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Dizziness, physical capacity, and health-related aspects among 70-year-olds in an urban population

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Dizziness is a common complaint among older adults and one of the most important risks for falls.

Objectives. This study aimed to report falls, physical capacity, and self-rated health in men and women with and without dizziness in a population-based sample of 70-year-olds, and to investigate which factors may be associated with falls and dizziness.

Methods. A cross-sectional population-based sample from 1203 70-year-olds (644 women, 559 men, response rate 72%) was surveyed regarding dizziness, falls, physical capacity, medications, and self-rated health. Physical capacity level was assessed using the six-minute walk test, chair stand test, and tandem standing test with eyes opened and closed.

Results. Dizziness was more commonly reported among women than among men ($p < 0.0001$) and associated with decreased self-rated health and physical levels among both men and women. Dizzy women tended to fall more often, performed worse in fitness measurements (chair stand, tandem standing), exercised less frequently, and went for walks less often than non-dizzy women. The number of medications and dizziness were identified as having significant associations with falls.

Conclusions. To experience dizziness already at the age of 70 affects health and physical levels in both men and women, and dizzy women tended to fall more often than non-dizzy women. We suggest that dizziness among older adults should be carefully evaluated regarding medications, physical function, and treatable causes, and when needed, postural training and vestibular rehabilitation should be initiated to avoid future falls and improve quality of life.

Key words: dizziness, fitness level, falls, self-rated health, walking

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INTRODUCTION

The proportion of adults reaching older ages has increased worldwide,

with life expectancy rising to over 70 years of age in most countries [1]. With longer life expectancy, the occurrence of dizziness will most likely be a growing health problem as dizziness tends to increase with age [2,3]. An earlier population-based study from Sweden showed that dizziness among older adults (75 years) was experienced in 34% of women and 23% of men [4]. The ability to walk, stand, and move safely is fundamental for an independent and active life. Symptoms that can reduce physical activity and impairment in daily life are dizziness, instability, and imbalance [5]. Since dizziness is one of the most critical risk factors for falls [6,7], it may not only result in reduced physical performance, but persons who experience dizziness may also voluntarily limit their walking speed and mobility due to fear of losing balance and falling, thereby leading to more sedentary behavior [8]. Living with dizziness is also associated with reduced quality of life [9-11]. The most common cause of dizziness originating from the vestibular system is benign paroxysmal positional vertigo (BPPV) [12]. Prior research has shown that BPPV is underdiagnosed in older individuals [4] and that the symptoms are more diffuse in older than younger people [13]. Another common cause of dizziness in older adults is multisensory dizziness [14]. There is no accepted definition of multisensory dizziness, but it often described as dizziness or instability attributed to older adults and impairment in several sensory organs [14]. Postural control, or the act of maintaining balance, involves the interaction of dynamic sensorimotor processes, including the interpretation of convergent sensory information from the somatosensory, vestibular, and visual systems coupled with the coordination of movement strategies to stabilize the center of body mass [15]. Biomechanical limitations that can affect an individual's balance include decreased leg strength and reduced mobility in the knees and ankles [15]. Dizziness is more often reported in women, which is well known, at least until age 75 [16,17]. Reasons for this gender difference are not well explored. However, vestibular diseases, like BPPV and Meniere's disease, are more common among women than men [16]. Together with postural training, vestibular rehabilitation can reduce dizziness, improve walking ability, and potentially reduce falls [18-20]. The concept of vestibular rehabilitation not only means restoring the vestibular system but also includes postural training and compensation for other causes of vertigo, dizziness, and general instability [21]. We believe that dizziness already at the age of 70 negatively affects health and should therefore be taken seriously and assessed for treatable causes, like BPPV, or addressed with rehabilitation to avoid fall accidents and the development of fear of falling. This study aimed to report falls, physical capacity, and self-rated health in men and women with and without dizziness in a population-based sample of 70-year-olds, and to investigate which factors may be associated with falls and dizziness.

MATERIALS AND METHODS

Setting and study population

The study comprised the baseline examination of the sixth cohort in the Gothenburg H70 Birth cohort studies (the H70 studies) in Sweden. The H70 studies are multidisciplinary population studies examining representative birth-cohorts of older populations in Gothenburg, Sweden. The present study uses data from the 1944 birth cohort examined in 2015-16 at age 70. Study participants born on pre-specified birth dates and registered as residing in ordinary or special housing in Gothenburg, Sweden, were invited to participate. The design, procedures, and methods for data collection have been reported elsewhere [22]. Information regarding date of birth and address was obtained from the Swedish Population Register, covering all persons registered in Sweden. Invitations to participate in the study were first sent by letter, including the consent form, and then all invited participants were contacted by telephone. Participants were considered eligible for the study regardless of residence (i.e., private households or special housing for the elderly). A total of 1667 individuals (894 women, 773 men) were invited, and 1203 (644 women, 559 men, response rate 72%) agreed to participate. Reasons for refusal to participate were not registered due to lack of consent.

Demographics and study-specific questions

Participants were asked about marital status, country of birth, and educational level (Tab. I) and answered questions regarding dizziness, falls, and physical fitness (Tab. II). Participants were divided into groups depending on their answer to the question, "Do you have any problems with dizziness?" with response options "yes" or "no." They were also asked whether they had fallen in previous years and if so, how many times. Participants were also asked to list their medications.

Tests of physical capacity and balance

Training nurses, public health professionals, or physiotherapists performed fitness and balance tests at the neuropsychiatric outpatient clinic at Sahlgrenska University Hospital (Gothenburg, Sweden).

To test physical capacity, the participants walked alone at their own maximal pace for the six-minute walk test (6-MWT) and were instructed to walk back and forth along a 30-m long corridor, for six minutes [23]. Lengths

Table I. Response alternatives for study-specific questions.

Study-specific questions	Response alternatives
Questions about dizziness	
Do you have any problems with dizziness?	Yes
	No
Have you experienced dizziness or balance problems in the last three months?	Yes
	No
How often do you have symptoms of dizziness?	Less than once a week
	Every week
	Daily
Do you have problems with dizziness preventing you from performing certain activities?	Yes
	No
What kind of dizziness do you have?	Vertigo
	Unsteadiness
	Another type of dizziness
How long have you had dizziness?	Less than 2 years
	More than 2 years
Have you sought medical care for your dizziness?	Yes
	No
Questions about falls	
Have you fallen during the last year?	Yes
	No
How many times have you fallen?	Number of falls
Questions about physical fitness	
Do you generally take daily walks?	Yes
	No
How would you judge your present physical fitness?	Very poor
	Poor
	Quite good
	Good
	Very good
How often do you exercise?	
	Once per month
	Once per week
	2-4 times per week
	Daily
Questions about health	
How would you rate your health?	Very good
	Good
	Fairly good
	Bad
	Very bad
	Bad
Do you generally feel tired?	Yes
	No

in meters and walking speed were calculated. The 6-MWT has good test-retest reliability (ICC = 0.95) for community-dwelling older adults [24].

The chair stand test was used to test the participants' ability to rise from a 45-cm high chair without support. Participants were instructed to perform the test as quickly as possible five times in a row, and the total time in seconds was calculated [25]. Stair climbing was used to test the participants' ability to climb onto boxes of varying heights (10, 20, 30, 40, and 50 cm) [25]. The

Table II. Demographic characteristics of the cohort of the 70-year-olds in the Gothenburg H70 Birth cohort studies.

Variable	Women	Men	Total
	n = 644 (%)	n = 559 (%)	n = 1203 (%)
Marital status			
Having a partner	405 (64)	462 (84)	867 (73)
Widowed	75 (12)	20 (4)	95 (8)
Divorced	136 (21)	49 (9)	185(16)
Single	19 (3)	19 (4)	38 (3)
Country of birth			
Sweden	551 (87)	455 (82)	1006 (85)
Other Nordic countries	34 (5)	29 (5)	63 (5)
Other non-Nordic countries	50 (8)	69 (13)	119 (10)
Education			
Primary education ≤ 9 years	164 (26)	185 (34)	349 (30)
Primary education > 9 years	205 (33)	125 (23)	330 (28)
University degree	262 (42)	240 (44)	502 (43)

height from the strongest leg was used in the analysis. Grip strength was tested with a Martin Vigorimeter (KLS Mar Group Tuttlingen, Germany), with three balloon sizes. The medium-sized balloon was used for women, and the larger balloon was used for men. Grip strength was measured at an elbow angle of 90 degrees, with the shoulder joint in a neutral position. The test was repeated three times for each hand, and the highest value of the hand with the strongest grip strength was included in the analyses (kPa). This method has been shown to have good psychometric properties [26,27]. Regarding physical activity levels, the participants were asked about their walking habits, how often they exercised, and their self-rated fitness level on a four-item scale. Balance function was tested using the tandem standing test, without shoes, with eyes open, and with eyes closed. The tests were performed with the heel of the dominant foot directly in front of the toe of the non-dominant foot and the participants' arms alongside their body. The tests were terminated when the person lost balance when moving one foot or both feet. The best result of three trials was recorded, and the maximum time for the test was 30 s.

Self-rated health

Self-rated health was measured using the question," How is your general health?" with response options ranging from "very good", "good", "fairly good", "bad" to "very bad". Self-rated physical level was measured using the question, "How would you rate your current physical level?" with response options ranging from "miserable", "bad", "pretty good" to "good".

Table III. Study-specific characteristics of the study population.

Variable	Women	Men	P-value
	n = 644 (%)	n = 559 (%)	
Having problem with dizziness	177 (27)	89 (16)	< 0.0001
Dizziness during the last 3 months	107 (19)	55 (11)	0.0004
Frequency of symptoms of dizziness	n = 156	n = 82	
Less than once a week	84 (54)	49 (60)	
All week	34 (22)	18 (22)	
Daily	38 (24)	15 (18)	0.0002
Prevented from doing activities by dizziness	40 (7)	9 (2)	0.0002
Dizziness type	n = 159	n = 82	
Rotational vertigo	59 (37)	22 (27)	
Unsteadiness	85 (53)	48 (59)	
Other type	15 (9)	12 (15)	0.2
Length of time experiencing dizziness			
≤ 2 years	46 (30)	33 (40)	
> 2 years	108 (70)	50 (60)	0.1
Seeking medical care due to dizziness	64 (11)	28 (6)	0.002
Fallen during the last year	131 (23)	77 (15)	0.002
Number of falls last year			
0	448 (78)	429 (85)	
1	78 (14)	45 (9)	
2	29 (5)	14 (3)	
> 2	20 (4)	15 (3)	0.02
Number of medications			
0	69 (11)	95 (17)	
1-5	366 (57)	320 (58)	
> 5	203 (32)	138 (25)	0.0002

[a]P-values represent differences between women and men.

Statistical analyses

For descriptive purposes, frequency and proportions are reported for categorical variables and mean and standard deviation (SD) for continuous variables. Tests for univariate difference between those with and without dizziness or between men and women included Fisher's exact test for dichotomous variables, Mantel-Haenzel Chi-square test for ordered variables, Chi-square test for non-ordered variables, and t-tests for continuous variables. Significance was reported for two-tailed tests, and $p < 0.05$ was considered significant. To identify variables related to falls and dizziness and how they were interrelated, unit- and multivariable binary logistic regression analyses were performed. Potential

risk factors in multivariable regression were sex, vision impairment, hearing impairment, body weight, number of drugs, walking speed, chair stand, and tandem standing. Backward stepwise regression was conducted ($p < 0.05$) to identify the most important risk factors within the models tested. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). The software used for the statistical analysis was SPSS and a statistics program package developed at the Department of Geriatrics at the University of Gothenburg (GIDSS for Windows).

RESULTS

Demographic characteristics

Characteristics of the cohort from which the study population was selected are presented in Table II.

Dizziness and falls

More women than men reported problems with dizziness (27% of the women and 16% of the men, $p < 0.0001$). Women also reported more problems with dizziness, where 13% compared to 6% of the men ($p < 0.001$) reported dizziness on a daily or weekly basis, and more women had fallen more than once during the last year compared to men (23 *vs* 15%, $p = 0.002$). Concerning the type of dizziness, no significant difference was observed between sexes (Tab. III). Women sought medical care for dizziness more often and felt, to a greater extent, more inhibited in activities due to dizziness than men. Women who reported dizziness had also fallen significantly more often than women without dizziness ($p = 0.0004$), but no significant difference in the number of falls was observed among dizzy and non-dizzy men (Tab. IV). The most frequently reported type of dizziness by all participants was unsteadiness followed by rotational symptoms. Women reported taking more medications than men, and both men and women who reported dizziness were prescribed more medications than participants without dizziness.

Both women and men with dizziness performed worse in the 6-MWT than participants without dizziness, $p < 0.003$ (Fig. 1). However, no significant differences were observed between participants with or without dizziness according to the box climbing or grip strength tests. In the chair stand test and tandem standing tests (both with eyes open and closed), significant differences between dizzy and non-dizzy women were observed, but not between dizzy and non-dizzy men.

Self-reported levels of fitness as well as self-rated health were significantly lower in participants reporting dizziness. Women with dizziness exercised less than women without dizziness, a trend not seen among men. In univariate logistic regression analyses, previous falls were associated with being female (OR 1.6 [CI: 1.20-2.24], $p = 0.002$); having many medications (OR for every medication added 1.1 [CI: 1.06-1.15], $p < 0.0001$), dizziness (OR 2.1 [CI: 1.54-2.99], $p < 0.0001$); and time to complete the chair stand test (OR 1.3 [CI: 1.54-2.24], $p = 0.002$). However, in adjusted models, only the number of medications and dizziness were identified as having significant associations with falls.

For dizziness, univariate analyses revealed significant relationships with being female (OR 1.9 [CI: 1.40-2.54], $p < 0.0001$) and the number of medications (OR for every medication added 1.12 [CI: 1.08-1.17], $p < 0.0001$) which also remained significant in multivariate analyses.

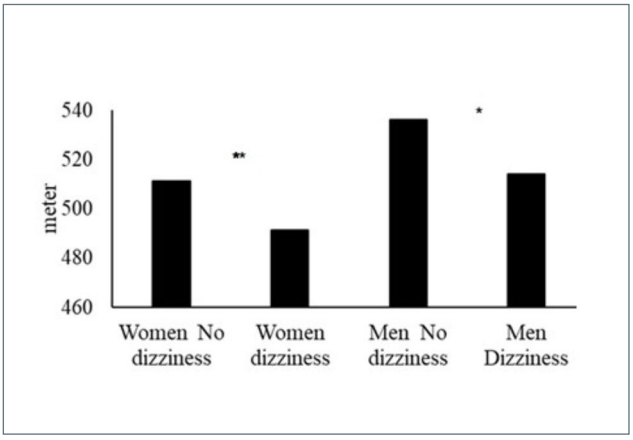

Figure 1. Six-minute walking test results between participants with and without dizziness. *P < 0.001

DISCUSSION

In this study investigating a population-based sample of 70-year-olds, dizzy women tended to fall more often than non-dizzy women, and both men and women with dizziness had lower physical capacity than participants without dizziness. Self-rated health and fitness level were lower in participants who reported dizziness. Women with dizziness exercised less than women without dizziness, a trend not seen among men. An increased number of medications was significantly associated with an increased number of falls.

Dizziness is one of the most frequent conditions associated with falling, and other symptoms, such as loss of balance, disturbance of gait, and reduced muscle strength, increase the risk for falls [7,28]. In this study one-third (33%) of the women with dizziness had fallen during the last year, which was almost twice as often as among women without dizziness (19%), in line with previous reports.

Table IV. Physical capacity and balance among participants with and without dizziness.

	Women			Men		
	No dizziness	Dizziness	P-value	No dizziness	Dizziness	P-value
	n = 422	n = 155		n = 425	n = 83	
Fallen last year, n (%)	80 (19)	51 (33)	0.0004	58 (14)	19 (23)	0.03
Number of falls last year, n (%)						
0	341 (81)	107 (69)		365 (87)	64 (77)	
1	55 (13)	23 (15)		32 (8)	13 (16)	
2	15 (4)	14 (9)		12 (3)	2 (2)	
> 2	9 (2)	9 (6)	0.0001	11 (3)	4 (5)	0.07
Six-minute walking test						
Number of meters (SD)	511 (85)	491 (73)	0.001	536 (96)	514 (95)	0.01
Speed mean, m/s	1.42	1.36	0.005	1.49	1.43	0.03
Box climbing, n (%)						
50 cm height	155 (80)	42 (79)		304 (98)	51 (93)	
40 cm height	28 (14)	8 (15)		6 (2)	4 (7)	
30 cm height	5 (3)	1 (2)		0	0	
20 cm height	5 (3)	1 (2)		0	0	
10 cm height	1 (1)	1 (2)	0.9	1 (0)	0	0.6
Chair stand test 5 times						
Mean in s (SD)	12 (3)	14 (4)	0.0002	12 (4)	13 (4)	0.06
Tandem standing, eyes open						
Mean in s (SD)	27 (7)	24 (10)	0.001	26 (8)	26 (7)	0.9
Tandem standing, eyes closed						
Mean in s (SD)	12 (10)	9 (9)	0.01	12 (10)	10 (11)	0.2
Grip strength, kPa, mean (SD)	73 (14)	71 (15)	0.1	84 (17)	85 (17)	0.5
Vision impairment, n (%)	96 (23)	35 (23)	1.0	62 (15)	20 (24)	0.01
Taking daily walks, n (%)	243 (54)	79 (46)	0.08	194 (43)	33 (38)	0.4
Self-rated fitness level, n (%)						
Miserable	16 (4)	8 (5)		13 (3)	2 (2)	
Bad	78 (17)	44 (26)		75 (17)	27 (31)	
Pretty good	203 (45)	85 (49)		198 (44)	42 (48)	
Good	145 (32)	32 (19)		151 (34)	16 (18)	
Very good	10 (2)	3 (2)	0.01	14 (3)	1 (1)	0.001
Exercise frequency, n (%)						
Never	192 (43)	95 (53)		190 (42)	38 (43)	
Once per month	6 (1)	6 (4)		15 (3)	2 (2)	
Once per week	84 (19)	27 (16)		72 (16)	12 (14)	
2-4 times per week	158 (35)	45 (26)		158 (35)	35 (40)	
Daily	11 (2)	3 (2)	0.01	19 (4)	1 (1)	0.9
Self-rated health, n (%)						
Very good	52 (12)	9 (6)		63 (16)	6 (7)	
Good	178 (43)	36 (25)		158 (39)	25 (31)	
Fairly good	137 (33)	61 (42)		151 (37)	30 (37)	
Bad	46 (11)	38 (26)		31 (8)	17 (21)	
Very bad	3 (1)	3 (2)	0.0001	4 (1)	3 (4)	0.0001
Nr of medications, n (%)						
0	60 (13)	9 (5)		83 (18)	12 (13)	
1-5	276 (60)	90 (51)		274 (59)	46 (52)	

The association between dizziness and falls among women, but not among men, has been reported previously[10], but the reasons for these sex differences are little explored. One possible explanation could be that men do not remember falls, if the fall cause them no harm. Riva et al. [29] found older women to be significantly less stable than older men, potentially explaining why falls are reported more often among women than among men. Riva and colleagues also showed that the decreased stability in older persons may be explained by impaired proprioceptive control and a decrease in compensatory visual stabilization [29]. Another explanation can be that men have better endurance and muscle strength in the lower extremities [30], also seen here, where men performed better on the box climbing test.

We found that women with dizziness were less physically active than those without dizziness, which is in line with prior population-based research from the same area showing that persons with dizziness are less physically active than non-dizzy individuals [5]. Prior falls are an important risk factor for future falls, indicating that this sex difference regarding falls might continue in later years, at least if imbalance symptoms are not treated. Unfortunately, avoidance of activity and movement might lead to further adverse effects of balance and potentially even more sedentary behavior.

Both women and men with dizziness performed worse on the 6-MWT than their non-dizzy counterparts. The 6-MWT was chosen as a physical capacity measure because of its ease of administration and similarity to normal daily activities [27]. The participants in the current study showed a high walking speed, representing an overall high level of fitness and health in relation to other age-related reference groups [31], and around half of the participants reported regular exercise. Despite this high level of functioning, more than one quarter of the female participants reported dizziness.

Women with dizziness performed significantly worse on the chair stand test than women without dizziness, indicating a difference in muscular strength in the lower extremities between the two groups. The chair stand test measures endurance and leg muscle strength as well as balance. Good muscle strength in the lower extremities is essential for maintaining balance and avoiding falls when stumbling and losing equilibrium and a study from 2014 by Maarsingh et al. found impaired function of the lower extremities to be an important predictor of dizziness in older adults at 7- and 10-year follow-ups [32]. No difference regarding grip strength between participants with and without dizziness was observed in this study, even though it has been shown that hand strength can be used to identify participants that need to improve muscle strength and function in general [27,33]. Study participants could generally only manage tandem standing for a short period, possibly due to age and the high demand on balance in this test. Tandem standing with eyes opened or closed is a more difficult test than the Romberg test when standing with the feet together. Tandem standing indicates balance, while standing in an upright position provides information about postural control. Tandem standing with eyes closed is often a difficult test, especially for persons with balance issues since visual cues are not present, and thus full trust of the vestibular and proprioception systems is required.

Women in this study took more medications and reported seeking medical care more often than men. Women also reported experiencing dizziness and that dizziness impacts their daily lives more often than men, as reported by others [34]. Women seek medical care due to fall-related injuries more often than men, while men die due to fall-related injuries more often than women [35]. Preventing falls is, and will continue to be, a major concern since fall-related accidents entail enormous costs for society, both economically and considering patient pain and morbidity [21,36]. As dizziness and imbalance are some of the absolute most important risk factors for falls, preventing dizziness and enhancing balance will be major challenges for society in the future.

A 2018 study by Marcos Rossi-Izquierdo et al. showed that vestibular rehabilitation can decisively improve balance and hopefully even reduce dizziness, in older individuals with instability, which can lead to a significant reduction of falls [37]. Vestibular rehabilitation with balance enhancement training and strength training, especially for lower extremities, can reduce the number of falls while promoting balance and increasing the number of healthy active years at older ages [21,36]. Exercise is effective in preventing injuries due to falls [38] and may possibly be effective if started as late as age 70.

Strengths and limitations

The strength of this study is the population-based sample with high response rate, selected through date of birth in the population registry. The examinations were carried out by physiotherapists and specially trained nurses, public health professionals or physicians. Due to the cross-sectional design of the study, the direction of the associations cannot be established. This study has not investigated sensibility in lower extremities, which would have been interesting when evaluating balance.

CONCLUSIONS

In this population-based sample of 70-year-olds, one-third of the women with dizziness had fallen during the last year, which was almost twice as often as women

without dizziness. Both men and women with dizziness reported lower health and physical capacity than those without dizziness. The number of medications and dizziness were identified to have significant associations with falls. We believe that postural- and weight training as vestibular rehabilitation may be effective already at age 70 to avoid future falls and enhance overall well-being.

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Conflict of interest statement
The authors declare no conflict of interest.

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Ethical considerations
The study was conducted according to the Declaration of Helsinki and was approved by the Regional Ethical Review Board in Gothenburg, Sweden (approval number 869-13). All participants provided written informed consent before inclusion in the study.

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