF/the degree of FoF and the 1st and 3rd minutes of OH in older people.

Methods

Participants

This cross-sectional study was conducted with 314 adult participants aged 65 years and over, who were referred to one geriatric clinic in Turkey between August 2018 and March 2019. Inclusion criteria included: age 65 years and over, applying to the clinic for any health reason and the ability to understand and answer questions. Patients who refused to participate, participants diagnosed with dementia or unable to complete FoF questionnaires, and patients with serious illnesses that may impair the general health condition such as acute cerebrovascular accident, sepsis, acute renal failure, acute coronary syndrome and acute respiratory failure were excluded from the study. Patients' age, gender, level of education, concurrent systemic and chronic diseases and number of medications used were recorded. During admission, patients were asked whether they had fallen in the previous year and the previous month. History of hypertension, coronary artery disease, congestive heart failure, diabetes mellitus, hyperlipidemia, peripheral arterial disease, chronic obstructive pulmonary disease, osteoporosis, thyroid disease and cerebrovascular disease were determined by patients' self-report.

The Falls Efficacy Scale—International (FES-I) [11]

FES-I was used to determine and classify FoF. The scale consists of 16 questions and 1–4 points are assigned to each question. FoF was classified according to the total score given to the questions. Total FES-I scores range from minimum 16 (no concern about falling) to maximum 64 (severe concern about falling). In addition, if the total score of the FES-I scale was 16–19, 20–27 and ≥ 28, it was assumed that there was low FoF, moderate FoF and high FoF, respectively. Timed Up and Go test (TUG) were also used for evaluation gait and balance function.

Orthostatic hypotension (OH) [1]

The blood pressure of patients was measured in the supine position and after standing up for the diagnosis of OH. Blood pressure measurements were carried out in an environment away from noise and temperature in accordance with the correct measurement rules. The patients were informed about avoiding exercise and not eating or drinking (caffeinated beverages such as coffee, tea, cola, cigarettes) 30 min before their appointment. Moreover, the patients then waited for 30 min before measurements were taken. Blood pressure was measured in the supine position, and after the patient stood up, and at the 1st and 3rd minutes. For the measurement of blood pressure, a calibrated Omron M2 Compact (HEM 7102-E) device that meets the requirements of the international protocol was used. OH was defined as a decrease in systolic and/or diastolic blood pressure ≥ 20 and/or ≥ 10 mmHg, respectively, when an individual moved from the supine position to the upright position. For example, the diagnosis of OH in the 1st min was made by the presence of systolic OH in the 1st min and/or diastolic OH in the 1st min.

Laboratory findings

To evaluate the biochemical relationship of FoF and the metabolic condition, blood samples were collected in the morning after at least 8 h of fasting. Venous blood samples were drawn into a standard biochemical tube for biochemical assay from all patients. Complete blood count, kidney, liver and thyroid function tests, electrolytes and vitamin D were recorded.

Statistical analysis

Histogram, q–q graphs and Shapiro–Wilk test were used to evaluate data normality. Levene test was performed to evaluate variance homogeneity. To compare the differences among groups, independent samples *t* test, one-way analysis of variance (ANOVA) and Kruskal–Wallis tests were used for continuous variables, while Pearson Chi-square analysis were used for categorical variables. For post hoc comparisons, Tukey, Tamhane T2, Dunn-Bonferroni and Bonferroni-adjusted *z* test were applied. Relationships between FoF groups and OH groups were investigated using multiple binary regression models adjusted for all potential confounders including age, gender, education, marital status, living arrangement, history of falls, diabetes, cardiovascular disease, hypertension, TUG time scores, hemoglobin level and vitamin D deficiency. All statistical analyses were performed using the Statistical Package for the Social Sciences 22.0

(SPSS Inc.). p values below 0.05 were considered statistically significant. The required number of samples was calculated as at least 276 patients, with an acceptable 5% error and 95% confidence level.

Results

A total of 314 participants were included in the study aged 65 to 93 years (mean age 74.2 ± 8.5 years), and 193 (61.5%) were female. Of the 314 older adults admitted to the clinic, 30.6, 29.6 and 39.8% were in the low FoF, moderate FoF and high FoF groups, respectively. OH was examined at 1 and 3 min after standing up, and the prevalence of OH1 and OH3 was 20.3 and 21% in the study population, respectively. In patients with high FoF, the prevalence of OH1 and OH3 was 28 and 31.2%, respectively. The comparison of patients characteristics according to FoF's groups is summarized in Table 1. Among these groups, significant differences were found for age, gender, education, marital status, who the patient lived with, the history of falling in the past year and last month, TUG test scores, hemoglobin level and hypertension ($p < 0.005$).

The prevalence of OH1, systolic OH1 and OH3, and systolic and diastolic OH3 were found to be significantly higher in those with a FoF score of 20 and above than those below 20 ($p < 0.005$).

According to those with low FoF (FES-1 score 16–19), the risk of OH in the moderate FoF and high FoF groups is shown in Table 2. Participants who reported a high FoF had higher risk for OH1 and OH3 (OR 2.14, 95% CI 1.14–4.0, $p = 0.017$; OR 2.72, 95% CI 1.46–5.09, $p = 0.002$, respectively), after adjustment for all potential confounders including age, gender, education, marital status, living arrangement, history of falls, diabetes, cardiovascular disease, hypertension, TUG time scores, hemoglobin level and vitamin D deficiency. However, after adjustment for the same confounders, those with moderate FoF had no increased risk of having OH compared to low FoF ($p > 0.05$).

It was determined that there was a significant relationship between 7 items of FoF and 1 min OH, and 14 items of FoF with 3 min OH ($p < 0.005$). Supplementary Table 1 shows which items of FoF are related to OH in the 1st and 3rd min. The presence of OH according to scores from each FES-1 questions is also shown in this table.

Discussion

In this study, it was observed that moderate and high FoF is common in the elderly (30 and 40%, respectively). It was found that there was a higher FoF in women, those living alone, living with relatives or caregivers, those with a history of falling in the past month or in the past year, and with hypertension. It was observed that advanced age, low hemoglobin and prolonged TUG test were associated with increased FoF. Moreover, it was observed that the OH prevalence of the first and third minutes increased as FoF from low to high grade increased.

FoF may be an important correlate for the development of disability in older adults [12] The prevalence of FoF is 20–39% among older adults [12–14]. In the present study, the percentage of participants who stated that they had low FoF, moderate FoF and high FoF was 30.6, 29.6 and 39.8%, respectively. The reason for these high ratios may be owing to differences in populations studied (community-dwelling older adults versus outpatients). On the other hand, studies conducted in health institutions have been shown to be as high as the present study [15, 16]. These results underscore the importance of evaluating FoF in older adults who are admitted to the hospital with any health problems. The finding that FoF is seen more frequently in older women than men, compatible with sevral previous studies. Indeed, older women compared to older men are more likely to avoid activity due to pain. Moreover, decrease in muscle strength or musculoskeletal problems such as degenerative arthritis are more common in older women than older men [13, 17]. This may result in over-fear of falling among older women. In those who live alone, if they fall, maybe not being able to get up for an extended period of time, or the absence of anyone to lift them off the ground, may cause a heightend FoF. On the other hand, FoF may be high in people living with relatives or caregivers, as they may be affected by their functional capacity to live alone at home. The relationship between prolonged TUG test and increased FoF supports this hypothesis.

Both OH and FoF have many common adverse outcomes such as cognitive impairment, functional impairments, depression and poor quality of life in the older adults [18]. However, the number of studies investigating the relationship between these two situations is very limited. In this study, it was found that there was a positive correlation between the presence of FoF and OH and, also, OH was more frequent, especially in those who described high FoF. Since the present study is cross-sectional, the direction of the association is not known, that is, whether FoF leads to OH or whether OH leads to FoF. Nevertheless, some possible mechanisms can explain this relationship. Depending on OH, recurrent falls and problems with gait and balance in older adults can lead to decreased functionality, thus resulting in physical inactivity and consequently may contribute to the development of FoF. OH causes sudden reduction in brain perfusion and oxygenation within a few minutes of postural change; this may result in symptoms such as dizziness, postural lightheadedness, vertigo and blurred vision in those with

Table 1 Comparison of demographic data, laboratory results and orthostatic blood pressure changes with fear of falling groups obtained from FES-I scores

		FES-I scores			
		16–19 (*n* = 96)	20–27 (*n* = 93)	≥ 28 (*n* = 125)	*p*
Age	Year	71.57 ± 5.97	72.81 ± 6.18	74.13 ± 7.14	0.016
Sex	Female	45 (23.2)	63 (32.6)	85(44.0)	0.002
	Male	51 (42.1)	30 (24.8)	40(68)	
Education (years)	none	33 (23.6)	51 (36.4)	56 (40)	0.027
	1–5	52 (26)	37(24.7)	61(40.7)	
	5-over	8 (38.1)	4 (19)	6 (28.6)	
Marital status	Married	79 (33.7)	77 (32.9)	78 (33.3)	< 0.001
	Widowed	17 (21.2)	16 (20.0)	47 (58.7)	
Living arrangement	Alone	16 (28.5)	13 (23.1)	27 (48.2)	< 0.001
	Spouse	80 (31.0)	80 (31.0)	98 (38.0)	
Falling (last year)	Yes	9 (16.9)	14 (26.4)	30 (56.6)	0.014
	No	87 (33.3)	79 (30.3)	95 (36.4)	
Falling (last month)	Yes	3 (15)	2(10)	15 (75)	0.004
	No	93 (31.6)	91 (31)	110 (37.4)	
Polypharmacy	Yes	15 (35.7)	14 (33.3)	13 (31)	0.449
	No	81 (29.7)	79 (29)	112 (41.2)	
DM	Yes	38 (39.1)	26 (26.8)	33 (34)	0.084
	No	58 (26.7)	67 (30.9)	92 (42.4)	
Cardiovascular disease	Yes	11 (20)	14 (25.5)	30 (54.5)	0.078
	No	85 (32.8)	79 (30.5)	95 (36.7)	
HT	Yes	50 (24.3)	63 (30.7)	92 (44.9)	0.003
	No	46 (42.2)	30 (27.5)	33 (30.2)	
Depressive symptoms	Yes	8 (25.8)	9 (29)	14 (45.2)	0.776
	No	88 (31.1)	84 (29.7)	111 (39.2)	
TUG (3 m)		10 (7–20)	11(7–22)	14(0–44)	< 0.001
Laboratory findings					
Glucose	mg/dL	120 (102–158)	113 (100–138)	109 (100–133)	0.153
Hemoglobin	g/dL	14.78 ± 1.56	13.95 ± 1.60	13.35 ± 1.56	< 0.001
TSH	mg/dL	1.26 (0.80–2.28)	1.06 (0.69–1.89)	1.16(0.69–1.86)	0.516
Deficiency of Vitamin D	Yes	71 (28.6)	77 (31)	100 (40.3)	0.308
	No	25 (37.8)	16 (24.2)	25 (37.9)	
Orthostatic blood pressure changes					
Systolic OH (first minute)	Yes	2 (7.1)	10 (35.7)	16 (57.1)	0.016
	No	94 (32.8)	83 (29)	109 (38.1)	
Diastolic OH (first minute)	Yes	8 (20)	13 (32.5)	19 (47.5)	0.289
	No	88 (32.1)	80 (29.2)	106 (38.7)	
OH (first minute)	Yes	9 (14)	20 (31.3)	35 (54.7)	0.008
	No	87 (34.8)	73 (29.2)	90 (36)	
Systolic OH (third minute)	Yes	5 (12.8)	11 (28.2)	23 (59)	0.013
	No	91 (23.6)	82 (29.8)	102 (37.1)	
Diastolic OH (third minute)	Yes	4 (10)	13 (32.5)	23 (57.5)	0.006
	No	92 (33.6)	80 (29.2)	102 (37.2)	
OH (third minute)	Yes	8 (12.1)	19 (28.8)	39 (59.1)	< 0.001
	No	88 (45.5)	74 (29.8)	86 (34.7)	

The data are expressed using *N* (%). mean ± standard deviation or median at the first and third quarter

DM diabetes mellitus; *HT* hypertension; *OH* orthostatic hypotension; *TSH* thyroid-stimulating hormone; *TUG* Timed Up and Go

Table 2 The association between fear of falling and orthostatic hypotension

	FES-I scores			
	20–27 (n = 93)		≥ 28 (n = 25)	
	OR (95% CI)	p	OR (95% CI)	p
Systolic OH (first minute)	1.20 (0.51–2.81)	0.670	2.58 (1.07–6.24)	0.035
Diastolic OH (first minute)	1.30 (0.61–2.74)	0.488	1.22 (0.57–2.60)	0.599
OH (first minute)	1.10 (0.59–2.06)	0.747	2.14 (1.14–4.00)	0.017
Systolic OH (third minute)	0.79 (0.36–1.71)	0.55	2.69 (1.26–5.77)	0.011
Diastolic OH (third minute)	1.16 (0.54–2.45)	0.69	1.98 (0.93–4.49)	0.073
OH (third minute)	0.89 (0.47–1.67)	0.727	2.72 (1.46–5.09)	0.002

OH orthostatic hypotension, logistic regression analysis. (*OR* odds ratio, *CI* confidence ınterval)

OH [9]. On the other hand, OH causes impaired muscle microcirculation and pain in the neck, hip and calf muscles [19]. At the same time, chronic brain pathology, such as brain atrophy, microbleeds and white matter brain lesions are more common in those with OH, which might influence the perception of verticality, resulting in positive dizziness. All these reasons can explain how OH can cause FoF.

FOF has been identified as an independent risk factor for reduced quality of life, activity restriction, loss of independence and fall-risk, a leading cause of injury, morbidity and mortality [20]. As a result, those who have FoF begin to limit their daily activities not to fall again, and, consequently, there may be a decrease in muscle strength and balance abilities. The reduced muscle mass and muscle strength can lead to a reduction in effective venous return, since venous pumps in the leg muscles pump blood from the lower extremity to the heart, which is important in maintaining cardiac filling pressure [21]. For example, Suzuki et al., in their study of young subjects, reported that there was a decrease in venous return and cardiac output following 20-day bed rest, due to the decrease in muscle mass and muscle strength, and that patients had deterioration in orthostatic tolerance capacity [22]. Accordingly, FoF can be a risk factor for OH in older adults.

The present study has several strengths. Blood pressure measurements and the data of all other tests were collected by one physician. Moreover, OH-related studies are generally performed using single measurement; blood pressure measurements for OH in this study were carried out over 1–3 min. Measurements were performed using a device that calibrates automatically and by this way physcian error was minimized. The most important limitation of the study is its cross-sectional nature. Thus, further longitudinal studies are now required for the determination of causality. Another limitation may be that OH was not measured utilizing the Head-up-Tilt table test.

Conclusion

OH and FoF are two major geriatric syndromes that are closely related. Moreover, the higher the severity of FoF, the stronger is the association between FoF and OH. Therefore, when evaluating an older adult with FoF in geriatric practice, OH should also be evaluated and vice versa. Thus, more effective management of the two will be possible and common complications due to both may be reduced.

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Compliance with ethical standards

Conflict of interest The authors report no conflict of interest.

Ethical approval The study design and all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (Ethics Committee of Erciyes University Health Application and Research Center Hospital—2017/544) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Human and animal rights disclosure This article does not contain any studies with animals performed by any of the authors.

Informed consent
Informed consent was obtained from all individual participants included in the study.

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