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Research Article

Role of Perceived Physical and Mental Fatigability Severity on Prospective, Recurrent, and Injurious Fall Risk in Older Men

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Abstract

Background: Falls occur annually in 25% of adults aged ≥65 years. Fall-related injuries are increasing, highlighting the need to identify modifiable risk factors.

Methods: Role of fatigability on prospective, recurrent, and injurious fall risk was examined in 1 740 men aged 77–101 years in the Osteoporotic Fractures in Men Study. The 10-item Pittsburgh Fatigability Scale measured perceived physical and mental fatigability (0–50/subscale) at Year 14 (2014–16); established cut-points identified men with more severe perceived physical (≥15, 55.7%), more severe mental (≥13, 23.7%) fatigability, or having both (22.8%). Prospective, recurrent (≥2), and injurious falls were captured by triannual questionnaires ≥1 year after fatigability assessment; risk of any fall was estimated with Poisson generalized estimating equations, and likelihood of recurrent/injurious falls with logistic regression. Models adjusted for age, health conditions, and other confounders.

Results: Men with more severe physical fatigability had a 20% (p = .03) increased fall risk compared with men with less physical fatigability, with increased odds of recurrent and injurious falls, 37% (p = .04) and 35% (p = .035), respectively. Men with both more severe physical and mental fatigability had a 24% increased risk of a prospective fall (p = .026), and 44% (p = .045) increased odds of recurrent falling compared with men with less severe physical and mental fatigability. Mental fatigability alone was not associated with fall risk. Additional adjustment for previous fall history attenuated associations.

Conclusions: More severe fatigability may be an early indicator to identify men at high risk for falls. Our findings warrant replication in women, as they have higher rates of fatigability and prospective falls.

Keywords: Epidemiology, Fatigue, Risk factors

Falls are a highly prevalent cause of injury and disability, with more than 25% of older adults ≥65 years falling annually in the United States (1). In 2019, >3 million older adults visited the emergency room due to an unintentional fall with nearly 900 000 hospitalized (2). Fall death rates are increasing (3,4), and the Centers for Disease Control and Prevention anticipates that by 2030, there will be 7 fall deaths every hour in the United States (5). Nonfatal injuries due to falls account for $50 billion in medical costs each year, whereas fatal falls account for $754 million (6). Many factors have been associated with fall risk in older adults, including older age, female sex, greater body mass index, impaired balance and walking, visual impairments, pain, certain medications (ie, sedatives, benzodiazepines, etc.), history of previous falls, physical and cognitive dysfunction, and lower body weakness (5,7–9). Depressive symptomatology is also associated with an increased risk of falling and injurious falls (10). Taken together, the increasing rate of falls and fall-related injuries coupled with costs to treat these incidents highlight the need to find novel modifiable risk factors to target for intervention.

Strong evidence exists for an association between fatigue and incident fall risk with odds ratios (ORs) ranging from 4% to 350% (11,12). Data examining the relation between fatigue and recurrent, as well as injurious, falls are limited. The existing work is further affected by methodological issues regarding the measurement of fatigue, namely due to being global in nature (ie, no differentiation between physical and mental states) and lacking context (ie, characterized as a general symptom reflecting one's overall feelings of tiredness or lack of energy). Recently, the construct of perceived physical and mental fatigability, whole-body or mental (eg, psychological, emotional, and cognitive) tiredness contextualized to defined activity of fixed intensity and duration, has been established as a more sensitive and clinically relevant patient-reported measure of one's vulnerability to fatigue (13–18). Perceived fatigability characterizes energy capacity, that is, what an individual thinks they can do as well as how much effort it takes to perform standard activities commonly done by older adults. Moreover, both physical and mental fatigability are highly prevalent in older adults, with rates increasing with advancing age (17,19–21), whereas measures of global fatigue often do not reflect this same association, underscoring its lack of sensitivity (19,22). Similar to fatigue, fatigability is associated with factors that increase fall risk, including worse physical function, executive dysfunction, slower reaction time, sleep disturbances, depressive symptomatology, and mortality (7,17,19,23–29).

Because we and others previously established the relation between fatigue and falls (11,12), the purpose of this study was to expand our understanding of the association of both physical and mental fatigability individually and combined on prospective falls, recurrent falls, and injurious falls in older men. We hypothesized that men with more severe fatigability would have an increased risk of falling, recurrent falling, and experiencing injurious falls compared with men with less severe fatigability, and the greatest risk will be for those with both more severe physical and mental fatigability.

Method

Study Participants

The Osteoporotic Fractures in Men Study (MrOS) is a multicenter, prospective cohort study initially designed to examine osteoporosis, fractures, and prostate cancer risk factors in older men (30,31). MrOS enrolled 5 994 community-dwelling, ambulatory men from 6 sites in the United States (Birmingham, AL; Minneapolis, MN; Palo Alto, CA; Pittsburgh, PA; Portland, OR; and San Diego, CA) between 2000 and 2002. Recruitment details were published elsewhere (30). This work includes the Year 14 (Visit 4, 2014–16, N = 2 424) visit when the Pittsburgh Fatigability Scale (PFS) was added, as well as subsequent triannual follow-up questionnaires. The institutional review board from each site approved the study protocol, and written informed consent was obtained from all participants.

Outcome Measure—Falls and Fall Injury Assessment

We collected information on falls from triannual follow-up questionnaires mailed to participants in March, July, and November following the Year-14 visit. The questionnaire assessed whether the participant had fallen in the previous 4 months; if the participant indicated a fall, it queried how many times they had fallen in the last 4-month period (1, 2, 3, 4, 5, or more) and if they were injured. Recurrent falling was defined as having 2 or more falls within 1 year of follow-up after Year 14.

Predictors—Perceived Physical and Mental Fatigability

We assessed perceived fatigability at Year 14 using the PFS (23,32). The PFS is a self-administered, 10-item questionnaire that asks participants to rate their level of physical and mental fatigue from 0 ("no fatigue") to 5 ("extreme fatigue") that they expected or imagined they would feel after completing each activity. Scores for each subscale ranged from 0 to 50 (higher scores = greater fatigability), with established cut-points to denote more severe versus less severe physical (PFS Physical scores ≥15 vs <15) and mental (PFS Mental scores ≥13 vs <13) fatigability (17,33). We imputed PFS Physical and/or Mental scores if 1–3 items were missing, n = 8 (34).

Covariates

At Year 14, demographic characteristics, such as age, race/ethnicity, and education, were obtained using self-administered questionnaires. During the clinic visit, certified examiners measured height (stadiometer) and weight (digital or balance beam scale) to calculate body mass index (BMI; weight [kg]/height [m^2]). Self-reported health was measured using the question "Compared to other people your own age, how would you rate your overall health?" on a 5-point Likert scale, with higher scores indicating better health. Trouble with dizziness was self-reported and phrased as follows: "Do you sometimes have trouble with dizziness?" Conditions that may prevent standing or stepping were self-reported and phrased in the following manner: "Do you have any problems from recent surgery, injury, or other health conditions that might prevent you from standing straight up from a chair or walking quickly?" Medical history questions were self-reported and phrased: "Has a doctor or other health care provider ever told you that you had X disease" (ie, diabetes, cancer, hypertension, heart attack, congestive heart failure, and stroke). We recorded all current medications, including the use of benzodiazepines, antidepressants, sedative hypnotics, and opioid analgesics, because of their potential influence on fatigue and fall rates (35). Sleep quality was assessed using the Pittsburgh Sleep Quality Index (range: 0–21, score >5 indicates poor sleep quality) (36,37). The Teng Modified Mini-Mental State Examination (3MS; range: 0–100) was administered during the clinic visit to assess global cognition (38). The Geriatric Depression Scale assessed depressive symptoms, with continuous scores used in the models (39). We assessed physical activity levels with the Physical Activity Scale for the Elderly (40). Functional status was measured by a questionnaire that asked about difficulty with 5 instrumental activities of daily living. Gait speed (m/s) from the faster of two 6-m walks performed at the participant's usual pace was our indicator of mobility (41). Fall history was queried with the question "during the past 12 months, have you fallen and landed on the floor or ground, or fallen and hit an object like a table or chair?"

Statistical Analyses

The final analytic sample included 1 740 men due to missing data for the covariates of interest, Figure 1. Men included were more likely to be younger, White, had lower perceived physical and mental fatigability (all $p < .05$), and were generally healthier than those excluded from the analytic sample (Supplementary Table 1).

Baseline characteristics were compared using *t* tests or Wilcoxon Mann–Whitney *U* tests for continuous variables and chi-square tests for categorical variables. When estimating the effects of fatigability on prospective, recurrent, and injurious falls, we generated separate models for (a) more severe versus less severe perceived physical fatigability; (b) more severe versus less severe perceived mental fatigability; and (c) both with more severe perceived physical and mental fatigability versus only more severe perceived physical fatigability versus only more severe perceived mental fatigability versus both with less severe perceived physical and mental fatigability. We used Poisson generalized estimating equations (GEEs) for repeated measures to model the association of fatigability and prospective falls over 1 year. A first-order autoregressive correlation structure accounted for the correlated responses from the same participants. Risk ratios (RR) and 95% confidence intervals (CIs) were estimated for any prospective fall during 1 year of follow-up from the GEE models. Multivariable logistic regression (0 or 1 fall vs ≥2 falls) was used to model the odds of recurrent falling during 1-year follow-up. Further, we used logistic regression to model the odds of any injurious fall in 1-year follow-up. ORs and 95% CIs were estimated for recurrent and injurious falls, respectively, during 1-year follow-up from the logistic regression models. We first adjusted for age and site. Additional covariates were included in the multivariable models that reached the threshold of either having a model $p < .20$ or attenuated the relationship between fatigability and fall risk by more than 10%. Lastly, we generated models that (a) included previous fall history as a covariate and (b) stratified by previous fall history.

We performed all analyses using SAS 9.4 software (SAS Institute Inc. 2014, Cary, NC). Statistical significance was considered at *p* value of <.05.

Results

Men were mean ± standard deviation (*SD*) age 84.3 ± 4.1 years (range: 77–101 years) at Year 14, with 970 (55.7%) categorized as having more severe perceived physical fatigability (PFS Physical scores ≥15), 413 (23.7%) with more severe perceived mental fatigability (PFS Mental scores ≥13), and 397 (22.8%) with both more severe perceived physical and mental fatigability (Table 1 and Supplementary Table 2).

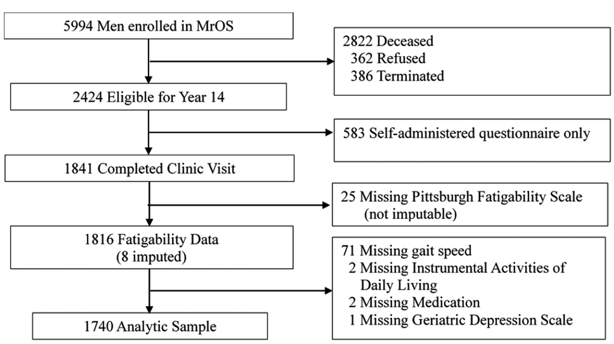

Figure 1. Flow chart of analytic sample to examine the role of physical and mental fatigability on prospective fall risk in the Osteoporotic Fractures in Men Study (MrOS).

Men with more severe perceived physical or mental fatigability were older, had lower physical activity, worse mobility, poorer cognition, worse depressive symptomatology, poorer self-reported health, were taking a greater number of medications, reported more frequent difficulty with dizziness, and a more significant fall history compared with men with less severe physical or mental fatigability. Perceived physical and mental fatigability were moderately correlated with one another ($r = 0.66$, $p < .0001$). Compared with PFS Physical scores, PFS Mental scores were more positively skewed (Supplementary Figure 1).

Risk of Prospective Falls

During 1-year follow-up, 36.6% ($n = 637$) of men had reported at least 1 fall, and the cumulative frequency of falls was consistently higher at each 4-month period by perceived fatigability severity (Figure 2). Men with more severe perceived physical fatigability had a 20% increased risk of falling compared with men with less severe perceived physical fatigability (RR: 1.20, 95% CI: 1.02, 1.41, $p = .03$; Table 2), adjusted for age, site, gait speed, self-reported conditions preventing standing or stepping, self-reported diabetes, dizziness, sleep quality, number of medications, and depressive symptoms. Further adjustment for previous fall history attenuated these results (RR: 1.15, 95% CI: 0.99, 1.34, $p = .07$; Table 2). When stratified by previous fall history, perceived physical fatigability was not associated with fall risk among those with no previous fall history ($p = .69$) and those with a previous fall history ($p = .06$). Perceived mental fatigability was not associated with prospective fall risk ($p = .15$; Table 2). When stratified by previous fall history, perceived mental fatigability was not associated with fall risk among those with no previous fall history ($p = .79$) and those with a previous fall history ($p = .35$). Men with both more severe perceived physical and mental fatigability had a 24% increased risk of having a prospective fall (RR: 1.24, 95% CI: 1.03, 1.51, $p = .026$; Table 2) compared with men with both less severe physical and mental fatigability. Adjustment for previous fall history attenuated the association (OR: 1.17, 95% CI: 0.98, 1.40, $p = .09$; Table 2).

Risk of Recurrent Falling

Men with more severe perceived physical fatigability had 37% increased odds of recurrent falling (OR: 1.37, 95% CI: 1.01, 1.85, $p = .043$; Table 2) compared with men with less severe perceived physical fatigability; previous fall history attenuated the association (OR: 1.31, 95% CI: 0.96, 1.78, $p = .09$; Table 2). Perceived mental fatigability was not associated with increased odds of recurrent falling, ($p = .19$). Men with both more severe perceived physical and mental fatigability had 44% increased odds of recurrent falling (OR: 1.44, 95% CI: 1.01, 2.04, $p = .045$) compared with men with less severe physical and mental fatigability (Table 2). Adjustment for previous fall history attenuated the findings (OR: 1.34, 95% CI: 0.92, 1.96, $p = .12$; Table 2).

Risk of Injurious Falls

More severe perceived physical fatigability was associated with increased odds of an injurious fall by 35% (OR: 1.35, 95% CI: 1.02, 1.79, $p = .035$) compared with having less severe perceived physical fatigability (Table 2). Adjustment for previous fall history attenuated the association (OR: 1.32, 95% CI: 0.99, 1.76, $p = .06$, Table 2).

Table 1. Characteristics of Participants in the Osteoporotic Fractures in Men Study (MrOS) Stratified by Perceived Physical and Mental Fatigability Severity† at Year 14 (N = 1 740)

	Perceived Physical Fatigability			Perceived Mental Fatigability		
	More Severe (≥15) n = 970 Mean ± SD or n (%)	Less Severe (<15) n = 770 mean ± SD or n (%)	p Value	More Severe (≥13) n = 413 mean ± SD or n (%)	Less Severe (<13) n = 1 327 mean ± SD or n (%)	p Value
Demographics and anthropometrics						
Age, years	85.0 ± 4.3	83.4 ± 3.6	<.0001	85.0 ± 4.4	84.1 ± 4.0	<.0001
Race			.51			.72
White	882 (90.9)	693 (90.0)		372 (90.1)	1,203 (90.7)	
Non-White	88 (9.1)	77 (10.0)		41 (9.9)	124 (9.3)	
Education			.68			.86
Less than high school	35 (3.6)	25 (3.2)		15 (3.6)	45 (3.4)	
Completed high school	147 (15.2)	107 (13.9)		57 (13.8)	197 (14.8)	
College or graduate school	788 (81.2)	638 (82.9)		341 (82.6)	1085 (81.8)	
Body mass index, kg/m²	27.2 ± 3.9	26.5 ± 3.5	.0001	27.0 ± 3.8	26.8 ± 3.7	.31
Physical activity, physical and cognitive function, sleep and fatigability						
Physical Activity Scale for the Elderly score	102.8 ± 62.5	133.9 ± 64.0	<.0001	95.1 ± 63.7	123.3 ± 64.0	<.0001
Short Physical Performance Battery score, 0–12	8.7 ± 3.1	10.3 ± 2.2	<.0001	8.5 ± 3.1	9.7 ± 2.7	<.0001
Usual-paced 6-m gait speed, m/s	1.04 ± 0.26	1.20 ± 0.23	<.0001	1.01 ± 0.26	1.14 ± 0.25	<.0001
Any difficulty with Instrumental Activities of Daily Living	457 (47.1)	106 (13.8)	<.0001	221 (53.5)	342 (25.8)	<.0001
Self-reported any conditions preventing standing/stepping	287 (29.6)	95 (12.3)	<.0001	130 (31.5)	252 (19.0)	<.0001
Self-reported trouble with dizziness	322 (33.2)	159 (20.7)	<.0001	145 (35.1)	336 (25.3)	.0001
Previous history of falling (12 months prior Year 14)	424 (43.7)	237 (30.8)	<.0001	196 (47.5)	465 (35.0)	<.0001
Teng 3MS score, 0–100	91.5 ± 7.8	92.8 ± 6.5	<.0001	90.9 ± 8.4	92.4 ± 6.8	.0007
Geriatric Depression Scale score, 0–15	2.5 ± 2.4	1.3 ± 1.7	<.0001	3.1 ± 2.7	1.6 ± 1.9	<.0001
Pittsburgh Sleep Quality Index score, 0–21	5.8 ± 3.2	4.8 ± 2.9	<.0001	6.4 ± 3.3	5.0 ± 3.0	<.0001
PFS Physical scores, 0–50	25.8 ± 7.1	13.6 ± 8.4	<.0001	—	—	—
PFS Mental scores, 0–50	—	—	—	11.5 ± 8.8	2.8 ± 3.6	<.0001
Medical history* and medications						
Self-reported good/excellent health	813 (83.8)	743 (96.5)	<.0001	336 (81.4)	1,220 (91.9)	<.0001
Diabetes	178 (18.4)	104 (13.5)	.007	80 (19.4)	202 (15.2)	.05
Cancer (nonskin)	310 (32.0)	235 (30.5)	.52	140 (33.9)	405 (30.5)	.20
Hypertension	527 (54.3)	375 (48.7)	.02	226 (54.7)	676 (50.9)	.18
Heart attack	152 (15.7)	80 (10.4)	.001	58 (14.0)	174 (13.1)	.63
Congestive heart failure	113 (11.7)	37 (4.8)	<.0001	44 (10.7)	106 (8.0)	.09
Stroke	55 (5.7)	32 (4.2)	.15	22 (5.3)	65 (4.9)	.73
Total number of medications used	9.7 ± 4.8	8.3 ± 4.5	<.0001	10.1 ± 4.9	8.8 ± 4.6	<.0001
Benzodiazepine use	41 (4.2)	19 (2.5)	.05	22 (5.3)	38 (2.9)	.02
Antidepressant use	124 (12.8)	54 (7.0)	<.0001	58 (14.0)	120 (9.0)	.003
Sedative hypnotic use	25 (2.6)	14 (1.8)	.29	8 (1.9)	31 (2.3)	.63
Opioid analgesic use	107 (11.0)	22 (2.9)	<.0001	52 (12.6)	77 (5.8)	<.0001

Notes: SD = standard deviation; PFS = Pittsburgh Fatigability Scale; Teng 3MS = Teng Modified Mini-Mental State Examination.

*Self-report doctor diagnosis.

†More severe perceived physical and mental fatigability were not mutually exclusive categories as participants could be classified into both.

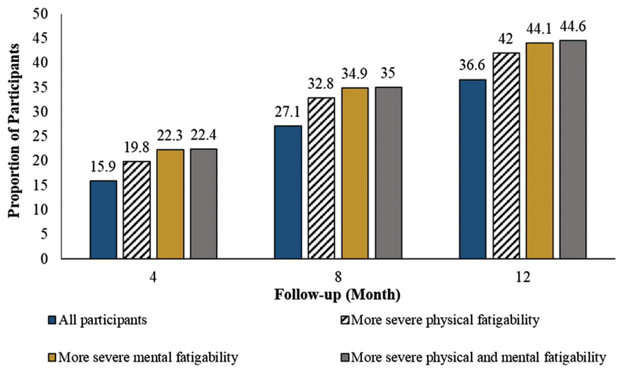

Figure 2. Cumulative frequency of falls by perceived fatigability severity over 1-year follow-up in the Osteoporotic Fractures in Men Study (MrOS).

More severe perceived mental fatigability was not associated with injurious falls (p = .31; Table 2). Further, there was a trend that men with both more severe perceived physical and mental fatigability had increased odds of an injurious fall compared with men with less severe physical and mental fatigability (OR: 1.38, 95% CI: 0.98, 1.96, p = .07).

Discussion

Our findings extend current knowledge to include fatigability as a risk factor for falling, including recurrent and injurious falls. We found that men with more severe perceived physical fatigability had a 20%, 37%, and 35% increased risk of prospective, recurrent, or injurious falls, respectively. Perceived mental fatigability severity alone was not associated with fall risk. Yet, men with both more severe perceived physical and mental fatigability had the highest risk of prospective (24%) and recurrent (44%) falling over 1 year compared with those with both less severe perceived physical and mental fatigability. Additional adjustment for previous fall history attenuated our findings.

Our findings expand upon previous work that demonstrated an association between fatigue and incident fall risk (11,12). Using a measure of global fatigue, men with higher fatigue had a 25% increased fall risk and 50% increased odds of recurrent falling compared to men with lower fatigue. However, the use of a global measure of fatigue lacks context and specificity. The current study used a measure of perceived physical and mental fatigability, which is a more sensitive and clinically relevant patient-reported measure of one's vulnerability to fatigue (13–15,17,18). Therefore, this study was able to differentiate the independent and combined effects of perceived physical and mental fatigability on prospective, recurrent, and injurious fall risk.

We found that, in this sample, having more severe perceived physical fatigability was highly prevalent (55.8%) and comparable with other cohorts that used the PFS (17,19,20). Interestingly, a substantial proportion of MrOS men (22.8%) reported more severe fatigability for both subscales. These findings suggest that perceived mental fatigability alone may be rare (0.9% of men in MrOS had more severe mental fatigability alone) at least in older men, typically presenting itself along with perceived physical fatigability, potentially explaining our null findings. The Long Life Family Study showed that the prevalence of either perceived physical or mental fatigability was greater across age strata (19,20), highlighting a need to identify early interventions to reduce the burden of fatigability and potential downstream health outcomes, including fall risk, in older adults.

In this study, men with more severe perceived physical, mental, or both physical and mental fatigability had lower physical activity and worse physical function; both of these risk factors are independently associated with fall risk (1,7,42). In MrOS, it was found that men with low physical activity and worse physical function had the highest incidence of future falls (8). Further, the Long Life Family Study revealed that perceived physical fatigability may be the pathway by which physical activity leads to poor physical function (43). Recently, Qiao et al. (18) showed that a short-term personalized physical activity intervention conferred clinically meaningful reductions in perceived physical fatigability concurrent with increased activity levels. Moreover, the U.S. Preventive Services Task Force has emphasized physical activity and exercise interventions as effective fall prevention interventions in older adults (1). Collectively, current knowledge points to testing a physical activity intervention for those at-risk, as reducing fatigability may be in the pathway by which physical activity leads to poor physical function and subsequent fall risk. Although targeting high-risk groups is one potential approach, there should also be an effort in making these interventions accessible to older adults in order to maximize their effectiveness (44).

Activities included in the PFS require varying degrees of physical and mental exertion. Although physical exertion may rely more on current fitness and physical performance, mental exertion may further tap executive functioning, perceived effort, and motivation required to complete complex tasks (32,45). As such, mental fatigability may contribute additively to physical fatigability in determining fall risk. This may explain why the combined effect of having both more severe perceived physical and mental fatigability was associated with a much greater risk of prospective and recurrent falls when compared with having more severe perceived physical or mental fatigability alone. Ultimately, targeting physical or mental subdomains alone may be insufficient to reduce fall risk in those with more severe fatigability.

The effect of perceived physical fatigability on prospective, recurrent, and injurious fall risk was attenuated after we adjusted for previous fall history. Fall history is regularly assessed in screening questionnaires estimating fall risk in older adults; however, there is much debate on whether to control for fall history, as previous falls and prospective falls typically share the same risk factors (5,7–9). Although these risk factors (eg, self-rated health, physical function, physical activity level, etc.) may be associated with increased fall risk at the time of the previous falls, the previous falls may also increase the effect of those risk factors, as injurious falls tend to result in poorer functioning and less physical activity (46). Because the PFS was added to MrOS at Year 14, we were unable to determine if fatigability preceded fall history or if the previous fall history affected fatigability severity. With conditions and medications that can cause fatigue, it is important to be careful in adjusting for these variables, as over-adjustment can lead to the total causal effect of fatigability to be biased toward the null (47). Additionally, the fall history attenuation may be an indicator that a previous fall(s) could be a marker for fatigability by indirectly reducing one's physical activity levels (43).

One of the major strengths of this study is that MrOS is a large cohort of community-dwelling oldest-old men with frequent contacts. However, MrOS is mostly non-Hispanic White participants, so how these finding generalize to populations that are more diverse is unknown. Another strength included our ability to adjust for many correlates of fatigability and fall risk to limit confounding.

Table 2. Risk of Prospective, Recurrent, and Injurious Falls for Those With More Severe Versus Less Severe Perceived Physical (PFS Physical scores ≥15), Mental (PFS Mental scores ≥13), or Both Physical and Mental Fatigability as a Predictor in 1-Year Follow-up in the Osteoporotic Fractures in Men Study (MrOS)

	Age and Site Adjusted		Multivariate Adjusted†		Multivariate Adjusted + Previous Fall History	
Variables	RR (95% CI)	*p* Value	RR (95% CI)	*p* Value	RR (95% CI)	*p* Value
Prospective fall risk						
More severe perceived physical fatigability	1.52 (1.30, 1.77)	<.0001	1.20 (1.02, 1.41)	.03	1.15 (0.99, 1.34)	.07
More severe perceived mental fatigability	1.41 (1.21, 1.64)	<.0001	1.12 (0.96, 1.32)	.15	1.08 (0.93, 1.24)	.32
More severe perceived physical and mental fatigability	1.69 (1.41, 2.02)	<.001	1.24 (1.03, 1.51)	.026	1.17 (0.98, 1.40)	.09
	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value	OR (95% CI)	*p* Value
Recurrent fall risk						
More severe perceived physical fatigability	1.97 (1.51, 2.57)	<.0001	1.37 (1.01, 1.85)	.043	1.31 (0.96, 1.78)	.09
More severe perceived mental fatigability	1.77 (1.36, 2.32)	<.0001	1.22 (0.91, 1.63)	.19	1.15 (0.84, 1.58)	.37
More severe perceived physical and mental fatigability	2.37 (1.72, 3.25)	<.0001	1.44 (1.01, 2.04)	.045	1.34 (0.92, 1.96)	.12
Injurious fall risk						
More severe perceived physical fatigability	1.71 (1.31, 2.22)	<.0001	1.35 (1.02, 1.79)	.035	1.32 (0.99, 1.76)	.06
More severe perceived mental fatigability	1.46 (1.11, 1.92)	.006	1.17 (0.87, 1.56)	.31	1.12 (0.83, 1.5)	.48
More severe perceived physical and mental fatigability	1.86 (1.35, 2.56)	<.0001	1.38 (0.98, 1.96)	.07	1.31 (0.92, 1.88)	.14

Notes: CI = confidence interval; OR = odds ratio; PFS = Pittsburgh Fatigability Scale; RR = relative risk.

†Adjusted for age, site, gait speed, self-reported conditions preventing standing or stepping, self-reported diabetes, dizziness, sleep quality, number of medications, and depressive symptoms. These variables reached the threshold of either having a model $p < .20$ or attenuated the relationship between fatigability and fall risk by more than 10%.

A limitation of this is work is the use of self-reported falls collected every 4 months versus a daily fall calendar, which can be affected by recall bias as older adults may not remember minor falls and those who are injured or hospitalized from a fall tend to remember falls and fall events better compared with those who fall but are not injured (48). However, the prospective triannual ascertainment of falls helps minimize underreporting (49). We also excluded men with missing covariate data, but this likely produced estimates of the association of perceived fatigability on fall risk that were more conservative, as those who were excluded were less healthy and thus, could have had more severe perceived fatigability.

In conclusion, more severe perceived physical fatigability was associated with increased prospective, recurrent fall risk, and injurious fall risk. However, results were largely attenuated after accounting for fall history, suggesting these patterns may have been occurring prior to the study measurements. Having more severe fatigability for both subscales conferred an even greater risk of prospective and recurrent fall risk. Our findings warrant replication in women, a population with higher rates of physical fatigability and incident falls (19,20,50). Novel interventions designed at reducing both physical and mental fatigability should also be tested as targets for their effects on fall risk.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None declared.

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Author Contributions

S.C.W. and N.W.G. had full access to all of the data in the study and take responsibility for the integrity of the data and accuracy of the data analysis. All authors: interpretation of data, critical revision of manuscript for important intellectual content. All authors read and approved the submitted manuscript.

Data Availability

MrOS data are publicly available at https://mrosonline.ucsf.edu. Analytic code is available upon request of the corresponding author (N.W.G.).

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