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Re-evaluating the Implications of Recurrent Falls in Older Adults: Location Changes the Inference

Jennifer L. Kelsey, Ph.D.^{*}, Elizabeth Procter-Gray, Ph.D., M.P.H.^{*}, Sarah D. Berry, M.D., M.P.H.^{†,‡}, Marian T. Hannan, D.Sc., M.P.H.^{†,‡}, Douglas P. Kiel, M.D., M.P.H.^{†,‡}, Lewis A. Lipsitz, M.D.^{†,‡}, and Wenjun Li, Ph.D.^{*}

^{*}University of Massachusetts Medical School, Division of Preventive and Behavioral Medicine, Worcester, Massachusetts

[†]Institute for Aging Research, Hebrew Senior Life, Boston, Massachusetts

[‡]Department of Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Department of Medicine, Boston, Massachusetts

Abstract

OBJECTIVE—To compare characteristics of indoor and outdoor recurrent fallers and explore some implications for clinical practice, in which a fall risk assessment for all recurrent fallers has been recommended.

DESIGN—Prospective cohort study.

SETTING—MOBILIZE Boston, a study of falls etiology among community-dwelling older individuals from randomly sampled households in the Boston MA area.

PARTICIPANTS—713 women and men, mainly of age 70 years and older, with at least one year of follow-up.

MEASUREMENTS—Data at baseline and an 18-month follow-up examination were collected by questionnaire and comprehensive clinic examination. During follow-up participants recorded falls on daily calendars. A telephone interview queried location and circumstances of each fall.

RESULTS—145 participants reported recurrent falls (≥ 2 falls) during the first year. Those who had fallen only outdoors had good health characteristics, whereas those who had fallen only indoors were generally in poor health. For instance, 25.5% of indoor-only recurrent fallers had gait speeds < 0.6 meters/second compared to 2.9% among outdoor-only recurrent fallers; the respective percentages were 44.7% and 8.8% for Berg balance score < 48 . Recurrent indoor fallers

Corresponding Author: Jennifer Kelsey, University of Massachusetts Medical School, Division of Preventive and Behavioral Medicine, Shaw Building, 55 Lake Avenue North, Worcester, MA 01655. Telephone and fax: 860 664-4246; jennykelsey@comcast.net. Alternate Corresponding Author: Wenjun Li, University of Massachusetts Medical School, Division of Preventive and Behavioral Medicine, Shaw Building, 55 Lake Avenue North, Worcester, MA 01655. Telephone: 508 856-6574; fax: 508 856-4543; Wenjun.Li@umassmed.edu.

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generally had poor health characteristics regardless of their activity at the time of their falls, whereas recurrent outdoor fallers who fell during vigorous activity or walking were especially healthy. A report of *any* recurrent falls in the first year did not predict number of positive findings on either a comprehensive or abbreviated fall risk assessment at the 18-month follow-up examination.

CONCLUSION—Characteristics of community-dwelling older people with recurrent indoor and outdoor falls are very different. If confirmed, these results suggest that different types of fall risk assessment are needed for specific categories of recurrent fallers.

Keywords

recurrent falls; risk factors; aging research; fall risk assessment

Falls in community-dwelling older people are sometimes seen as early indications of illness, and repeated falls are frequently regarded as portending a decline in functional ability.¹ Recurrent falls have been associated with increased physician contact, functional decline, admission to long-term care facilities, and mortality.^{2–6} The American Geriatric Society (AGS) and British Geriatric Society (BGS) have recommended that all persons who report recurrent falls in the past year have a comprehensive multifactorial fall risk assessment performed by a clinician.^{7,8}

It is known, however, that persons who fall outdoors are on average healthier than others of their age, while those who fall indoors tend to have compromised health.^{9–15} To our knowledge, no reports have examined whether health characteristics of *recurrent* fallers differ according to the location of the falls. In addition, it has long been recognized that a person's activity at the time of a fall is important in evaluating the fall.¹⁶ If people who fall recurrently outdoors or who fall during certain activities tend to be healthier than other individuals, then these falls should not necessarily trigger the same comprehensive follow-up by a clinician.

Our primary purpose is to examine among recurrent fallers whether indoor and outdoor falls and falls during various activities are indicators of different health profiles. We also explore the implications of our findings for clinical practice.

METHODS

The data used in these analyses are from the Maintenance of Balance, Independent Living, Intellect, and Zest in the Elderly of Boston Study (MOBILIZE Boston), described in detail elsewhere.^{17,18} Briefly, MOBILIZE Boston is a prospective cohort study to identify risk factors and mechanisms of falls among 765 community-dwelling men and women, mainly aged 70 years and older, who live in the Boston, Massachusetts, area. Other eligibility criteria included ability to read and speak English, ability to walk 20 feet without the assistance of another person, intention to stay in the Boston area for at least 2 years, and adequate cognition (scoring at least 18 points on the Mini-Mental Status Examination¹⁹). Participants were enrolled from September 2005 to December 2007, using door-to-door recruitment in randomly sampled households with at least one member aged 70 years and older as recorded in annual Massachusetts town lists. From 5,655 sampled households, 4,303 people aged 70 years and older were identified. Of the 4,303, 1,581 were not eligible, and 1,973 either refused to participate or were unable to be contacted. Sixteen persons in the age range 64–69 years who were spouses or living with a participant were added to the cohort, for a total of 765 participants. The data presented here are based on events during the first 2 years of follow-up, and include the 713 participants who had at least one full year of

follow-up. This study was approved by the Institutional Review Board of Hebrew SeniorLife; all participants signed a consent form.

At baseline and at 18 months, participants underwent comprehensive assessments, including a home visit and clinic examination. In analyzing associations between baseline data and subsequent falls, it was decided *a priori* to include age, gender, and 12 key indicators of health status at baseline. Physical activity level in the previous week was estimated using the Physical Activity Scale for the Elderly (PASE) questionnaire.²⁰ The Short Physical Performance Battery (SPPB) measured lower extremity function.²¹ Balance was measured using the Berg balance scale.²² Inability to perform chair stands (unable or used arms) was also assessed. Gait speed (m/sec) was the shortest time in 2 trials for a usual-paced four-meter walk.²³ The Activities of Daily Living (ADL) scale^{24, 25} was scored according to ability to perform 5 activities (bathing, dressing, toileting, transferring, eating). Number of self-reported comorbid conditions was summed from the participant's response to whether a health care provider had told her/him that she/he had any of several specific major medical conditions.²⁶ Participants rated their health status as excellent, good, fair, or poor. Each participant's prescription and over-the-counter medications used during the previous 2 weeks were coded using the Iowa Drug Information System (IDIS) ingredient codes.²⁷ Topical medications, vitamins, and herbals were excluded. Psychotropic medications included anti-depressants, hypnotics, benzodiazepines, anti-psychotics, or other sedatives. Fear of falling was measured by the Falls Efficacy scale.²⁸ The Mini-Mental State Exam (MMSE) assessed cognitive function.¹⁹

A fall was defined as unintentionally coming to rest on the ground or other lower level. A recurrent faller was a person who had 2 or more falls during the first year or during the first and second years of follow-up, depending on the analysis. During the home visit, interviewers instructed participants on how to use a calendar to record whether a fall occurred each day. At the end of each month participants mailed their falls calendar to the study office. Those not returning calendars within 10 days of the end of a month or returning an incomplete calendar were telephoned by study staff. Information on whether a fall had occurred was obtained for 98.5% of follow-up months in the first year and 90.8% in the second year.

When participants reported a fall, a structured telephone interview was conducted to determine the circumstances. The first question was, "Could you please describe to me, what happened when you fell on (date)?" As needed, this was followed by: "What were you doing when you fell?" and "Where were you exactly when you fell?" Location of the fall (indoors versus outdoors) was available for 1121 (99.6 %) of the 1126 reported falls included in these analyses for the first 2 years of follow-up. An indoor fall was one said to have occurred inside the participant's home, inside someone else's home, inside another building, or inside, other location. During the first 2 years of follow-up, 80.4% of all indoor falls occurred in a person's own home. Outdoor falls were those reported to have occurred anywhere outside. From this information, the following "faller categories" were created: recurrent indoor falls only, recurrent outdoor falls only, at least one indoor and one outdoor fall, one indoor fall only, one outdoor fall only, and no fall. The activity of a person at the time of the fall was available for 1111 (98.7%) of the falls. The activities were initially grouped in 7 categories: vigorous physical activity; walking; ascending stairs; descending stairs; transitioning, which includes getting in or out of a chair, bed, car, or tub/shower; not moving at all; and other or unknown. They were subsequently combined into the 4 groups shown in Table 2, omitting the other or unknown.

In the statistical analysis, we first compared baseline characteristics of participants in the various faller categories during the first year of follow-up. P-values for differences between

characteristics of indoor-only recurrent fallers and outdoor-only recurrent fallers were based on the Kruskal-Wallis rank test for quantitative variables and the chi-square test for categorized variables. We next examined baseline characteristics of indoor and outdoor recurrent fallers according to their activity at the time of the fall, using falls during the first 2 years of follow-up in order to have larger numbers.

Then, we explored the usefulness of recommendations such as those in the AGS/BGS Guidelines⁸ that all those with recurrent falls during the previous year have a comprehensive multifactorial fall risk factor assessment. First we examined the extent to which recurrent indoor falls, recurrent outdoor falls, any recurrent falls, and one-time falls were associated with number of positive findings on 28 fall risk factors that were measured at the 18-month follow-up assessment. The 28 attributes, listed in a footnote to Table 3, were selected to approximate what is recommended for assessment in the Guidelines. They cover medical history; medications; findings on physical examination (e.g., balance, gait, mobility, lower extremity strength); cognition; and functional ability. To make such an assessment more relevant to what might be practical for routine clinical use, we also pre-selected a subset of 12 risk factors from the comprehensive risk assessment that are readily obtained from a clinical evaluation and that cover most of the areas represented in the Guidelines; when possible, we selected factors that are modifiable or treatable. These 12 risk factors are also listed in a footnote to Table 3, and include certain illnesses, signs, and symptoms; gait speed; leg strength; balance; cognition; vision; and medications. For both the 28 and 12 risk factor assessments, we first compared the mean number of positive findings among the categories of fallers, using the Kruskal-Wallis rank test to obtain p-values. We then tabulated the number of persons with various numbers of positive findings at the follow-up assessment according to their fall history during the first year. Trends were similar no matter what number of positive findings we used, and we show the results for the median value of ≥ 6 positive findings among all participants for the 28 risk factors and the median value of ≥ 2 positive findings for the 12 risk factors. Specifically, we show positive predictive values, defined as the percentage of persons in various faller categories during year one who had the given number of positive findings (e.g., ≥ 6 positive findings for the 28 risk factors, ≥ 2 positive findings for the 12 risk factors) at the 18-month follow-up examination, and the sensitivity, defined as the percentage of persons with the given number of positive findings (e.g., ≥ 6 for the 28 risk factors, ≥ 2 for the 12 risk factors) at follow-up who had been classified in various faller categories during year one. All statistical analyses were done in Stata 11.2 (Stata Corp., College Station TX).

RESULTS

One hundred forty-five participants reported recurrent falls during year one. About 32% had only indoor falls, 24% had only outdoor falls, and 44% had at least one indoor fall and one outdoor fall. Table 1 shows large differences in the health characteristics of the recurrent fallers who fell only indoors and only outdoors. The outdoor-only recurrent fallers had better health characteristics than even those who had not fallen at all, while the indoor-only recurrent fallers had by far the worst health characteristics of any of the groups. For most health characteristics, those who had fallen both indoors and outdoors were quite similar to the total study population, and had only slightly worse health status than those with no falls. The results were similar when we considered other periods of follow-up (data not shown).

Table 2 considers the activities of recurrent fallers at the time of falls during the first 2 years of follow-up. The columns are not mutually exclusive, as a person who had a fall in more than one activity category is counted in each category. Among indoor recurrent fallers, those who fell on stairs tended to be somewhat healthier than the other indoor fallers. Among

outdoor recurrent fallers, the small number who fell while transitioning or stationary tended to be in poorer health than those who fell in other outdoor activities.

Finally, if the recommendation in the AGS/BGS Guidelines⁸ that all recurrent fallers undergo a comprehensive multifactorial fall risk assessment is valid, then one would expect strong associations between a history of recurrent falls during the first year and positive findings on the follow-up assessment at 18 months. Among participants aged ≥ 80 years, almost all were positive for several risk factors, regardless of fall history. For instance, the mean numbers of positive findings out of the total of 28 on the comprehensive multifactorial risk assessment were 8.3 for indoor-only recurrent fallers, 8.4 for outdoor-only recurrent fallers, 7.5 for recurrent fallers with at least one indoor and one outdoor fall, 7.1 for non-fallers, 8.5 for fallers with only one indoor fall, and 7.3 for fallers with only one outdoor fall. Statistical tests indicated that the slight variation in means could easily have occurred by chance. In addition, for this age group none of the categories of fall history was better than chance in predicting various numbers of positive findings (e.g., ≥ 6 , ≥ 2) on either the comprehensive or abbreviated fall risk assessment (data not shown).

In contrast, among those < 80 years (Table 3), the mean number of positive findings differed considerably by fall history, with indoor recurrent fallers having by far the highest mean numbers of positive findings (mean = 10.4 for the 28 risk factors, mean = 3.3 for the 12 risk factors) and outdoor recurrent fallers the smallest (mean = 4.7 for the 28 risk factors, mean = 1.3 for the 12 risk factors). We then considered an adverse multifactorial risk assessment to be a certain number of positive findings. For example, among all recurrent fallers, 60.0% were found to have ≥ 6 positive findings on the 28-item multifactorial risk assessment, while in the entire cohort, 51.4% of the 432 participants who had the 18-month follow-up examination had ≥ 6 positive findings. For the 12-item risk assessment, the corresponding percentages for ≥ 2 positive findings were 56.7% and 52.8%, respectively. Thus, the likelihood of having more than the median number of positive findings among recurrent fallers was not much greater than the average regardless of fall history for either the 28-item or 12-item assessment. The highest positive predictive values, 88.0% for the 28-item assessment and 80.0% for the 12-item assessment, were for indoor-only recurrent fallers, and the lowest were for outdoor-only recurrent fallers. The sensitivity of any recurrent falls was only 24.3% in predicting ≥ 6 positive findings on the 28-item assessment, and only 22.4% in predicting 2 or more positive findings on the 12-item assessment. These figures indicate that using any recurrent falls as the criterion for referral would result in missing more than three-quarters of those with more than the median number of positive findings. The sensitivities for all faller categories were poor (Table 3). The highest sensitivities among fallers were for one or more indoor falls during the first year, while the lowest were for outdoor-only recurrent fallers. Relative differences among the faller categories were similar using a variety of numbers of positive findings as cutpoints, although positive predictive values substantially decreased and sensitivities for all but outdoor fallers tended to become slightly greater as the number of positive findings increased (data not shown).

In Tables 1, 2, and 3, if falls are categorized as indoor falls within the home versus falls in all other locations, the results are similar to those shown, except that the percentages with poor health characteristics were slightly greater among indoor at-home recurrent fallers than among all indoor fallers within each activity group in Table 2.

DISCUSSION

Recurrent falls have generally been considered an indicator of poor health,²⁻⁶ but our results suggest that although this is true for indoor recurrent falls, outdoor recurrent falls are associated with very good health. Therefore, recurrent falls in general are not an optimal

indicator of declining health, as the associations of outdoor falls with good health and indoor falls with poor health largely cancel each other out. The health status of persons who had falls both indoors and outdoors was similar to that of the entire cohort. Outdoor falls are common and important, but they are mostly associated with different risk factors from indoor falls.^{9–15} Thus, different approaches are needed for their prevention.

Tinetti and Speechley¹⁶ have called attention to the need to consider the activity at the time of the fall when assessing what the fall portends. We found that with the possible exception of falls on stairs, indoor recurrent falls were associated with indicators of poor health. Among outdoor recurrent fallers, those who fell at least once while transitioning or stationary were in much poorer health than other outdoor recurrent fallers, but only 12.7% of outdoor recurrent fallers reported one or more outdoor falls while transitioning or stationary.

When screening for health problems, good sensitivity and positive predictive value are highly desirable. High sensitivity means that a large percentage of people with the condition (e.g., a certain number of abnormalities on follow-up assessment) are identified, but the sensitivity was low for all categories of faller in this study. A high positive predictive value means that a large proportion of those referred for follow-up assessment in fact have positive findings on the assessment. For persons < 80 years, the positive predictive value for recurrent fallers was good, but little better than in the cohort as a whole. Among those aged ≥ 80 years, all categories of faller, including non-fallers, had multiple positive findings on follow-up.

Our results suggest that among those < 80 years, it will be more efficient to undertake comprehensive or abbreviated fall follow-up examinations only for persons who have had at least one indoor fall or recurrent indoor falls rather than for all people who have had recurrent falls. Among those < 80 years old, if those who have had recurrent falls only outdoors are excluded, the number of follow-up examinations would decrease by 29% (26/90). If those with both indoor and outdoor recurrent falls are also excluded, the number of follow-up examinations would decrease by 72% (65/90). However, even the value of referring indoor fallers for a follow-up examination was marginal. This finding is consistent with the work of Pepe et al.,³⁰ who showed that the association between a marker (e.g., recurrent falls) and an outcome (e.g., ≥6 or ≥2 positive findings on follow-up assessment) has to be very strong for the marker to be effective in classifying people according to the outcome.

We hypothesize that the difference in the health status of indoor and outdoor recurrent fallers is largely attributable to the tendency of less healthy people to stay indoors, so the question arises as to whether querying changes in the amount of time spent indoors and outdoors would be a better indicator of declining health than questions about falls.

Of course the purpose of a multifactorial risk assessment is not simply to identify a certain number of abnormalities, but to synthesize the data into a reasonable inference regarding the cause(s) of falls. Therefore, the most appropriate “gold standard” to assess the utility of follow-up examinations is whether modifiable causes of falls are identified and addressed. Since abnormalities on the comprehensive multifactorial risk assessment are so common in non-fallers and in those ≥ 80 years, it would be worth studying whether this assessment or an abbreviated assessment should be included in the routine evaluation of all older people, or at least those with limited outdoor activity.

MOBILIZE Boston data were not collected for the purposes of these analyses, and consequently our work has several limitations. No information on time spent indoors and outdoors was available. This study did not use all the specific components of the fall risk assessment recommended in the AGS/BGS Guidelines,⁸ although it did include most of

them. We could not explore the usefulness of the 2 other factors that are listed in the Guidelines as triggers for a comprehensive assessment, namely, presenting for medical attention because of a fall and reporting difficulty with walking or balance.

In conclusion, our study demonstrates that community-dwelling indoor recurrent fallers were generally in poor health and outdoor recurrent fallers in good health. If a comprehensive or abbreviated fall risk factor evaluation is to be targeted to a high-risk group, a history of indoor falls for those < 80 years appears to be better criterion than a report of any recurrent falls. However, even selecting indoor fallers for an expensive comprehensive evaluation or for an abbreviated evaluation was only somewhat more clinically effective than picking people at random for such an evaluation, and may well not be cost effective. Over age 80 years, most people had several fall risk factors regardless of fall history. Other studies are needed to confirm our findings and examine the optimal follow-up for different categories of recurrent fallers.

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Table 1
Baseline Characteristics of Participants According to Faller Category (Mean + S.D. or Frequency (%)) During First Year of Follow-Up

Characteristic	P-Value For					Total (N=713)
	Recurrent Fallers, Indoors Only (N=47)	Recurrent Fallers, Outdoors Only (N=34)	Recurrent Fallers Indoors & Outdoors (N=64)	One-time Indoor Fallers; Never Outdoors (N=85)	One-time Outdoor Fallers; Never Indoors (N=78)	
Age (years)	79.4 + 5.8	77.0 + 4.8	78.2 + 6.1	78.9 + 5.6	77.0 + 4.9	78.0 + 5.4
Male gender	12 (25.5)	14 (41.2)	27 (42.2)	22 (25.9)	29 (37.2)	253 (35.5)
Physical activity (bottom quartile, PASE<55)	18 (39.1)	3 (8.8)	15 (23.8)	18 (22.0)	12 (15.4)	165 (23.3)
Berg Balance Scale score						
51+	15 (31.9)	21 (61.8)	29 (45.3)	40 (47.1)	46 (59.0)	386 (54.1)
48-50	11 (23.4)	10 (29.4)	19 (29.7)	23 (27.1)	19 (24.4)	175 (24.5)
< 48	21 (44.7)	3 (8.8)	16 (25.0)	22 (25.9)	13 (16.7)	152 (21.3)
Unable to do chair-stand test unless using arms	10 (21.3)	2 (5.9)	3 (4.7)	5 (5.9)	5 (6.4)	51 (7.2)
Gait speed						
≥1.30 m/sec	4 (8.5)	9 (26.5)	9 (14.1)	9 (10.6)	4 (5.1)	60 (8.4)
1.00-1.29 m/sec	9 (19.2)	12 (35.3)	20 (31.3)	25 (29.4)	32 (41.0)	251 (35.2)
0.60-0.99 m/sec	22 (46.8)	12 (35.3)	28 (43.8)	43 (50.6)	36 (46.2)	339 (47.6)
<0.60 m/sec	12 (25.5)	1 (2.9)	7 (10.9)	8 (9.4)	6 (7.7)	63 (8.8)
Activities of daily living:						
No difficulty	27 (57.5)	33 (97.1)	43 (67.2)	57 (67.1)	62 (79.5)	556 (78.0)
Little/some difficulty	8 (17.0)	1 (2.9)	17 (26.6)	19 (22.4)	13 (16.7)	105 (14.7)
Much difficulty/inability	12 (25.5)	0 (0)	4 (6.3)	9 (10.6)	3 (3.9)	52 (7.3)
Short physical performance battery<10	28 (59.6)	5 (14.7)	28 (43.8)	47 (55.3)	23 (29.5)	284 (39.8)
Number of comorbid conditions	4.1 + 1.6	2.5 + 1.8	3.2 + 1.5	3.4 + 1.6	2.8 + 1.5	3.1 + 1.5
Fair/poor self-rated health	12 (25.5)	1 (2.9)	10 (15.6)	12 (14.1)	10 (12.8)	96 (13.5)
Number of medications						
0-4	10 (21.3)	15 (44.1)	26 (40.6)	27 (31.8)	34 (43.6)	245 (34.4)
5-8	19 (40.4)	15 (44.1)	25 (39.1)	35 (41.2)	28 (35.9)	330 (46.3)
9 +	18 (38.3)	4 (11.8)	13 (20.3)	23 (27.1)	16 (20.5)	138 (19.4)
Any psychotropic medication	19 (40.4)	5 (14.7)	15 (23.8)	23 (27.1)	13 (16.7)	144 (20.3)

Characteristic	P- Value For					One-time Outdoor Fallers; Never Indoors (N=78)	Did Not Fall (N=405)	Total (N=713)
	Recurrent Fallers, Indoors Only (N=47)	Recurrent Fallers, Outdoors Only (N=34)	Indoors Only vs. Recurrent Outdoors Only *	Recurrent Fallers Indoors & Outdoors (N=64)	One-time Indoor Fallers; Never Outdoors (N=85)			
Falls Efficacy Scale score <90	12 (25.5)	3 (8.8)	0.06	11 (17.5)	14 (16.5)	10 (12.8)	45 (11.1)	95 (13.4)
Impaired cognition (MMSE 18-23)	8 (17.0)	1 (2.9)	0.05	7 (10.9)	6 (7.1)	6 (7.7)	52 (12.8)	80 (11.2)

Faller categories are mutually exclusive.

All participants included here had at least one year of follow-up. Measurements of all characteristics had sample sizes of 95–100% of full N shown.

* Kruskal-Wallis equality of populations rank-test was used for age and number of comorbid conditions; chi-square was used for all other variables.

S.D.= standard deviation; PASE=Physical Activity Scale for the Elderly; MMSE = Mini-Mental State Exam.

Table 2

Baseline Characteristics of Recurrent Fallers with at Least Two Falls in the First Two Years of Follow-Up Who Had One or More Falls in the Designated Activity, by Location (Mean + S.D. or Frequency (%))

Characteristic	Indoor Recurrent Fallers				Outdoor Recurrent Fallers			
	Transitioning* or Not Moving (N=76)	Going Up or Down Stairs (N=38)	Walking (N=82)	Doing Vigorous Activity (N=17)	Transitioning* or Not Moving (N=14)	Going Up or Down Stairs (N=32)	Walking (N=79)	Doing Vigorous Activity (N=32)
Age (years)	79.5 + 6.3	77.2 + 6.0	79.1 + 5.8	81.0 + 6.4	79.9 + 3.8	75.9 + 4.3	76.6 + 5.1	76.5 + 4.5
Male gender	25 (32.9)	15 (39.5)	19 (23.2)	4 (23.5)	8 (57.1)	11 (34.4)	32 (40.5)	17 (53.1)
Physical activity (Bottom quartile, PASE<55)	30 (40.0)	7 (18.9)	24 (30.0)	7 (41.2)	4 (28.6)	5 (15.6)	11 (13.9)	5 (15.6)
Berg Balance Scale score								
51+	29 (38.2)	18 (47.4)	31 (37.8)	8 (47.1)	6 (42.9)	20 (62.5)	47 (59.5)	27 (84.4)
48-50	16 (21.1)	11 (29.0)	20 (24.4)	3 (17.7)	4 (28.6)	9 (28.1)	25 (31.7)	4 (12.5)
<48	31 (40.8)	9 (23.7)	31 (37.8)	6 (35.3)	4 (28.6)	3 (9.4)	7 (8.9)	1 (3.1)
Unable to do chair-stand test unless using arms	7 (9.2)	1 (2.6)	13 (15.9)	2 (11.8)	1 (7.1)	0 (0)	4 (5.1)	1 (3.1)
Gait speed								
≥ 1.30 m/sec	5 (6.6)	6 (15.8)	4 (4.9)	2 (11.8)	1 (7.1)	4 (12.5)	16 (20.3)	11 (34.4)
1.00-1.29 m/sec	18 (23.7)	12 (31.6)	21 (25.6)	6 (35.3)	2 (14.3)	14 (43.8)	31 (39.2)	13 (40.6)
0.60-0.99 m/sec	37 (48.7)	19 (50.0)	40 (48.8)	7 (41.2)	7 (50.0)	11 (34.4)	29 (36.7)	7 (21.9)
< 0.60 m/sec	16 (21.1)	1 (2.6)	17 (20.7)	2 (11.8)	4 (28.6)	3 (9.4)	3 (3.8)	1 (3.1)
Activities of daily living:								
No difficulty	45 (59.2)	27 (71.0)	51 (62.2)	12 (70.6)	8 (57.1)	28 (87.5)	66 (83.5)	30 (93.8)
Little/some difficulty	20 (26.3)	6 (15.8)	20 (24.4)	3 (17.7)	6 (42.9)	4 (12.5)	11 (13.9)	2 (6.3)
Much difficulty/inability	11 (14.5)	5 (13.2)	11 (13.4)	2 (11.8)	0 (0)	0 (0)	2 (2.5)	0 (0)
Short physical performance battery<10	42 (55.3)	16 (42.1)	49 (59.8)	9 (52.9)	7 (50.0)	6 (18.8)	23 (29.1)	4 (12.5)
Number of comorbid conditions	3.7 + 1.6	3.4 + 1.6	3.6 + 1.7	3.9 + 1.9	3.3 + 1.5	3.4 + 1.6	3.0 + 1.5	2.7 + 1.8
Fair/poor self-rated health	16 (21.1)	3 (7.9)	22 (26.8)	4 (23.5)	3 (21.4)	2 (6.3)	7 (8.9)	1 (3.1)
Number of medications								
0-4	20 (26.3)	14 (36.8)	23 (28.1)	7 (41.2)	4 (28.6)	14 (43.8)	32 (40.5)	15 (46.9)
5-8	30 (39.5)	10 (26.3)	31 (37.8)	4 (23.5)	6 (42.9)	12 (37.5)	34 (43.0)	14 (43.8)

Characteristic	Indoor Recurrent Fallers			Outdoor Recurrent Fallers		
	Transitioning* or Not Moving (N=76)	Going Up or Down Stairs (N=38)	Walking (N=82)	Doing Vigorous Activity (N=17)	Transitioning* or Not Moving (N=14)	Going Up or Down Stairs (N=32)
9 +	26 (34.2)	14 (36.8)	28 (34.2)	6 (35.3)	4 (28.6)	6 (18.8)
Any psychotropic medication	26 (34.7)	12 (32.4)	26 (31.7)	6 (35.3)	3 (21.4)	6 (18.8)
Falls Efficacy Scale score <90	19 (25.0)	7 (18.4)	17 (20.7)	3 (17.7)	6 (42.9)	4 (12.5)
Impaired cognition (MMSE 18 – 23)	10 (13.2)	6 (15.8)	8 (9.8)	0 (0)	2 (14.3)	2 (6.3)
Doing Vigorous Activity (N=32)						13 (16.5)
						21 (26.6)
						10 (12.8)
						8 (10.1)

Fall activity categories are not mutually exclusive, i.e., a person may be included in more than one column if she/he fell at least once during each activity. However, a faller is included only once per column regardless of how many times she/he fell in that activity.

People with less than one full year of follow-up are excluded.

The activity classifications shown were based on 295 outdoor falls and 348 indoor falls. Excluded are 80 outdoor and 99 indoor falls that could not easily be assigned to any of these activity categories, e.g., household tasks, bending over, dressing, etc., or unknown activity.

Measurements of all characteristics had sample sizes of 95–100% of full N shown.

* Transitioning includes getting in or out of a chair, bed, car, tub, or shower.

S.D. = standard deviation; PASE = Physical Activity Scale for the Elderly; MMSE = Mini-Mental State Exam.

Table 3

Mean Number of Positive Findings in a Comprehensive Multifactorial Fall Risk Assessment of 28 Attributes* and in an Abbreviated Assessment of 12 Attributes† at 18-Month Follow-Up, Positive Predictive Value (PPV), and Sensitivity (Sens) by First-Year Faller Category for Participants Younger Than 80 Years of Age

Faller Category (N)	Comprehensive Assessment of 28 Fall Risk Factors			Abbreviated Assessment of 12 Fall Risk Factors		
	Number of Positive Findings (of 28)		Predicting 6 or More Positive Findings (of 28)	Number of Positive Findings (of 12)		Predicting 2 or More Positive Findings (of 12)
	Mean (95% CI)	PPV	Sens	Mean (95% CI)	PPV	Sens
Any recurrent falls (90)	7.1 (6.1 – 8.0)	60.0%	24.3%	2.3 (1.9 – 2.7)	56.7%	22.4%
Fell at least once indoors (109)	7.4 (6.6 – 8.2)	63.3%	31.1%	2.5 (2.2 – 2.8)	67.0%	32.0%
Fell at least once outdoors (116)	5.9 (5.2 – 6.5)	49.1%	25.7%	1.9 (1.6 – 2.2)	49.1%	25.0%
Mutually-Exclusive Categories‡:						
Recurrent indoors only (25) δ	10.4 (8.6 – 12.2)	88.0%	9.9%	3.3 (2.5 – 4.1)	80.0%	8.8%
Recurrent outdoors only (26)	4.7 (3.4 – 5.9)	42.3%	5.0%	1.3 (0.9 – 1.8)	34.6%	4.0%
Recurrent indoors & outdoors (39)	6.5 (5.2 – 7.9)	53.9%	9.5%	2.3 (1.7 – 2.9)	56.4%	9.7%
Once only indoors (45)	6.6 (5.5 – 7.7)	57.8%	11.7%	2.2 (1.8 – 2.7)	68.9%	13.6%
Once only outdoors (51)	6.0 (5.1 – 6.8)	49.0%	11.3%	1.9 (1.5 – 2.3)	51.0%	11.4%
Non-faller (246)	5.9 (5.5 – 6.3)	47.6%	52.7%	1.8 (1.6 – 2.0)	48.8%	52.6%
All participants (432)	6.2 (5.9 – 6.6)	51.4%		1.9 (1.8 – 2.1)	52.8%	

*The 28 attributes included were (1) fair-poor self-rated health; (2) moderate-severe bodily pain in past 4 weeks; (3) ever told by doctor have heart disease/heart attack/MI; (4) ever told by doctor have atrial fibrillation/irregular heart rhythm; (5) using a pacemaker; (6) ever told by doctor have angina; (7) ever told by doctor have congestive or chronic heart failure; (8) controlled or uncontrolled hypertension (stated history or medication or measured systolic blood pressure >140 or diastolic >90); (9) diabetes or probable diabetes (stated history or medication or HbA1c >7% or random glucose ≥200mg/dL); (10) minor or major depression (satisfied Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria in past month); (11) ever told by doctor have osteoarthritis or rheumatoid arthritis; (12) urinary incontinence (stated history of any one of three incontinence problems); (13) uses any walking aid when going out (cane, walker, wheelchair); (14) impaired cognition, mini-mental score <24; (15) unable to stand from a chair without using arms; (16) foot pain/aching/stiffness on most days; (17) orthostatic hypotension (20mm Hg difference supine - standing at 1 min); (18) peripheral neuropathy, based on monofilament tests; (19) corrected distance vision at 10 feet worse than 40/100; (20) SPPB <10 (components: gait, balance, time to stand from a chair); (21) osteoarthritis in knee; (22) osteoarthritis in hip; (23) SF12 physical component²⁹ T-score <100; (24) poorest 10th percentile Trails-B test of executive function; (25) much difficulty or inability in activities of daily living; (26) Falls Efficacy Scale score <90; (27) 9 or more medications; (28) any psychotropic medications.

†The 12 attributes included were (1) ever told by doctor have atrial fibrillation/irregular heart rhythm; (2) ever told by doctor have Parkinson's disease; (3) ever told by doctor had a stroke; (4) measured gait speed <1.0 m/sec; (5) inability to stand from a chair without using arms; (6) SPPB total balance score <4 (inability to balance at least 10 sec in side-by-side, semi-tandem, or tandem test) (7) impaired cognition, mini-mental score <24; (8) foot pain/aching/stiffness on most days; (9) orthostatic hypotension (20mm Hg difference supine - standing at 1 min); (10) corrected distance vision at 10 feet worse than 40/100; (11) 9 or more medications; (12) any psychotropic medications.

[‡] Kruskal-Wallis equality-of-populations rank test for differences in number of positive findings among the six mutually-exclusive faller categories: $p=0.0001$ for set of 28 attributes; $p=0.0004$ for subset of 12 attributes.

[§] Kruskal-Wallis equality-of-populations rank test for differences in number of positive findings between indoor-only vs. outdoor-only recurrent fallers: $p<0.0001$ for set of 28 attributes; $p=0.0002$ for subset of 12 attributes.

CI = confidence interval; PPV = positive predictive value; Sens = sensitivity; SPPB=short physical performance battery scale.