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Original Study

Orthostatic Hypotension is a Risk Factor for Falls Among Older Adults: 3-Year Follow-Up

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A B S T R A C T

Objectives: To assess the prevalence of orthostatic hypotension (OH) and the association of OH with the risk of falls among community-dwelling older adults with a previous fall.
Design: Longitudinal study.
Setting and Participants: The subjects (n = 561) were participants in fall prevention conducted in western Finland.
Methods: Blood pressure (BP) was measured in supine position and at 30 seconds and 3 minutes after standing. The participants were divided according to the consensus definition to an OH group (OHG) and a non-OH group (non-OHG). Falls were recorded by fall diaries during 12 months. Falls requiring treatment were gathered from health center and hospital registers during 12 and 36 months.
Results: The prevalence of OH was 23.4% (30 seconds) and 7.3% (3 minutes). The 30-second measurement showed that the incidence of falls and that of falls requiring treatment were significantly higher in OHG compared with non-OHG during 12 months. After adjustments, the incidence of falls remained higher in all 5 adjusted models whereas that of falls requiring treatment remained higher only after adjustment for functional balance. The 3-minute measurement showed that the incidence of falls was higher in OHG compared with non-OHG during 12 months and remained higher after adjustments for functional balance and for age and functional balance. During the 36-month follow-up, OH measured at 30 seconds or 3 minutes after standing was not associated with the occurrence of falls leading to treatment.
Conclusions and Implications: OH at 30 seconds or 3 minutes after standing is associated with a greater risk for falling within 12 months in older adults. The 30-second blood pressure measurement is more reliable to detect the risk than the 3-minute measurement. The results support the usability of 30-second measurement in determining OH and the risk for falling among older persons.

Falling is a common serious clinical problem[1,2] and falls are the leading cause of injury, premature institutionalization, and long-term disability in older adults worldwide.[3] Falls represent a significant burden on health care systems.[4] Surgically treated fall injuries among older adults, especially among older women, are associated with substantial economic costs.[5]

Orthostatic hypotension (OH) is another common problem among older adults.[6] It may occur with or without symptoms and signs.[7–9] OH is an underdiagnosed and overlooked disorder in clinical practice[10–12] although it causes balance impairment.[13] The prevalence of OH varies from 22% to 30% among older adults.[9,14,15]

There exist studies testing the associations between OH and falls and the hypothesis if OH is a risk factor of falls.[10,12,13,16,17] The earlier longitudinal studies have failed to show a clear association of OH with falls.[18] The results of the studies, which have tested OH at baseline and assessed falls during the follow-up, have suggested that OH is a cause

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rather than a consequence of falls.[17] The meta-analysis by Mol et al[17] revealed that the adjustment for potential confounders was limited in the previous studies. The quality of the majority of the previous studies was only moderate or low, and no critical conclusions could be drawn about any causal relationship between OH and falls.

The aim of this prospective study was to assess the prevalence of OH and the relationship between OH and the risk of falls during 12-month and 36-month follow-ups among older adults with quite good physical function and having fallen during the previous 12 months. We specifically aimed at assessing if there is any difference between OH defined by an early (30 seconds) measurement and a later (3 minutes) measurement in predicting the risk of falls.

Methods

Subjects

The subjects were volunteer participants (n = 591) of the multifactorial fall prevention intervention study conducted in western Finland. They were aged ≥65 years with good or moderate cognitive abilities (Mini Mental State Examination score ≥17), at least 1 fall during the previous 12 months, and ability to walk 10 m independently with or without walking aids. They lived at home or in sheltered housing.[19]

Measurement of Orthostatic Blood Pressures

Blood pressure and heart rate were measured with a standard mercury sphygmomanometer in the supine position and at 30 seconds and 3 minutes after standing. The right arm of the participant was used for measurement. The trained clinical research nurses measured intermittent blood pressures. Measurements were obtained at least 2 hours after breakfast or lunch and 10 minutes lying on the examination bed.

Definition of OH

OH was defined according to the consensus definition by the Consensus Committee of the American Autonomic Society and the American Academy of Neurology and European Federation of Neurological Societies[10,20] as a reduction of systolic blood pressure of ≥20 mm Hg or diastolic blood pressure of ≥10 mm Hg within 3 minutes of standing. We measured systolic and diastolic blood pressures at 30 seconds and 3 minutes after standing.

The participants (n = 561) were classified to those with OH (OH group; OHG) and those without OH (non-OH group; non-OHG) according to the consensus definition by using separately these 2 measurement values.

Falls

A fall was defined as an event that results in a person unintentionally coming to rest on the ground, floor, or other lower level with or without loss of consciousness or injury during the 12-month follow-up.[21,22] Falls resulting from extraordinary environmental factors (eg, traffic accidents and falls while riding a bicycle) were excluded.[23] A fall requiring treatment was defined as a fall leading to examinations and treatment of the injury caused by the fall in a health center or a hospital.

Falls were recorded by fall diaries that subjects were given and instructed to fill in and asked to mail to the research assistants (RAs) monthly during a 12-month follow-up. In addition, the participants were advised to report their falls by telephone to the RA as soon as possible after the fall. If a monthly fall diary was not returned at the beginning of the following month, the RA called the participant by telephone and asked about falls having occurred during the previous month. The occurrences of falls requiring treatment were collected from the health center and hospital registers by the RA during the 12- and 36-month follow-ups.

Other Measurements

Interviews and observations with previously validated scales were used in measuring potential confounding factors.[19,24] Age, number of prescribed medications, depressive symptoms, functional balance, walking ability, and self-assessed physical function were used as potential confounding factors. All participants were asked to take the prescriptions and pillboxes of regularly or irregularly used drugs to the interviews. Drugs were coded using the modified Anatomical Therapeutic Chemical (ATC) coding system.[24] Number of prescribed medications was dichotomized as <4 and ≥4. Depressive symptoms were measured with the Geriatric Depression Scale (GDS). Depression was defined according to the validated cut-off score: ≥11 points indicated a high amount of depressive symptoms.[25,26] Functional balance was measured with a shortened Berg Balance Scale (BBS-9), which consists of 9 items of the original BBS (sitting to standing, transfers, reaching forward with outstretched arm, retrieving object from floor, turning to look behind, turning 360°, placing alternate foot on stool, standing with one foot in front and standing on one foot). Each item was scored on a 0-4 scale (0 = cannot perform, 4 = normal performance), with the highest total score of 36. The cut-off score of 32/33 was used in the analyses.[27,28] Walking ability was measured by the time (seconds) in walking 10 m, which could be carried out with or without walking aids. Physical function was measured with a 3-scale question "How do you consider your physical function to be?" (1 = good, 2 = average, 3 = poor).

Ethics

The study was conducted according to the guidelines of the Declaration of Helsinki. The Ethics Committee approved the study protocol. The participants gave informed consent in a written form.

Statistical Analyses

Categorical baseline characteristic variables between OHG and non-OHG were compared with chi-squared or Fisher exact tests. The Mann-Whitney *U* test was used to test the differences in continuous baseline characteristic variables between OHG and non-OHG.

Poisson regression was used to compare the incidences of falls during the 12-month follow-up and the incidences of falls requiring treatment during the 12- and 36-month follow-ups between OHG and non-OHG. The results were expressed using incidence rate ratios with 95% confidence intervals. Age, number of prescribed medications, depressive symptoms, functional balance, walking ability, and self-assessed physical function were considered as potential confounding factors. These confounding factors were selected by analyzing the associations between previously found potential risk factors of falls, and the incidence of falls and those with a significant association were adjusted in further analyses. Confounding factors related to incidence of falls were adjusted in further analyses by taking these factors one by one to the models.

First, unadjusted incidence rate ratios were calculated (model 1). Second, Poisson models were adjusted only for functional balance (BBS-9) (model 2) and for age and functional balance (BBS-9) (model 3). In model 4, the Poisson model was adjusted for age, functional balance (BBS-9), number of prescribed medications, and depressive symptoms. Age, functional balance (BBS-9), number of prescribed medications, depressive symptoms, and physical function were used as adjusting variables in model 5 and age, functional balance (BBS-9),

Table 1
Baseline Characteristics of the Participants

	Total Sample (n = 561)	OH Group: 30 s (n = 130)	Non-OH Group: 3 min (n = 429)	P Value	OH Group: 3 min (n = 41)	Non-OH Group: 30 s (n = 520)	P Value
Gender, n (%)							
Male	92 (16)	29 (22)	63 (15)		10 (24)	82 (16)	
Female	469 (84)	102 (78)	367 (85)	.043	31 (76)	438 (84)	.15
Age, n (%)							
65-74 y	361 (64)	66 (50)	295 (69)		20 (49)	341 (66)	
≥75 y	200 (36)	65 (50)	135 (31)	<.001	21 (51)	179 (34)	.031
Living circumstance, n (%)							
Living with a spouse or another	254 (45)	60 (46)	194 (45)		20 (49)	234 (45)	
Living alone	307 (55)	71 (54)	236 (55)	.88	21 (51)	286 (55)	.60
Education*, n (%)							
More than basic	152 (27)	27 (21)	125 (29)		15 (37)	13 (26)	
Basic	402 (72)	101 (77)	301 (70)		25 (61)	377 (73)	
Less than basic	7 (1)	3 (2)	4 (1)	.09	1 (2)	6 (1)	.26
Use of walking aids, n (%)							
No	456 (81)	102 (78)	354 (82)		34 (83)	422 (81)	
Yes	105 (19)	29 (22)	76 (18)	.25	7 (17)	98 (19)	.78
Self-assessed physical function, n (%)							
Good	198 (35)	40 (31)	158 (37)		17 (42)	181 (35)	
Adequate	299 (54)	75 (57)	224 (52)		14 (34)	285 (55)	
Bad	62 (11)	169 (12)	46 (11)	.41	10 (24)	52 (10)	.005
Number of prescribed medications, n (%)							
<4	292 (52)	58 (44)	234 (54)		14 (34)	278 (53)	
≥4	269 (48)	73 (56)	196 (46)	.042	37 (66)	242 (47)	.017
Body mass index, n (%)							
<25	102 (18)	27 (21)	75 (17)		6 (15)	96 (18)	
25-29.99	263 (47)	63 (48)	200 (47)		24 (59)	239 (46)	
≥30	196 (35)	41 (31)	155 (36)	.53	11 (27)	185 (36)	.30
10-m walk (time in seconds), median (IQR)	6.7 (5.8-7.9)	7.0 (6.0-8.4)	6.6 (5.7-7.7)	.015	7.1 (6.0-8.6)	6.7 (5.8-7.9)	.38
Mini-Mental State Examination score, median (IQR)	28.0 (26.0-29.0)	28.0 (26.0-29.0)	28.0 (26.0-29.0)	.26	27.0 (24.5-29)	28.0 (26.0-29.0)	.08
Geriatric Depression Scale score, median (IQR)	4.0 (1.0-8.0)	4.0 (2.0-10.0)	4.0 (1.0-7.0)	.18	6.0 (3.0-11.0)	4.0 (1.0-7.0)	.023
Visual acuity, median (IQR)	0.8 (0.7-1.0)	0.8 (0.6-1.0)	0.9 (0.7-1.0)	.002	0.8 (0.6-1.0)	0.8 (0.7-1.0)	.29
Functional balance (BBS-9) score, median (IQR)	33.0 (29.0-35.0)	32.0 (28.0-34.0)	33.0 (30.0-35.0)	.002	32.0 (29.0-34.0)	33.0 (30.0-35.0)	.19

IQR, interquartile range.
*More than basic: >6 years of school; basic: 6 years of school; less than basic: <6 years of school.

number of prescribed medications, depressive symptoms, and walking ability in model 6.

Statistical analyses were performed using the SAS system for Windows, release 9.4 (SAS Institute, Cary, NC, USA). *P* values ≤.05 were considered statistically significant.

Results

Baseline Characteristics

A total of 561 participants, aged 65-94 years (mean age 73.1 years), formed the sample. Other baseline characteristics of the participants are expressed in Table 1.

Prevalence of OH

Prevalence of OH was 23.4% (131/561) according to the 30-second measurement and 7.3% (41/561) according to the 3-minute measurement (Table 2).

Association of OH With the Incidence of Falls

The 30-s measurement definition

By determining OH with the 30-second measurement, 435 falls (127 in OHG and 308 in non-OHG) and 44 falls requiring treatment (18 in OHG and 26 in non-OHG) occurred during the 12-month follow-up (Table 3). During 36 months, there were 150 falls that required treatment (42 in OHG and 108 in non-OHG).

The incidence of falls was significantly higher in OHG compared with non-OHG during the 12-month follow-up. After adjustments, the incidence of falls during the 12-month follow-up remained significantly higher in all 5 adjusted models.

The incidence of falls requiring treatment was significantly higher in OHG compared with non-OHG during the 12-month follow-up, but no difference was found during the 36-month follow-up. The incidence of falls requiring treatment during the 12-month follow-up remained significantly higher in OHG compared with non-OHG only after adjustment for functional balance (Table 3).

The 3-minute measurement definition

By determining OH with the 3-minute measurement, 440 falls (50 in OHG and 390 in non-OHG) and 40 falls requiring treatment (2 in OHG and 38 in non-OHG) occurred during the 12-month follow-up (Table 2). During 36 months, there were 150 falls that required treatment (12 in OHG and 138 in non-OHG).

By using the 3-minute measurement, the incidence of falls was significantly higher in OHG compared with non-OHG during the 12-month follow-up, and it remained significantly higher after adjustment for functional balance and for age and functional balance (Table 4). No differences in the incidence of falls requiring treatment during the 12- or 36-month follow-ups were found between OHG and non-OHG.

Discussion

The main finding of this standardized longitudinal study with adjustments for several potential confounding factors showed that OH

Table 2
Number and Incidence of Falls and Falls Requiring Treatment in OHG and Non-OHG and Incidence Rate Ratios for Falls Between Groups by Determining OH Either at 30 Seconds or 3 Minutes

	30-s Measurement					3-min Measurement				
	Number of Participants	Number of Falls	Incidence (95% CI)	IRR (95% CI)	*P* Value	Number of Participants	Number of Falls	Incidence (95% CI)	IRR (95% CI)	*P* Value
Falls during 12-mo follow-up										
OH group*	130†	127	1.00 (0.84-1.19)	1.35 (1.10-1.66)	.004	41	50	1.14 (0.85-1.53)	1.48 (1.04-2.02)	.013
Non-OH group‡	429†	308	0.74 (0.66-0.83)	1		518§	390	0.77 (0.70-0.85)	1	
Falls requiring treatment during 12-mo follow-up										
OH group*	131	18	0.14 (0.09-0.22)	2.04 (1.13-3.66)	.018	41	2	0.05 (0.01-0.20)	0.58 (0.14-2.37)	.45
Non-OH group‡	430	26	0.07 (0.05-0.10)	1		520	38	0.09 (0.06-0.11)	1	
Falls requiring treatment during 36-mo follow-up										
OH group*	131	42	0.11 (0.08-0.15)	1.28 (0.89-1.83)	.18	41	12	0.10 (0.06-0.18)	1.13 (0.63-2.03)	.69
Non-OH group‡	430	108	0.09 (0.07-0.10)	1		520	138	0.09 (0.08-0.11)	1	

CI, confidence interval; IRR, incidence rate ratio.
*Group includes subjects with diastolic or systolic orthostatism (30-second or 3-minute measurements).
‡Group includes subjects without diastolic or systolic orthostatism (30-second or 3-minute measurements).
†1 missing value.
§2 missing values.

measured at 30 seconds after standing was related to the risk of falls occurring during 12 months after measuring OH. In addition, OH measured at 30 seconds after standing was related to the risk of the occurrence of falls leading to treatment during 12 months, but this finding was noticed only after adjusting for functional balance.

By determining OH at 3 minutes after standing, we found that OH is associated with falls during 12 months after adjusting for functional balance or functional balance and age during 12 months. However, no association with the occurrence of falls leading to treatment during 12 months was found.

The follow-up of falls leading to treatment during 36 months did not show any associations of OH with these kinds of injurious falls. Both OH measured by determining blood pressure at 30 seconds and 3 minutes after standing verified this nonexistence.

OH measured at 30 seconds after standing was related to the risk of occurrence of falls, leading to treatment during 12 months but not during 36 months. No management to treat OH and no intervention to adjust medication were involved. There may be intervening causes for the difference between the results according to the length of the follow-up, which we have not measured.

We used the definition established by the Consensus Committee of the American Autonomic Society and the American Academy of Neurology and European Federation of Neurological Societies in defining OH. According to this definition, OH is a reduction of systolic blood pressure of at least 20 mm Hg or diastolic blood pressure of at least 10 mm Hg within 3 minutes of standing.[10,20] We used 2 measurements, blood pressure at 30 seconds and at 3 minutes after standing. Intermittent measurement and standardized mercury sphygmomanometer were used as in many earlier studies. Two trained clinical research nurses measured the blood pressure with a standardized mercury sphygmomanometer, and standardized techniques were used.

The results show the prevalence of OH to be 23.4% according to the 30-second measurement and only 7.3% according to the 3-minute measurement. These findings show that blood pressure is leveled rapidly after standing. We conclude that the 3-minute measurement is a poor indicator of OH and cannot be used as a single measure in determining OH. According to earlier studies, the prevalence of OH is age dependent, ranging from 22% to 30% among the older adults.[9,14,15]

The cohort study by Juraschek et al[29] found that OH measurements in the first 30 to 60 seconds had an association with future risk of falls. We showed that 30-second measurement is a valid and reliable measure in determining OH because it is a good risk indicator of future falls.

Table 3
Unadjusted and Adjusted IRRs for Falls Between OHG and Non-OHG (30-Second Measurement)

	Falls During 12-mo Follow-Up	Falls Requiring Treatment During 12-mo Follow-up		Falls Requiring Treatment During 36-mo Follow-up	
	IRR (95% CI)	*P* Value	IRR (95% CI)	*P* Value	IRR (95% CI)
Model 1*	1.35 (1.10-1.66)	.004	2.04 (1.13-3.66)	.018	1.28 (0.89-1.83)
Model 2†	1.32 (1.08-1.63)	.008	1.97 (1.09-3.55)	.025	1.20 (0.84-1.71)
Model 3‡	1.31 (1.06-1.62)	.012	1.74 (0.96-3.17)	.07	1.12 (0.78-1.61)
Model 4§	1.27 (1.03-1.58)	.026	1.57 (0.84-2.93)	.16	1.03 (0.71-1.49)
Model 5‖	1.28 (1.04-1.58)	.023	1.64 (0.87-3.06)	.13	1.04 (0.71-1.51)
Model 6**	1.27 (1.03-1.57)	.028	1.55 (0.83-2.98)	.17	1.01 (0.70-1.48)

CI, confidence interval; IRR, incidence rate ratio.
An IRR >1 indicates higher risk for falls in OHG compared with non-OHG.
*Unadjusted.
†Adjusted for functional balance (BBS-9: 0-32, 33-36).
‡Adjusted for age (<75, ≥75 years) and functional balance (BBS-9: 0-32, 33-36).
§Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), and depressive symptoms (GDS: 0-10, 11-15).
‖Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), depressive symptoms (GDS: 0-10, 11-15), and physical function.
**Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), depressive symptoms (GDS: 0-10, 11-15), and walking ability.

Table 4
Unadjusted and Adjusted IRRs for Falls Between OHG and Non-OHG (3-Minute Measurement)

	Falls During 12-mo Follow-up		Falls Requiring Treatment During 12-mo Follow-up		Falls Requiring Treatment During 36-mo Follow-up
	IRR (95% CI)	*P* Value	IRR (95% CI)	*P* Value	IRR (95% CI)
Model 1*	1.48 (1.09-2.02)	.013	0.58 (0.14-2.37)	.45	1.13 (0.63-2.03)
Model 2†	1.44 (1.06-1.96)	.021	0.54 (0.13-2.24)	.40	1.02 (0.57-1.84)
Model 3‡	1.42 (1.04-1.94)	.027	0.49 (0.12-2.04)	.33	0.98 (0.54-1.77)
Model 4§	1.30 (0.95-1.78)	.10	0.48 (0.12-2.03)	.32	0.92 (0.51-1.68)
Model 5‖	1.27 (0.92-1.74)	.15	0.49 (0.12-2.09)	.34	0.95 (0.52-1.75)
Model 6**	1.32 (0.96-1.81)	.09	0.51 (0.12-2.14)	.36	0.95 (0.52-1.74)

CI, confidence interval; IRR, incidence rate ratio.
An IRR >1 indicates higher risk for falls in OHG compared to the non-OHG.
*Unadjusted.
†Adjusted for functional balance (BBS-9: 0-32, 33-36).
‡Adjusted for age (<75, ≥75 years) and functional balance (BBS-9: 0-32, 33-36).
§Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), and depressive symptoms (GDS: 0-10, 11-15).
‖Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), depressive symptoms (GDS: 0-10, 11-15), and physical function.
**Adjusted for age (<75, ≥75 years), functional balance (BBS-9: 0-32, 33-36), number of prescribed medications (<4, ≥4), depressive symptoms (GDS: 0-10, 11-15), and walking ability.

During 12 months, we recorded falls by monthly falling diaries and by phone calls to participants who did not send their diaries to us after the recording period of 1 month. Our method is among to the best possible ones used in falling studies. No diaries were used after this follow-up. Only falls leading to treatment were recorded from the hospital and health center registers after the follow-up of 12 months, and they were recorded also during the first 12 months. Thus, we have 2 kinds of indicators of falls during 12 months and only 1 indicator after 12 months. We did not believe that participants are eager to fill in fall diaries as long as 36 months and we had no resources to call them weekly or monthly in order to ask their fall occurrences. However, we wanted to collect some evidence of falls during a period longer than 12 months. The Finnish health care registers are accurate. Our numbers of treatments are reliable.

In our study, 10% of falls led to open care or hospital treatment during 12 months. Earlier studies have shown a quite similar proportion of 5% to 20%.[30–32] Thus, only about every 10th fall, those leading to hospital treatment, was recorded. The number of falls leading to treatment shows only the amount of the most severe falls.

OH was measured at the beginning of the follow-up. OH is an adverse effect of many medications; however, new illnesses and new prescriptions of the participants during the follow-up are unknown. They are intervening variables, that must be taken into account in assessing the results.

The follow-up of 36 months is a long period to detect associations because of many possible intervening variables during the follow-up. We used only the variable describing the occurrence of falls leading to treatment in measuring falls during this long period, which leads to weaknesses in our results during the longer follow-up.

The earlier meta-analysis made by Mol et al[17] consisted of 63 studies. The populations of 17 studies were community-dwelling older adults and 9 of these studies were longitudinal; moreover, in only 4 of them was OH defined according to the consensus definition.[33–36] OH was assessed with head-up tilt in 2 of these 4 studies[34,36] and with patient standing (as we performed) in 2 studies.[33,35] McDonald et al[35] measured blood pressure with digital photoplethysmography (continuous), and only Gangavati et al[33] used a blood pressure method using a sphygmomanometer (intermittent) similarly to our study. Thus, we compare our results only with the results of the study by Gangavati et al[33] in which the method to measure blood pressure was similar to ours.

There is an important difference between our study and the study by Gangavati et al.[33] The participants in their study were divided according to the occurrence of hypertension and the relationships between hypertension, orthostatic hypotension, and falls were analyzed. We did not make these kinds of analyses. Thus, no critical comparison between our results and the results by Gangavati et al[33] can be made.

According to Mol et al,[17] most previous studies are of a moderate or low quality, and no conclusions about any causal relationship between OH and falls can be drawn. The adjustments of potential confounders are limited. We used age, number of prescribed medications, depressive symptoms, functional balance, walking ability, and self-assessed physical function as potential confounding factors. The amount of adjusted potential confounders was substantial.

Some of the previous studies support the conclusion that OH is significantly associated with falls in older adults[10,12,13,16,17,37] and indicate OH as a potential predictor of falls.[17] The results by Doyle et al published in 2021[38] showed associations of OH with future fractures. Delayed BP recovery at 30 seconds was a significant predictor of any fracture and hip fracture. Delayed BP recovery at 30 and 60 seconds was an independent risk factor for hip fracture.

Our standardized longitudinal study with adjustment for potential confounding factors showed that OH is a risk factor for falls during a 12-month follow-up. We found that the 30-second measurement is a better predictor than the 3-minute measurement.

The high prevalence of OH in older adults and the association of OH with future risk on falls and fractures shown by previous studies and our study give evidence to include the measurement of OH in screening programs of older adults. Doyle et al[38] suggested that screening might be useful, as there are treatments (eg, antihypertensive or antidepressant medication) that might lower the risk of OH in community-dwelling older adults. We recommend that OH measurements should be routinely done in geriatric care.

The strength of our study was its high number of participants, longitudinal design, proper registration of falls, and valid methods and reliable measurements used in defining OH. We used the standardized technique, timing, and positioning for accurate OH assessment, and trained clinical research nurses made the measurements. OH was defined according to the consensus definition, and the blood pressure measurements were made with a standardized mercury sphygmomanometer. We used 6 potential confounding factors: age, number of prescribed medications, depressive symptoms, functional balance, walking ability, and self-assessed physical function. These confounding factors were selected by analyzing the relationships between previously found potential risk factors of falls and the incidence of falls, and those with a positive relationship were adjusted in further analyses.

There were some limitations that must be taken into account in interpreting the results. Our study was not a population-based one, and the participants were volunteers having fallen during the previous 12 months and their physical function was quite good. The number of participants was quite small for subgroup analyses. Most participants (84%) were women. A previous fall is a risk factor for future falls in older persons,[39,40] and women are at higher risk than men.[41] Our population is a risk population of falls. The selection of the population may have affected the results. Even quite weak associations may have appeared as stronger ones. Only a single OH measurement was used.

One-half of our population participated in the multifactorial prevention intervention during this study. Withdrawal of drugs with OH as an adverse effect did not belong to the prevention. Neither were other means to limit the occurrence of OH used. We believe that the prevention intervention has not affected our results.

Conclusions and Implications

OH at 30 seconds or 3 minutes after standing is associated with a greater risk for falling within 12 months in older adults. The 30-second blood pressure measurement is more reliable to find out the risk than the 3-minute measurement. The results support the usability of a 30-second measurement in determining OH and the risk for falling among older persons. The prevalence of OH is quite high, and many cases are asymptomatic. We recommend that OH measurements be routinely performed in geriatric care.

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