Interpreting Fear of Falling in the Elderly: What Do We Need to Consider?

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ABSTRACT

Purpose: Fear of falling (FF) is a serious problem in elderly. Available scales quantify FF by generating an aggregate total FF score disregarding the environment in which fear is expressed. This study examined the differences in psychosocial and physical characteristics and global functional capabilities between the elderly who experienced FF exclusively for activities usually performed in community environments and those who reported FF only for home-based activities. **Methods:** Older participants (age ≥ 65, n=1155) enrolled in the InCHIANTI study completed the evaluation of FF, personal mastery, depression, cognition, social support, lower limb strength, grip strength, balance, timed repeated sit-to-stand performance, visual acuity, and contrast sensitivity. Functional capacity measures included walking speed, ADL and IADL disability, self-reported difficulty climbing steps without support and difficulty walking at least 400m. Only those who reported FF exclusively for activities usually performed in the community environment (n=232) or in home environment (n=110) were included in the analysis. **Results:** Multivariate analysis of variance revealed that those who reported FF exclusively for home-based activities were significantly worse in psychosocial and physical characteristics measured ($F_{(1,339)}$= 4.27; p < 0.01) and were also less able in all global functional capacity measures (p= 0.04 to < 0.01). **Conclusions:** There are significant characteristic and functional differences between the older persons who have FF performing community environment activities and those who express FF in home environment activities. The results strongly indicate the need to classify FF according to the environment or alternatively, to derive an aggregate score by appropriately weighting according to the environment, for valid interpretation of FF.

Key Words: fear of falling, aging, environment

INTRODUCTION

Fear of falling (FF) is defined as a lasting concern about falling that can lead an individual to avoid activities that he/she remains capable of performing.[1] It is a serious and common problem among aging adults and has been identified as a legitimate focus for geriatric rehabilitation in several intervention studies.[2-5] Aging adults rate FF highest among other common fears such as criminal violence, financial crisis, or adverse health event.[6,7] Almost 50% of community dwelling older persons report FF[8,9] and the prevalence is even higher in certain subpopulations, for example, older women;[10] those with a previous history of falls;[11] and in persons with certain comorbidities such as rheumatoid arthritis and stroke.[12,13] Many fearful older persons resort to activity restriction, which in the long term may adversely impact both physical and mental health and actually increase risk of future falls.[10,14]

Fear of falling is quantified using standardized questionnaire scales. These scales either directly inquire about the FF (eg, Survey of Activities and Fear of Falling in the Elderly: SAFE)[15] or about confidence in maintaining balance or preventing a fall (eg, Activity specific Balance Confidence scale: ABC and Fall Efficacy Scale: FES)[16,17] while performing specific activities. These activities comprise a combination of activities performed in home environments (eg, walking around the house) and those performed in community environments (eg, shopping). According to present methods, the severity of FF is indicated by an aggregate score (total FF) disregarding the underlying environment in which fear is expressed.[15-17]

Although the home environment cannot be claimed to be completely inert, the complexity of the environment in terms of hazards and risks increases multifold in community settings.[18] In addition, community environment is less familiar compared to home environment. Therefore, biomechanical constraints and demands on information processing required for control of balance and maintaining stability are significantly more in community environment.[19] For example, walking around in a familiar and relatively static home environment is far less challenging as compared to walking in a crowded mall or crossing a street under temporal constraints of a traffic light.

The higher challenges imposed by community environment on balance control mechanisms instinctively suggest that fear of falling in community environment will precede fear of falling in home environment. Consequently, as expected, when FF scores in our population-based study (The INCHIANTI study)[20] were segregated according to activities performed in home and community environment, the results demonstrated that almost 34% older persons reported FF for activities commonly performed in community environment only; without any fear of falling for home-based activities. Unexpectedly, however, almost 16% of the older persons reported FF exclusively for the activities performed in home environments, with no FF for community-based activities. The primary purpose of this exploratory study was to identify underlying psychological, social and physical characteristics of older persons independently associated with exclusive FF either for activities performed in home or in community environment. The secondary purpose was to understand whether there are differences in the global functional capabilities between these two groups.

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METHODS

Participants

The InCHIANTI ('Invecchiare in Chianti' or aging in the Chianti area) Study is a population-based epidemiological study conducted to understand factors contributing to decline in mobility in late life. The study population represents the sample of the population living in two towns of the Chianti countryside of Tuscany, Italy. The study design and data collection have been described previously elsewhere.[20] Briefly, in 1998, 1270 older persons (aged ≥65 years) were randomly selected from the population registry of the two sites. Out of these, 1155 agreed to participate and were interviewed in their homes. Of those interviewed, 1026 also participated in a comprehensive medical examination and mobility evaluation at the local clinical center. Follow-up data were collected after 3 and 6 years. The study protocol was approved by the ethical committee of the Italian National Institute of Research and Care of Aging and complies with the Declaration of Helsinki. All participants received a detailed description of the study purpose and procedures and all signed informed consent.

All participants completed the Survey of Activities and Fear of Falling in the Elderly (SAFE) questionnaire[15] at the baseline to quantify FF. This is a reliable and valid scale that inquires about fear of falling for an array of 11 common activities performed outside and inside the home environment without assistance.[21] Community-based activities include shopping, walking outside home, walking on a slippery surface, visiting relatives or friends, going to crowded place and going for long walks. Home-based activities comprise of cooking, bathing or showering, getting out of bed, reaching up, and bending down to pick-up objects. For each activity, participants were asked whether they usually performed that activity. If the response to this first question was affirmative, they were asked if they were afraid of falling while performing that activity. If the response to the first question was negative, they were asked whether they usually did not perform that activity specifically because of fear of falling. Restriction of the activity due to any reasons other than fear of falling was exempted. The aggregate score of 'total fear of falling' (Total FF) was computed by adding the total number of activities for which the participant was either afraid of falling while doing the activity or if they usually did not perform that activity because of fear of falling (range 0 - 11).[8]

Participants with severe cognitive impairment (n = 78, MMSE scores < 15)[22,23] and those who used a proxy for the interview (n = 10) were excluded from this analysis. Out of 1067 remaining InChianti subjects, the potential participants for this project consisted of 673 individuals who reported some fear of falling (SAFE score >0). Participants who reported FF for both home-based and community-based activities were excluded from the analysis (n = 331). The participants who reported exclusive FF for activities performed in either community environment (n = 232) or in home environment (n = 110) were included in the final analysis.

Measures

Psychological domain

Cognitive function was evaluated by the Mini Mental State Examination (MMSE, range 0–30, higher scores indicate better cognitive functioning).[22] The MMSE is a reliable and valid test for measuring global cognition.[24] A MMSE score less than 24 suggests mild cognitive impairement.[22]

Depressive symptoms were evaluated using the Center for Epidemiological Studies Depression scale (CES-D), a 20 item self-report questionnaire. Scores can range from 0 to 60, with higher scores indicating more depressive symptoms. Scores above 16 indicate clinically relevant depressive symptoms. Center for Epidemiological Studies Depression scale is a reliable and valid measure for quantifying depressive symptoms.[25]

To evaluate the sense of personal mastery, a short version Pearlin and Schooler Mastery Scale (PSMS) was used (6 items, scores ranging from 6 to 30, higher scores indicate more mastery). Sense of mastery addresses the extent to which a person feels in control of his or her own life circumstances and how s/he would react to stresses, difficulties, and adversities of life.[26] The PSMS is a reliable and valid scale for assessing the sense of mastery.[27,28]

Social support

Social support from 9 categories of people (spouse, son, daughter, sister, brother, daughter-in-law, son-in-law, other relatives, other nonrelatives) was included to measure the degree of available social support. Participants were asked about the availability of these people (1 = completely available to 4 = not available) in case help or assistance was required. The mean score was calculated with higher scores indicating less support.[8]

Physical domain

A modified version of the test developed for The Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT- 4) trials was used to assess standing balance.[29] The test consists of 4 progressively more difficult positions: (1) standing with feet parallel and together (side by side); (2) standing in semi-tandem: side of the heel of one foot touching the big toe of the other; (3) standing in tandem, with one heel directly in front of and in contact with toes of the other foot, and (4) standing on one leg. If a subject could not maintain the parallel stance (position 1), the testing was performed with feet slightly apart, positioned directly below respective anterior superior iliac spines. If the participant could not maintain this alternative position, s/he was allowed to stand with the feet at any distance apart (free base). Standing balance was tested only in eyes open conditions. The time that each stance could be maintained (1-10 sec) was measured with a stopwatch. The scores range from 0 to 24, higher scores indicating better balance (Appendix 1). The FICSIT balance test is a reliable and valid protocol for measuring standing balance when visual information is available.[29]

Timed repeated sit-to-stand (TSS) is a valid test designed to assess the overall performance of the lower limbs while also reflecting dynamic balance.[30,31] The use of arms or an assistive device was not permitted. The time taken to complete 5 sit to stand to sit cycles times was measured using a stopwatch. Maximum time allowed was 50 seconds.

Strength of 4 lower limb muscle groups (hip flexors, hip abductors, knee extensors, and ankle dorsiflexors) was measured in kilograms (kg) using a hand-held dynamometer (Nicholas Manual Muscle Tester, model BK-5474, Fred Sammons, Burr Ridge, IL).[32] Strength of hip flexors, knee extensors, and ankle dorsiflexors was measured in a sidelying position. Hip abductor strength was measured in supine position. For assessment of hip flexors and abductors, the dynamometer was placed 10 cm above the superior margin of patella on the anterior and lateral

aspects of the thigh, respectively. For measuring knee extensor strength the dynamometer was placed on the anterior surface of the leg 10 cm above the proximal margin of external malleolus. Strength of the ankle dorsiflexors was measured by placing the dynamometer on the intermediate dorsal surface of the foot with the upper edge parallel to a line drawn through the head of the 5th metatarsal. Three measurements were taken, and maximum value was noted.[32] Normalized muscle strength was calculated by dividing maximum strength by body mass (kg).[33] Because there is significant correlation between the strength of 4 lower limb muscle groups (r = 0.87 to 0.92), average lower limb muscle strength was calculated from normalized strength of the 4 muscle groups.

Grip strength was measured with a hydraulic dynamometer (Smith and Nephew, Agrate Brianza, Milan, Italy). The participant was seated with the forearm supported on the table and the elbow flexed to 45°. The average of 2 attempts for each hand was calculated and the higher of the 2 averages was then normalized for body mass.[8]

Visual acuity was tested using a standard Snellen eye chart.[34] Visual acuity scores were graded from 0.04 to 0.50 logMAR, with higher values representing better acuity. A standard Pelli-Robson chart test was used to measure contrast sensitivity.[35,36] The last correctly identified letter was noted and the associated log contrast sensitivity was recorded. Contrast sensitivity scores range from 0.00 to 2.25 logMAR, higher values indicating better contrast sensitivity. The vision testing was completed using binocular vision with participant's usual corrective lenses.

Global Functional capability

Usual walking speed was measured in meters/second (m/s) over a 7 meter course. The starting location for walking was marked with a colored tape. The end of the walking path at the distance of 7 meters was not marked, to prevent anticipatory deceleration. A photocell was mounted at either ends of the 7 meter walking path. The total time to complete the walking task was measured starting as a foot crossed the plane of the first photocell, and ended when a foot crossed the plane of the second photocell.

Participants were asked if they could go up a flight of stairs without support (yes/no) and if they had difficulty walking 400 meters (yes/no). Additionally, participants were asked to report the number of activities of daily living (ADLs: bathing, dressing, eating, getting into and out of bed or chair, walking across a room and using the toilet) for which they required help; and an ADL disability score ranging from 0 to 6 was calculated. The disability score for instrumental activities of daily living (IADLs: preparing meals, shopping for groceries, managing money, making phone calls, light housework, heavy housework, getting to places outside of walking distances and managing medications) was computed in the same way (range 0 to 8).[37]

Demographic factors such as age, gender, and body mass index (BMI) (kg/m^2) were also recorded. Comorbidity index was determined by the total number of prevalent comorbidities (Parkinson's disease, stroke, angina, myocardial infarction, congestive heart failure, asthma, chronic obstructive pulmonary disease, hip fracture, hip or knee replacement surgery, symptomatic knee osteoarthritis, severe hip/knee/back pain, peripheral vascular disease and diabetes) from a self-reported questionnaire, the medical examination, and laboratory tests. Comorbidity index[38] and a history of a fall in the previous year (as defined by Tinitti [39]) were used for descriptive purposes.

Statistical analyses

Variables with a skewed distribution (FF, CES-D, MMSE, visual acuity and contrast sensitive, ADL and IADL disability scores) were log transformed for the analysis and back-transformed for data presentation. General linear model multivariate analysis was used to identify psychological, social, and physical characteristics independently associated with the fear of falling exclusively in the community and the home environments. Actual FF score was used as a covariate for this analysis to avoid potential confounding effects of degree of fear falling while identifying group differences. Univariate general linear models (for continuous variables) and binomial logistic regression (for categorical variables) analyses were used to test between group differences in the functional capabilities, adjusting for age, gender, and BMI. Missing values were replaced by overall means. All statistical analyses were conducted using SPSS version 13.0.

RESULTS

Out of 673 participants who reported some FF, 232 participants (age:73.5 ± 6.2, males 38.8%) reported FF exclusively for the activities performed in the community environments (Group I) and 110 participants (age:77.7 ± 77.5, males 30.9%) reported FF exclusively for the activities performed in the home environment (Group II). Multivariate analysis (overall $F_{(1,339)} = 4.27$, $p < 0.01$) revealed that older age, lower personal mastery, higher depressive symptoms, lower social support, lower muscle strength, worse dynamic balance, and poor visual contrast sensitivity were independently associated with fear of falling exclusively for activities performed in home environments (Table 1). Impaired cognition was also associated with fear of falling exclusively for activities performed in home environment; however, actual between-group differences in the MMSE scores were minimal.

After adjusting for demographic factors of age, gender, and BMI, participants who reported FF specifically for home-based activities generally demonstrated lower functional capability (Table 2A) compared to those who experienced FF only for community-based activities.

DISCUSSION

Using population-based sample of older adults we investigated the psychological, social, and physical characteristics independently associated with fear of falling exclusively for activities in either home or in community environment. The results clearly demonstrate that individuals who reported fear of falling only for home-environment activities were older and had significantly less psychological and social resources, as well as more difficulty with physical performance. Not surprisingly, they also demonstrated lower global functional capabilities.

Presently, the severity of FF is derived by using questionnaire scales that provide the total number of activities for which FF is reported. The activities include a combination of activities typically performed either in home environment or in community environment. However, considering the differences in the challenges imposed on maintaining balance and stability in these two environments,[18,19] activities in each of these environments might not make equal contribution to the overall severity of fear of fall-

Table 1. Psychological, social, and physical performance characteristics [Means (SD)] of the older persons who reported fear of falling exclusively for activities primarily performed in community environment (Group I) and those who expressed fear of falling only for activities usually performed in home environments (Group II). F and p values indicate significance in the multivariate analysis.

	FF in community environment Group I: n=232	FF in home environment Group II: n=110	F	*p*
Age (years)	73.5(6.2)	77.7(7.5)	21.09	<0.01
Gender (%males)	38.8	30.9	1.20	0.27
BMI (kg/m^2)	27.28(3.65)	27.21(3.64)	0.24	0.62
Personal Mastery[a]	20.3(3.9)	18.1(3.9)	15.79	<0.01
Depressive symptoms[b]	11.8(7.8)	16.5(9.1)	16.39	<0.01
Cognition[c]	25.4(2.9)	24.2(3.6)	7.28	<0.01
Social support[d]	20.1(6.3)	23.6(5.9)	20.49	<0.01
Average lower limb strength normalized for body weight	0.65(0.16)	0.58(0.18)	10.79	<0.01
Grip strength Normalized for body weight	1.08(0.41)	0.95(0.34)	5.95	0.01
Standing balance[e]	21.3(3.3)	19.9(3.7)	1.42	0.23
Si-to-stand performance[f] (s)	11.0(2.7)	13.0(6.8)	11.63	<0.01
Visual acuity[g]	0.42(0.12)	0.39(0.10)	3.64	0.06
Visual contrast sensitivity[h]	1.7(0.1)	1.6(0.1)	11.21	<0.01

[a] short version Pearlin and Schooler Mastery Scale (PSMS);
[b] Center for Epidemiological Studies Depression scale (CES-D);
[c] Mini Mental State Examination (MMSE);
[d] a total score for availability of 9 categories of people (1 = completely available to 4 = not available) in a hypothetical scenario where help or assistance was required;
[e] Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT- 4);
[f] time taken to get up and sit down in a chair 5 times;
[g] Snellen eye chart; [h]Pelli-Robson chart

ing. For example, fear of falling in a relatively low-risk activity such as walking around in the house should be considered a far bigger concern compared to fear of falling in a highly challenging community-based situation such as while walking on a slippery icy surface. This is supported by our findings that fear of falling in exclusively home environments is associated with significantly less physical, psychological, and social function compared to fear of falling only in community environment. To achieve better insight into our findings the total FF was computed for these participants using a usual method (ie, using the aggregate score independent of the environment); there was no difference in the FF of the 2 groups thus measured ($F_{(1,337)} = 3.81$, $p = 0.09$). This may mask severity of FF and, therefore, about the risk factors and consequences of FF. Our results suggest the need to classify FF according to environment or, alternatively, to derive a strategy for

Table 2. Global functional performance (A) and descriptive variables (B) of the older persons who reported fear of falling exclusively for activities primarily performed in community environment (Gr I) and those who expressed fear of falling only for activities usually performed in home environments (Gr II). F or X^2 values are reported as appropriate. p values indicate significance after adjusting for age, gender and BMI.

	FF in community environment (Group I: n=232)	FF in home environment (Group II: n=110)	F or x^2	*p*
A. Global functional performance				
Walking speed (m/s)	1.2(0.2)	1.0(0.3)	6.65	0.01
Inability to do steps without support (%)	47.0	70.0	4.27	0.04
Difficulty for walking 400 m (%)	9.9	43.6	29.14	<0.01
ADL disability[a]	0.1(0.4)	0.4(1.0)	19.56	<0.01
IADL disability[b]	0.3(0.9)	1.5(2.5)	21.07	<0.01
B. Descriptive variables				
History of falls in the past year (%)	21.1	30.0	1.10	0.29
Comorbidity Index	2.1(1.2)	2.3(1.3)	1.79	0.18

[a] number of difficulties in basic activities of daily living
[b] number of difficulties in instrumental activities of daily living

weighing FF according to the environment and then generating the aggregate or total FF score.

Considering the greater challenge inherent in activity in community environments, it was surprising that nearly 16% of our subjects who reported some fear of falling for home environment activities did not endorse any fear of falling for community-based activities. On further scrutiny, we found that more than 25% (n=29) of participants did not actually perform any of the community-based activities, possibly due to reasons other than fear of falling. Among those who reported FF for community-based activities, only 3 participants (1.3%) did not perform any community-based activities. Subsequent analysis was done, computing total number of community-based activities that participants actually performed (range 0 - 6). It was clear that compared to those who reported FF for community-based activities, those who reported FF for only home environment activities actually performed significantly fewer community activities ($F_{(1,337)} = 52.69$, $p < 0.01$). The more compromised functional capabilities of these participants (Table 2) suggests that they were more frail and typically performed at the lower end of the functional spectrum.

Overall results suggest that, when interpreting FF, balance confidence or fall efficacy scores, both classification by environment in which fear occurs and number of activities not performed due to other reasons must be considered. Some questionnaires require participants to make a hypothetical de-

cision about their confidence level for maintaining balance if the participants do not perform some of the activities included in the questionnaire.[16] The number of activities not typically performed may in fact reflect the functional status of the individual and may assist in valid interpretation of FF scores.

In conclusion, FF is known to be a multifactorial pervasive problem among aging adults that can lead to detrimental consequences such as activity restriction, social withdrawal, and loss of independence. Fear of falling is, therefore, a legitimate focus for rehabilitation in older persons. Compared to those who reported FF exclusively in community environment, those who reported FF exclusively in home environment were significantly less capable in terms of psychosocial, physical, and functional status. Use of a total FF that does not consider environment in which the fear occurs is probably misleading. Our findings suggests that considering both environment and typical activity improves quantification and interpretation of fear of falling. Including these factors may assist planning of well-targeted interventions and evaluation of the efficacy of those interventions.

ACKNOWLEDGEMENT

The InCHIANTI study was supported as a "targeted project" (ICS 110.1\RS97.71) by the Italian Ministry of Health and in part, by National Institute on Aging Contracts N01-AG-916413, N01-AG-821336, N01-AG-5-0002, and NIA Grant R01 AG027012 and the Intramural Research Program, National Institute on Aging, NIH.

Appendix 1. Balance Measure

Score	Best Position	Time (sec)	Condition
0	ASIS	< 1	
2	ASIS Free Base	2-9 2-9	
3	ASIS Free Base	2-9 10	With sway
5	ASIS	10	With sway
6	ASIS	10	Still
9	SBS ASIS Free Base	2-9 2-9 2-9	
12	SBS ASIS	2-9 10	With sway
13	SBS ASIS	2-9 10	Still
14	SBS Semi-tandem	10 <1	With Sway
15	SBS Semi-tandem	10 <1	Still
16	Semi-tandem	2-9	
17	Semi-tandem Tandem	10 <1	With sway
18	Semi-tandem Tandem	10 <1	Still
19	Tandem	2-9	
20	Tandem One leg	10 <1	With sway
21	Tandem One leg	10 <1 sec	Still
22	One leg	2-9 sec	
23	One leg	10	With sway
24	One leg	10 sec	Still

The participant was asked to maintain an erect standing position for 10 seconds in a series of positions characterized by progressive reduction of the base of support in the frontal plane. Foot positions were as follows:

ASIS	Feet placed under the respective anterior superior iliac spine
Free Base	Unable to maintain ASIS position >1 sec, used comfortable foot position;
SBS	Feet together in semi-tandem (heel of front foot at base of Hallux of back foot
Tandem	Heel of front foot directly touching big toe of back foot;
One Leg	Standing on one leg only.

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