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Multidimensional Geriatric Assessment: Back to the Future

Preclinical Disability as a Risk Factor for Falls in Community-Dwelling Older Adults

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Background. Falls are common and serious problems in older adults. The goal of this study was to examine whether preclinical disability predicts incident falls in a European population of community-dwelling older adults.

Methods. Secondary data analysis was performed on a population-based longitudinal study of 1644 community-dwelling older adults living in London, U.K.; Hamburg, Germany; Solothurn, Switzerland. Data were collected at baseline and 1-year follow-up using a self-administered multidimensional health risk appraisal questionnaire, including validated questions on falls, mobility disability status (high function, preclinical disability, task difficulty), and demographic and health-related characteristics. Associations were evaluated using bivariate and multivariate logistic regression analyses.

Results. Overall incidence of falls was 24%, and increased by worsening mobility disability status: high function (17%), preclinical disability (32%), task difficulty (40%), test-of-trend $p < .003$. In multivariate analysis adjusting for other fall risk factors, preclinical disability (odds ratio [OR] = 1.7, 95% confidence interval [CI], 1.1–2.5), task difficulty (OR = 1.7, 95% CI, 1.1–2.6) and history of falls (OR = 4.7, 95% CI, 3.5–6.3) were the strongest significant predictors of falls. In stratified multivariate analyses, preclinical disability equally predicted falls in participants with (OR = 1.7, 95% CI, 1.0–3.0) and without history of falls (OR = 1.8, 95% CI, 1.1–3.0).

Conclusions. This study provides longitudinal evidence that self-reported preclinical disability predicts incident falls at 1-year follow-up independent of other self-reported fall risk factors. Multidimensional geriatric assessment that includes preclinical disability may provide a unique early warning system as well as potential targets for intervention.

***Key Words*:** Assessment—Falls—Geriatric assessment—Older adults—Preclinical disability.

FALLS are common and serious problems in older adults; they place older adults at risk for serious injury, functional decline, disability, increased health care utilization, and they interfere with quality of life and independent living (1–4). Prevention of incident falls is therefore a major objective. Multidimensional geriatric assessment that includes fall risk factors is considered an opportunity to target intervention at the milder end of the disability continuum, potentially preventing incident falls and thwarting worsening disability (1,5–7). A critical assessment issue, however, is early detection of the onset of the progressive disablement process (8).

Preclinical disability has been described as an intermediary stage between high- and low-functioning states where modifications to method or frequency of performing a task are implemented without any perceived difficulty performing the task (9). Previous research has suggested that self-reported preclinical disability measures are sensitive to very early change in function and are potentially useful for identifying older adults at risk of functional limitation, disability, fear of falling, and increased physician visits and hospitalizations (9–13). It is conceivable, although unreported in the literature, that older adults in this preclinical disability stage may also be more prone to falls resulting from the underlying need for compensatory behaviors. Thus preclinical disability may precede and predict falls and offer a preventative framework as well as an opportunity for early intervention.

The goal of this study was to examine whether preclinical disability predicts incident falls in a European population of community-dwelling older adults. Our a priori hypothesis was that self-reported preclinical disability would be related to incident falls at 1-year of follow-up.

Methods

Study Population

This is a secondary analysis of data from the PRO-AGE trial (*PR*evention in *O*lder people–*A*ssessment in *GE*neral-

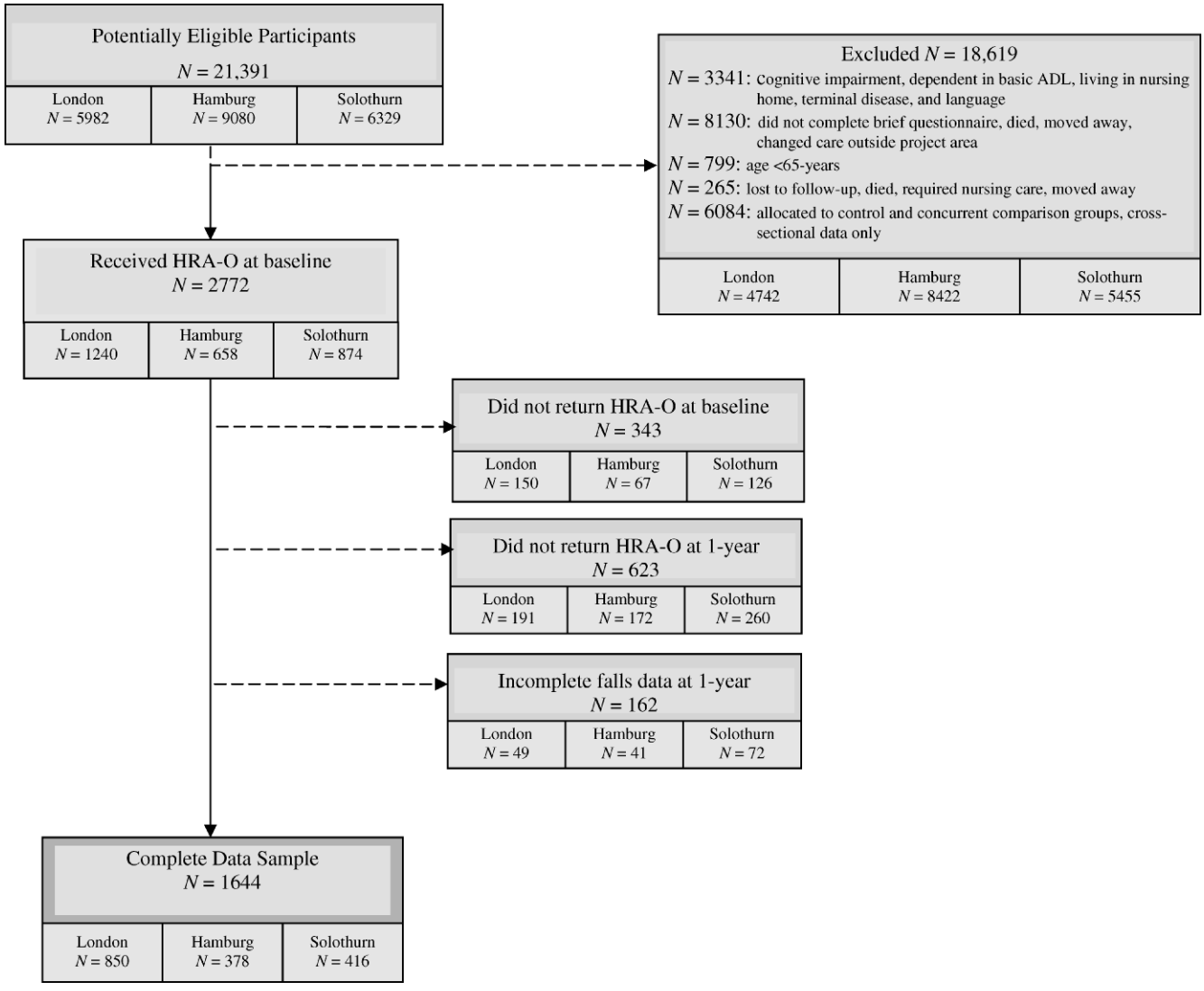

Figure 1. Study population flowchart. HRA-O = Health Risk Appraisal Questionnaire; ADL = Activities of Daily Living.

ists' practices), a multicenter study of a health-risk appraisal system among community-dwelling older adults living in London, U.K.; Hamburg, Germany; and Solothurn, Switzerland; conducted between 2001 and 2003. The study was approved by local research ethics committees. A detailed description of the PRO-AGE study design is reported elsewhere (14).

Primary care practices in the selected project areas generated lists of all registered patients 65 years old or older in London and Solothurn and 60 years old or older in Hamburg. Of 21,391 persons on these lists, 3341 persons were excluded based on physician practice records according to PRO-AGE a priori criteria (dependent or need for human assistance in basic activities of daily living, cognitive impairment, terminal disease, did not speak regional language), 8130 were excluded due to nonresponse (did not complete brief questionnaire, died, moved away, changed care outside project area), 799 did not meet the current study's inclusion criteria of being 65 years old or older, and 6084 were not randomized to the longitudinal follow-up group. Of the remaining 2772 randomized persons who were enrolled in the study and received the Health Risk Appraisal for Older Persons (HRA-O) questionnaire, 343 did not return the questionnaire at baseline, 623 did not return the questionnaire at 1-year follow-up, and 162 had incomplete outcome data. Included in the present analysis is a sample of 1644 persons who completed both baseline and 1-year follow-up questionnaires (Figure 1).

Instruments for Data Collection

The HRA-O supplemented by physician practice records was used for data collection. Information on the development, reliability, and validity of the questionnaire has been previously published (15). All participants completed a self-administered questionnaire at baseline and at 1-year follow-up. Due to budgetary restrictions, no reminders or follow-ups were conducted for nonresponse.

Falls Characteristics

Incident falls, and baseline history of falls, were assessed using validated questions (16–18). Incident falls were defined as a ''Yes'' response to the 1-year follow-up question: ''During the past 12-months have you fallen to the ground or floor?'' History of falls was measured as positive responses to either of the two baseline questions: ''Have you ever fallen and not been able to get up?'' or ''During the past 12-months have you fallen to the ground or floor?''

Demographic and Health-Related Characteristics

Age and gender were obtained from physician practice records. We considered participants as having a low level of education if they reported not receiving additional education after completion of the compulsory 9 years of school.

Health status was measured several ways (15): self-perceived health status on a 4-level scale (excellent, good, fair, poor) (19), comorbidity as number of chronic medical conditions (''yes/no'' from a list of 15 self-reported chronic conditions) (20), depressive mood defined as a score >66 on the 5-item Mental Health Inventory Screening Test (21), visual impairment based on five items of the National Eye Institute Visual Functioning Questionnaire (22), moderate or severe pain as a score of ≥ 30 on the Geriatric Pain Measure (23), and limitation in functional status assessed by instrumental activities of daily living (ADLs) on a 5-level scale reporting difficulty and/or need for assistance in walking, handling finances and medications, engaging in 'handyman' work, doing housework, doing laundry, preparing meals, shopping, using the telephone, and using public or private transportation (24,25). Medication use was measured as self-reported number of medications used (20). Emotional social support was measured using a 3-item version of the RAND Medical Outcome Study Social Support Survey (MOS-SSS) (26).

A single aggregate fall risk factor variable was constructed by summing the number of literature-reported fall risk factors out of: age >80 years, ≥ 4 medications, self-reported arthritis, depressive mood, visual impairment, impaired ADLs, and history of falls (categories 0–1, 2, 3, 4+) (1,3,5).

Mobility disability status was derived using two standard ADL questions (24,25) and the measurement method of preclinical disability of Fried and colleagues (9). At baseline, participants were first asked to report any difficulty, need for assistance, or inability to perform two mobility tasks (getting into a car, a bus, or a train, or walking half a mile). Both tasks are considered to be sensitive to mobility decline, signal the beginning of progressive disablement process, and are shown to be reliably identified by self-report (8,9,27). Participants reporting difficulty, need for assistance, or inability to perform the task were considered to have ''task difficulty.'' Those who were able to perform the task without difficulty or assistance were then asked two follow-on preclinical disability questions relating to each task: ''For health reasons, in the past 12-months, have you changed the way you ...'' and ''For health reasons in the past 12-months have you decreased how often you ...'' Participants reporting no difficulty or need for assistance performing a task but who either changed the method or decreased the frequency of performing it were defined as having ''task modification'' status or preclinical disability. Those who performed the task without difficulty or assistance and had not modified either method or frequency were categorized as ''high function.'' The two task-specific mobility disability status variables were similarly combined into a single 3-category (high function, preclinical disability, task difficulty) variable for analysis. For example, a participant reporting no difficulty performing individual tasks but reporting having modified task performance, either in terms of frequency or method of performance, for one or both of the individual tasks was defined as having preclinical disability (6,9,27,28).

Statistical Analyses

Summary statistics (univariate, proportion, and frequency) were used to describe falls and sociodemographic and health-related characteristics of the study population. We used Fisher's Exact test and the Cochran–Armitage test of trend to describe incidence of falls by mobility disability status and number of literature-reported fall risk factors. We examined bivariate relations using chi-square tests and Spearman correlations between falls and sociodemographic and health-related characteristics. Multivariate logistic regression models were used to evaluate associations between outcome falls and individual risk factors. All individual risk factors were selected for inclusion in the final adjusted models based on their association with falls. Additional analyses included stratification by history of falls and sensitivity analyses evaluating both number of literature-reported fall risk factors instead of individual fall risk factors and individual task-specific mobility disability status variables. Last, we conducted analyses of nonresponse by comparing characteristics of responders ($N = 1644$) with nonresponders ($N = 1077$) using analyses of variance (ANOVA) for continuous variables and Fisher's Exact test for dichotomous variables. All analyses were performed using STATA version 8.2 (2003; STATA Corporation, College Station, TX), and all p values were two-sided.

Results

There were 1644 participants in total: 850 from London, 378 from Hamburg, and 416 from Solothurn. Baseline characteristics of the study population are listed in Table 1.

Incidence of Falls

Figure 2 describes the overall incidence of falls as well as the incidence of falls by mobility disability status and number of literature-reported fall risk factors. The overall incidence of falls was 24%, and incidence increased by worsening mobility disability status, high function (17%), preclinical disability (32%), and task difficulty (40%), test-of-trend $p < .003$. The incidence of falls in participants with high function and task difficulty increased as the number of literature-reported risk factors increased (test-of-trend $p < .001$). Among participants with preclinical disability, a more equally distributed pattern of falls incidence was

Table 1. Baseline Characteristics of a European Population of Community-Dwelling Older Adults ($N = 1644$)

Sociodemographic and Health-Related Characteristics	Total *N* (%)
Female gender	920 (56.0)
Mean age (±*SD*)	74.4 ± 6.1
Age >80 y	311 (18.9)
Low level of education (≤basic school)	730 (46.1)
Fair/poor self-perceived health	349 (21.5)
≥3 chronic medical conditions	639 (40.2)
Mean number of chronic conditions (±*SD*)	2.2 ± 1.6
Use of ≥4 medications	566 (36.1)
Mean number of medications (±*SD*)	3.0 ± 2.6
Arthritis	760 (47.1)
Depressive mood (MHI5 score <66)	235 (14.4)
Visual impairment	234 (15.1)
Moderate/severe pain (GPM score ≥30)	461 (29.5)
Limitation in ≥1 instrumental ADL	613 (39.2)
Marginal emotional support (MOS-SSS score <6)	135 (8.4)
Number of literature-reported fall risk factors*	
0–1	622 (45.5)
2	325 (23.8)
3	219 (15.9)
4+	200 (14.8)
Mobility disability status	
High function	1113 (68.5)
Preclinical disability	243 (15.0)
Task difficulty	269 (16.6)
Falls during 12 mo prior to baseline	364 (23.2)
Ever fallen and not able to get up	193 (12.0)

Notes: Due to missing values for individual items on the Health Risk Appraisal (HRA-O) questionnaire, *N* varies between 1551 and 1644.

*Number of literature-reported fall risk factors: age >80 y, use of ≥4 medications, arthritis, depressive mood, visual impairment, limitation in ≥1 instrumental ADL, history of falls (1, 3, 5).

SD = standard deviation; MHI5 = 5-item Mental Health Index; GPM = Geriatric Pain Measure; ADL = activities of daily living; MOS-SSS = Medical Outcomes Study–Social Support Survey.

seen across categories of 0–3 literature-reported fall risk factors (approximately 26%, test-of-difference $p > .83$).

Predictors of Falls

Table 2 shows the crude and adjusted odds ratios (OR) for baseline predictors of falls at 1-year follow-up. Depressive mood, limitation in ≥1 instrumental ADL, and use of ≥4 medications were moderately predictive (not all statistically significantly) of falls. However, mobility disability status and history of falls were the strongest significant predictors of falls in this population. Having a mobility disability status of either preclinical disability or task difficulty similarly predicted falls (OR = 1.7, 95% confidence interval [CI], 1.1–2.5 and OR = 1.7, 95% CI, 1.1–2.6, respectively) when compared to those with high function at baseline. Stratified analyses suggested that preclinical disability status, unlike other fall risk factors, equally predicted falls in those with a history of falls (OR = 1.7, 95% CI, 1.0–3.0) and those without (OR = 1.8, 95% CI, 1.1–3.0) (Table 3). Results remained unchanged in sensitivity analyses evaluating number of literature-reported fall risk factors and individual task-specific mobility disability status variables.

Nonresponder Analysis

Table 4 presents comparisons of the responder ($N = 1644$) and nonresponder ($N = 1077$) groups showing no statistically significant differences except that nonresponders were slightly older and had a worse self-perception of their health.

Discussion

These findings suggest a unique and predictive relationship between preclinical disability and incident falls. In this population, the incidence of falls varied by mobility disability status and number of fall risk factors. Furthermore, baseline preclinical disability predicted falls at 1-year follow-up, indicating that older adults with preclinical disability, not just those experiencing task difficulty, are at increased risk. These findings are, to the best of our knowledge, the first to examine the relationship between preclinical disability and falls.

Our findings provide new and important information regarding the special relationship between preclinical disability and falls and the potential benefit from treating based on preclinical disability assessment. First, the odds of falling in participants with preclinical disability was nearly 2-fold those of participants with high function, yet equivalent to those of participants reporting task difficulty. This finding implies that targeting persons with preclinical disability identifies an otherwise unidentifiable group at an increased risk of falls similar to that of persons experiencing task difficulty. Second, preclinical disability was the strongest predictor of falls among those without a history of falls, and participants with preclinical disability and between zero and three literature-reported fall risk factors (approximately 10% in this population) had a similar incidence of falls, suggesting that persons in the preclinical stage of disability may present a unique opportunity to target prevention of falls regardless of other fall risk factors. Last, the ability to intervene before task difficulty presents potentially offers a chance to focus intervention on prevention rather than recovery. Thus, these findings provide further evidence in support of the recommendation by Weiss and colleagues (29) to apply what is known about preclinical disability to screening in clinical settings.

Several limitations of this study should be considered. We used a single composite variable for mobility disability status based on self-report data that could have introduced misclassification. However, previous studies have shown valid and reliable results with similar self-report measures (6,9,29,30), and sensitivity analyses indicated no sizable misclassification. We used getting into a car, bus, or train to define preclinical disability instead of the more commonly used task, climbing stairs, because it was not assessed in the HRA-O. We do not suggest that this is the only or even best definition and were unfortunately unable to test alternative definitions. Furthermore, fall risk factors were limited by our use of survey methodology. Other useful self-report items (e.g., recurrent falls, balance confidence) and factors such as physical performance or assessments of impairments (e.g., orthostasis, poor balance, cognitive impairment) were not collected, limiting our ability to compare self-reported preclinical disability to other performance measures. These

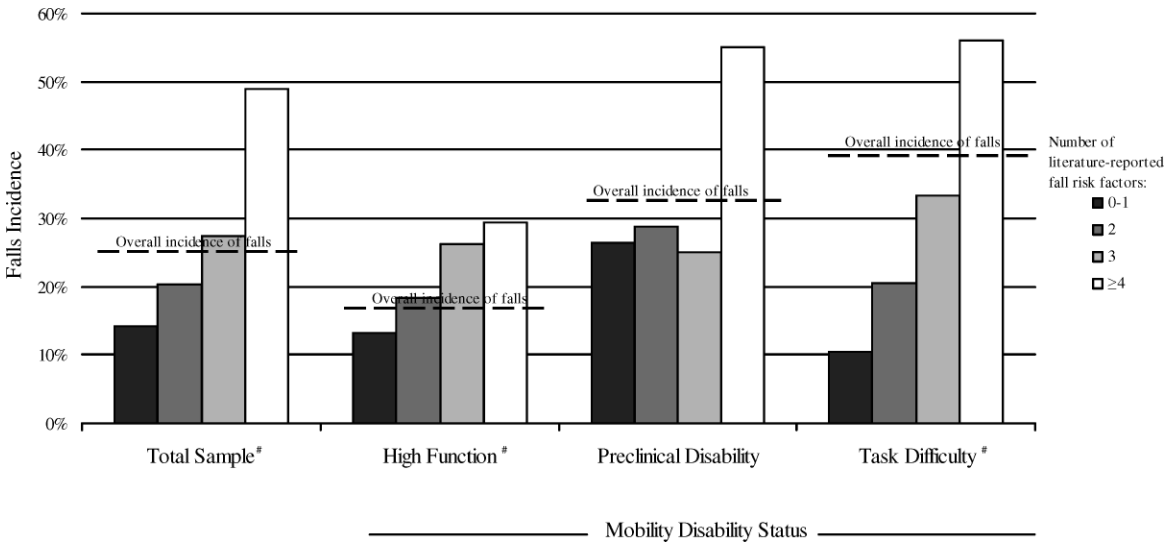

Figure 2. Overall incidence of falls by mobility disability status and number of literature-reported fall risk factors in a European population of community-dwelling older adults. Number of literature-reported fall risk factors: age >80 y, use of ≥4 medications, arthritis, depressive mood, visual impairment, limitation in ≥1 instrumental activities of daily living, history of falls (1,3,5). #$p < .05$ test-of-difference based on Fisher's Exact test, test-of-trend based on Cochran–Armitage test of trend. Denominators for subgroups in total sample are: 622 (0–1 risk factor), 325 (2 risk factors), 219 (3 risk factors), 200 (≥4 risk factors). Correspondingly, denominators for subsamples are: high function 553, 229, 107, 51; preclinical disability 49, 52, 56, 40; task difficulty 29, 44, 54, 109.

findings are not necessarily generalizable to other populations of community-dwelling older adults, as this sample appeared healthier and to have overall lower falls rates than previously reported (1,3,5). Nevertheless the study sample did include a broad representation of community-dwelling older adults with differing health and social characteristics (14). Selection bias is also a potential threat to the validity of these results due to the high nonresponder rate. However, differences between responder and nonresponder groups were small supporting our conclusion that selection bias is unlikely to have impacted the validity of our findings.

Additionally, our findings were limited to only 1-year of follow-up and do not provide any information on the more enduring effects of preclinical disability and falls in older adults. Moreover, 1-year recall of falls may be incomplete. For example, recurrent falls, potentially more clinically relevant than single falls, could not be assessed. Other

Table 2. Odds Ratios for Baseline Predictors of Falls at 1-Year Follow-Up in a European Population of Community-Dwelling Older Adults ($N = 1644$)

Sociodemographic and Health-Related Characteristics	Falls OR_{crude} (95% CI)	Falls $OR_{adjusted}$ (95% CI)*
Female gender	1.4 (1.1–1.7)	1.0 (0.8–1.4)
Age >80 y	1.6 (1.2–2.1)	1.1 (0.8–1.6)
Fair/poor self-perceived health	2.1 (1.6–2.7)	1.0 (0.7–1.5)
≥3 chronic medical conditions	1.8 (1.4–2.2)	1.1 (0.8–1.6)
Use of ≥4 medications	1.7 (1.3–2.1)	1.3 (1.0–1.8)
Arthritis	1.6 (1.3–2.1)	1.0 (0.7–1.3)
Depressive mood (MHI5 score <66)	2.3 (1.7–3.0)	1.3 (0.9–1.9)
Visual impairment	1.7 (1.3–2.3)	0.9 (0.6–1.3)
Limitation in ≥1 instrumental ADL	2.1 (1.7–2.7)	1.2 (0.9–1.6)
Mobility disability status		
High function	0.4 (0.3–0.5)	1.0 (ref)
Preclinical disability (modification)	1.7 (1.2–2.2)	1.7 (1.1–2.5)
Task difficulty (difficulty)	2.6 (2.0–3.5)	1.7 (1.1–2.6)
History of falls†	5.5 (4.3–7.0)	4.7 (3.5–6.3)

Notes: *Adjusted OR based on multivariate logistic regression including all variables listed.

†History of falls reported as either *falls* or *ever fallen and not able to get up* in the12 months prior to baseline.

OR = odds ratio; CI = confidence interval; ADL = activities of daily living; MHI5 = 5-item Mental Health Index.

Table 3. Odds Ratios for Baseline Predictors of Falls at 1-Year Follow-Up in a European Population of Community-Dwelling Older Adults ($N = 1644$) Stratified by History of Falls

	Participants With History of Falls*	Participants Without History of Falls*
Sociodemographic and Health-Related Characteristics	Falls $OR_{adjusted}$ (95% CI)†	Falls $OR_{adjusted}$ (95% CI)†
Female gender	0.8 (0.5–1.2)	1.3 (0.9–1.8)
Age >80 y	1.0 (0.6–1.7)	1.2 (0.8–2.0)
Fair/poor self-perceived health	1.1 (0.7–1.9)	0.9 (0.5–1.6)
≥3 chronic medical conditions	1.4 (0.8–2.3)	1.1 (0.7–1.7)
Use of ≥4 medications	1.5 (0.9–2.5)	1.1 (0.7–1.8)
Arthritis	0.7 (0.4–1.1)	1.3 (0.9–1.9)
Depressive mood (MHI5 score <66)	1.6 (0.9–2.7)	1.1 (0.6–2.0)
Visual impairment	1.0 (0.6–1.6)	0.6 (0.3–1.2)
Limitation in ≥1 instrumental ADL	0.9 (0.6–1.6)	1.4 (0.9–2.1)
Mobility disability status		
High function	1.0 (ref)	1.0 (ref)
Preclinical disability (modification)	1.7 (1.0–3.0)	1.8 (1.1–3.0)
Task difficulty (difficulty)	2.6 (1.4–5.0)	1.2 (0.6–2.2)

Notes: *History of falls reported as either *falls* or *ever fallen and not able to get up* in the 12 months prior to baseline.

†Adjusted OR based on multivariate logistic regression including all variables listed.

OR = odds ratio; CI = confidence interval; ADL = activities of daily living; MHI5 = 5-item Mental Health Index.

Table 4. Comparison of Self-Reported Baseline Characteristics of Responders, Nonresponders, and Participants Who Died During Follow-Up in a European Population of Community-Dwelling Older Adults

Baseline Characteristics	Responders $N = 1644$* N (%)	Nonresponders $N = 1077$* N (%)	Died During Follow-Up $N = 51$* N (%)	p Value†
Mean age ($\pm SD$)	74.4 ± 6.1	75.0 ± 6.4	77.2 ± 7.1	.02
Female gender	920 (56)	642 (60)	26 (51)	.06
Low level of education (≤basic school)	730 (46)	375 (50)	12 (39)	.11
Living alone	545 (34)	278 (35)	12 (40)	.43
Fair/poor self-perceived health	349 (22)	200 (27)	12 (40)	.003
≥3 self-reported chronic conditions	639 (40)	323 (43)	17 (55)	.28

Notes: *Due to missing values for individual items on the Health Risk Appraisal (HRA-O) questionnaire, N varies between 1589 and 1644 for responders, 758 and 1077 for nonresponders, and 30 and 51 for participants who died during follow-up.

†p values for continuous variables based on analysis of variance, for dichotomous variables based on Fisher's Exact test, comparing responders versus nonresponders.

SD = standard deviation.

disability studies of this potentially important relationship should be conducted to include evaluation of preclinical disability and falls using longer term follow-up. Because preclinical disability identifies a transitional group that is more vulnerable to change in health status, studies with longer follow-up will help to quantify the time frame of elevated risk associated with the predictive nature of preclinical disability and guide future interventions aimed at targeting the prevention of falls. Last, this is a descriptive study, and relevant proof of causality, as well as modifiability of this risk can only come from controlled intervention studies.

These findings have important clinical implications. First, a brief preclinical disability assessment can be easily incorporated into clinical practice as previously recommended (29). Second, these findings support Fried, Wolinsky, and others who suggest that preclinical disability is ''an early warning system'' for falls as well as other adverse health outcomes (6,9,10). Thus, assessment provides an important pathway to identify vulnerability and risk before the appearance of poor outcomes, thereby theoretically extending the period for preventative intervention. Moreover, interventions based on preclinical disability may present an opportunity for clinicians to identify and act on a single shared predictor of multiple health outcomes.

This first evidence supporting the importance of preclinical disability and incident falls is noteworthy; however, further confirmatory research involving longer follow-up and populations varying in age, ethnicity, locale, and heath status as well as intervention studies are needed. Notwithstanding, this research in conjunction with previous research provides evidence for the addition of preclinical disability to the domains of multidimensional geriatric assessment.

Conclusion

If preclinical disability is confirmed in other studies to be a modifiable risk factor for falls then screening for preclinical disability will have important clinical implications for fall prevention and other adverse outcomes. Clinical efforts focused on preclinical disability may lead to preventative measures that help maintain health in later life and result in substantial public health benefit.

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