Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:464-71

ORIGINAL ARTICLE

Falls Among Adults Aging With Disability

Patricia Noritake Matsuda, PT, PhD, DPT,[a] Aimee M. Verrall, MPH,[a] Marcia L. Finlayson, PhD, OT Reg (Ont), OTR,[b] Ivan R. Molton, PhD,[a] Mark P. Jensen, PhD[a]

From the [a]Department of Rehabilitation Medicine, University of Washington School of Medicine, Seattle, WA; and [b]School of Rehabilitation Therapy, Queen's University, Kingston, Ontario, Canada.

Abstract

Objective: To investigate the prevalence of and risk factors for falling among individuals aging with multiple sclerosis (MS), muscular dystrophy (MD), postpolio syndrome (PPS), and spinal cord injury (SCI).

Design: Cross-sectional survey data from 2009 to 2010 were analyzed. We used forward logistic regression models to examine whether risk factors such as age, sex, mobility level, years since diagnosis, vision, balance, weakness, number of comorbid conditions, and physical activity could distinguish participants who reported falling from those who did not.

Setting: Surveys were mailed to community-dwelling individuals who had 1 of 4 diagnoses (MS, MD, PPS, or SCI). The survey response rate was 91%.

Participants: A convenience sample of community-dwelling individuals (N=1862; age, 18−94y) with MS, MD, PPS, or SCI in the United States.

Interventions: Not applicable.

Main Outcome Measure: Self-reported fall within the last 6 months.

Results: Fall prevalence for people with MS (54%), MD (70%), PPS (55%), and SCI (40%). Across all 4 groups, fall rates peaked in middle age (45−64y) and among people with moderate mobility limitations. Seven risk factors differentiated participants who fell from those who did not: mobility level, imbalance, age, curvilinear age (age^2), number of comorbid conditions, duration of diagnosis, and sex. The models differed across diagnostic groups.

Conclusions: People aging with long-term physical disabilities experience unique challenges that affect their risk of falls. A better understanding of the frequency, severity, and risk factors of falls across diagnostic groups is needed to design and implement customized, effective fall prevention and management programs for these individuals.

Archives of Physical Medicine and Rehabilitation 2015;96:464-71

The consequences of falls among older adults are wide ranging and encompass physical and psychosocial issues, such as injuries, increased risk for mortality and morbidity, and loss of functional independence.[1-6] These adverse consequences have contributed to a growing interest among health care providers, policymakers, and consumers to find ways to reduce fall risk.[7,8] Developing and delivering effective programs for decreasing fall rates requires identification of individuals at risk and prioritization of their specific fall risk factors during intervention.[3]

An audio podcast accompanies this article. Listen at www.archives-pmr.org.

Several studies suggest that fall rates are higher among individuals with long-term, physically disabling conditions, such as multiple sclerosis (MS), muscular dystrophy (MD), postpolio syndrome (PPS), and spinal cord injury (SCI), than among otherwise healthy, community-dwelling older adults.[5,9] Among people with MS, for example, reported fall rates range from an average of 52% to 54%[10-13] to as high as 63%.[14] Furthermore, recurrent falls in this group are common,[1] with some authors reporting that one third of fallers experienced multiple falls in a single month.[2] Similarly high fall rates are reported in adults with MD,[15] PPS,[16-18] and SCI.[19-21]

There is a large convergent body of literature reporting that most falls among community-dwelling older adults are the result of multiple interacting factors.[5,22-27] Knowledge about fall risk factors for people aging with MS, MD, PPS, and SCI is limited,[1] although existing literature suggests that impaired gait and mobility[10,11,13,28,29] are important factors.[13,30] However, it is not

Supported by the Department of Education, National Institute on Disability and Rehabilitation Research (grant no. H133B080024). However, the contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the federal government.

Disclosures: none.

0003-9993/14/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.09.034

clear whether fall risk factors vary as a function of medical diagnosis. This knowledge gap makes it difficult to develop empirically informed fall prevention initiatives for people aging with MS, MD, PPS, and SCI or to decide whether interventions can be generic or must be diagnostically specific.

Although research has consistently demonstrated an association between age and fall risk, the age group at the highest risk is unclear. For example, among community-dwelling adults, some studies have reported increased fall risk with increased age[24,26]; however, other studies have reported that middle-aged adults (45–64y) have a higher prevalence of falls than do individuals 65 years and older.[31-33] Few studies have compared fall rates by age among adults aging with a long-term physical disability or determined whether risk factors for falls vary as a function of age. Walking is cited as the most frequent fall-related activity among older adults with a physical disability,[18,28,34] suggesting that the prevalence of falls will be higher in middle-aged individuals who are more active and therefore have greater risk exposure. Understanding the association between age and fall risk is essential to ensuring that fall prevention programs target individuals at the highest risk.

Preventing falls and their consequences among adults aging with a long-term physical disability is of paramount importance. Development of effective interventions requires a better understanding of who is at risk and what the underlying factors contributing to the increased risk are. Therefore, the purpose of this study was to examine both the prevalence of and risk factors for falls as a function of medical diagnosis and age among adults aging with physically disabling conditions, specifically MS, MD, PPS, and SCI.

Methods

Participants

Participants for present analyses came from the first time point of a longitudinal survey on aging with physical disability being conducted at the University of Washington's Rehabilitation Research and Training Center on Aging with a Physical Disability. Participants were recruited through existing participant databases (47%), through online and print advertisements distributed by national disability organizations (40%), and from other sources (13%). Of the 2202 respondents, 2041 were eligible for and indicated interest in participation. Eligible individuals were required to be at least 18 years old, be able to read and write English, and self-report having a diagnosis of MS, MD (including a probable diagnosis of MD), PPS (including a history of polio or polio sequelae), or SCI. These diagnostic groups were selected on the basis of the experience and knowledge of the original study's investigators.

Procedures

In 2009–2010, participants were mailed a paper survey (n=2041) and an institutional review board–approved consent form. A total of 1877 participants returned the survey. Fifteen participants returned the survey but were excluded (eg, ineligible, no consent returned, and late return), leaving a final sample of 1862 (MS, 584; MD, 340; PPS, 446; SCI, 492), a 91% response rate. Missing data were pursued within 1 month of the survey's return, and double entry was made to ensure accuracy.

List of abbreviations:

IPAQ	**International Physical Activity Questionnaire**
MD	**muscular dystrophy**
MS	**multiple sclerosis**
PPS	**postpolio syndrome**
SCI	**spinal cord injury**

Table 1 Description of mobility status categories

Level	Description
1—No limitation	Walk without restrictions but have limitations in more advanced gross motor skills
2—Mild limitation	Walk without an assistive device and have limitations walking outdoors and in the community
3—Moderate limitation	Walk with an assistive mobility device and have limitations walking outdoors and in the community
4—Severe limitation	Limited self-mobility with assistance or device (eg, another person, walker, and wheelchair) and use power mobility outdoors and in community only
5—Nonwalker	Severely limited self-mobility even with the use of assistive technology (eg, power mobility)

Measures

Survey questions addressed demographic characteristics, diagnosis, health, physical function, standardized measures of secondary conditions, activities of daily living, quality of life, and social support. To address the study aims, the following items were used.

Falls

The survey used a fall question that originated from previous research on falls in people with MS[11] asking, "Did you fall down in the past 6 months?" A fall was defined as "Falling includes landing on the ground or at some other level, such as a chair or bed."

Mobility

Mobility was assessed using a single question: "How would you classify your mobility, ability to get around?" The response options and categories are presented in table 1.[35-37]

Physical activity

Physical activity was measured using the short form of the International Physical Activity Questionnaire (IPAQ).[38,39] The IPAQ asks about minutes and hours per day spent engaging in walking, moderate, and vigorous activities. The descriptions of these activities in the questionnaire were modified to be applicable to individuals using a wheelchair or assistive device (eg, moderate activities and walking activities included walking or wheeling). Data were processed according to the measure guidelines.[40] Total metabolic equivalent minutes per week was calculated using the adjustment for older adults.[38] The IPAQ has been validated in adults with MS and SCI.[41,42]

Number of comorbid conditions

The survey included 12 National Health Interview Survey questions asking about other chronic health conditions "within the last

12 months" including hypertension or high blood pressure, coronary heart disease, chronic fatigue syndrome, cancer or a malignancy of any kind, diabetes, pain or aching or stiffness in or around a joint, arthritis (rheumatoid, gout, lupus, or fibromyalgia), neck pain, low back pain, severe headache or migraine, skin problems (pressure sores and ulcers), and urinary tract infections.[43] The number of comorbid conditions was a sum of affirmative responses.

Vision, imbalance, weakness, and problems thinking

Vision was assessed using the question "Do you have any trouble seeing, even when wearing glasses or contact lenses?" (yes/no).[43] Imbalance and weakness were assessed by asking the participants to rate the "current symptoms you experience due to your disability" on a scale of 0 to 10 (0=None; 10=Very severe). Perceived problems with thinking were captured by asking participants to respond to a single item asking them to rate how much of a problem this is for them on a 5-point Likert scale, anchored from "Not at all" to "Very much."[44]

Data analyses

For each diagnostic group, differences between participants who reported falling and those who did not were first evaluated using the Fisher exact test (categorical variables) and the Kruskal-Wallis test (continuous variables). Prevalence of falls was calculated overall and for each diagnostic group by age groups and mobility status. The risk factor variables were selected on the basis of theory and previous empirical findings from the literature on falls among disability and aging populations and included age, curvilinear age (age^2), sex, duration of injury or years since diagnosis, physical activity (IPAQ, weekly total metabolic equivalents), number of comorbid conditions, self-reported vision problems and trouble thinking, imbalance, and weakness. Variables were investigated for missing values. Continuous variables were evaluated for linearity using lowess graphs and fractional polynomial methods.[45] Initially, stepwise forward logistic regression models were run to identify important risk factors and the number of variables the samples could include in final models. Proper parameterization of the variables was determined using likelihood ratio tests. The final models were estimated using forward logistic regression analysis where Akaike's information criterion determined the most suitable model and odds ratios and 95% confidence intervals for fall risk factors were obtained.[46] Standard and Hosmer-Lemeshow goodness-of-fit tests and receiver operating characteristic[46] curves were used to evaluate the final models. All statistical analyses were performed in Stata (version 12).[47,a]

Results

Sociodemographic characteristics of participants

Sociodemographic variables of participants are presented in table 2. In all but the SCI group, survey respondents were predominately women (MS, 83%; MD, 58%; PPS, 75%; SCI, 33%) and non-Hispanic white (MS, 94%; MD, 96%; PPS, 94%; SCI, 85%). Only 14% of the respondents had a high school–level education or less; however, those with SCI had the largest proportion with low education (20%). Twenty-four percent of the respondents had a household annual income of <$25,000, with participants with SCI being the largest proportion (34%). Fifty-eight percent of the respondents were married (largest proportion, MD: 70%). Participants with PPS were the oldest (65y or older, 59%). In contrast, participants with SCI were younger than those from the other diagnostic groups (18–44y, 34%). Participants with MD typically had myotonic (54%) and fascioscapulohumeral (39%) forms of the disease. Fifty-three percent of the participants with MS reported having relapsing/remitting type. Forty percent of the participants with SCI reported complete injuries; among these, proportions with paraplegia and tetraplegia were equal. The prevalence of falling in the last 6 months was highest for those with MD (70%), followed by PPS (55%), MS (54%), and SCI (40%).

Prevalence of falls by age, mobility, and diagnostic group

As seen in figure 1, more people reported falling than those who reported no falls, in all diagnostic groups except for SCI. Prevalence of falling peaks in middle-age groups (55–64y) for participants with MS, PPS, and SCI and peaks at 45 to 54 years old in those with MD. However, younger participants (18–44y) were not entirely free of falls (MS, 44%; MD, 37% of individuals without mobility limitation; SCI, 53% of individuals who use assistive devices and outdoor power mobility).

Comparisons between participants who did and did not report falling by diagnostic group

There were no significant differences in the average age of participants reporting falls (average age, 57y; range 21–89y) and those reporting no falls (average age, 56y; range, 20–94y). As seen in table 2, bivariate analyses revealed that across all diagnostic groups except PPS, those reporting falls were more likely than participants reporting no falls to have higher ratings of imbalance (MS, 5.6 vs 3.6; MD, 5.5 vs 3.5; SCI, 4.2 vs 3.3; $P<.05$). Also, in all diagnostic groups, except for participants with MD, those reporting falls were more likely to report a greater number of comorbid conditions (MS, 3.8 vs 3.0; PPS, 4.9 vs 4.4; SCI, 4.1 vs 3.6; $P<.05$). Except for those with PPS, participants who reported falls were more likely to be walking with an assistive device (rated their mobility 3, moderate limitation) (MS, 27% vs 9%; MD, 28% vs 9%; SCI, 21% vs 4%; $P<.001$). Participants with MD who reported falling were more likely to rate higher levels of weakness (average, 6.3 vs 4.9; $P<.001$) and trouble thinking (median, 1.0 vs 0.0; $P<.05$) and be middle-aged (45–55y, 34% vs 22%; 55–64y, 29% vs 26%; $P<.05$). Participants with MS reporting falls were more likely to be men (20% vs 14%; $P<.05$) and report higher levels of weakness (average, 5.0 vs 3.5; $P<.001$). Participants with PPS who reported falling were more likely to self-report difficulty with vision (41% vs 27%; $P<.05$) relative to those who did not report falling. Participants with SCI who reported falling were more likely to have higher levels of physical activity (average total metabolic equivalents, 2310 vs 2003; $P<.05$).

Risk factors associated with falling

The forward logistic regression modeling (separate models for each diagnostic group) showed that mobility level was significantly associated with participants who reported falling across all diagnostic groups, except PPS (table 3). Factors that distinguished participants who reported falling from those who did not varied across diagnostic groups: age, curvilinear age (age^2), mobility

Table 2 Selected demographic characteristics of people with MS, MD, PPS, and SCI participating in a longitudinal survey on aging with a physical disability who reported falling in the last 6mo and those who did not

	Self-Reported Falling in the Last 6Mo							
	Yes				No			
Characteristic	MS (n=311)	MD (n=231)	PPS (n=242)	SCI (n=193)	MS (n=260)	MD (n=101)	PPS (n=197)	SCI (n=291)
Sex								
Male	63 (20.3)*	100 (43.3)	62 (25.6)	131 (67.9)	35 (13.5)*	40 (39.6)	47 (23.9)	193 (66.3)
Female	247 (79.4)*	131 (56.7)	180 (74.4)	62 (32.1)	225 (86.5)*	61 (60.4)	150 (76.1)	98 (33.7)
Age (y)								
18–44	45 (14.5)	42 (18.2)*	1 (0.4)	61 (31.6)	55 (21.2)	31 (30.7)*	0 (0)	107 (36.8)
45–54	94 (30.2)	78 (33.8)*	8 (3.3)	54 (28.0)	78 (30.0)	22 (21.8)*	5 (2.5)	72 (24.7)
55–64	119 (38.3)	67 (29.0)*	104 (43.0)	55 (28.5)	85 (32.7)	26 (25.7)*	64 (32.5)	68 (23.4)
≥65	53 (17.0)	44 (19.1)*	129 (53.3)	23 (11.9)	42 (16.2)	22 (21.8)*	128 (65.0)	44 (15.1)
Physical activity†								
Walking	116 (37.5)*	76 (33.0)	81 (33.9)	42 (22.2)*	72 (27.8)*	26 (26.0)	62 (32.0)	75 (26.2)*
Moderate	85 (27.5)*	70 (30.3)	60 (25.1)	61 (32.3)*	87 (33.6)*	31 (31.0)	41 (21.1)	61 (21.3)*
Vigorous	63 (20.4)*	44 (19.1)	45 (18.8)	67 (35.5)*	68 (26.3)*	24 (24.0)	29 (14.9)	63 (22.0)*
BMI								
Underweight	7 (2.3)	15 (6.5)	15 (6.2)	10 (5.2)	7 (2.7)	4 (4.0)	12 (6.1)	27 (9.3)
Normal	134 (43.1)	86 (37.2)	85 (35.1)	86 (44.6)	135 (51.9)	48 (47.5)	62 (31.5)	120 (41.2)
Overweight	89 (28.6)	78 (33.8)	65 (26.9)	62 (32.1)	63 (24.2)	30 (29.7)	62 (31.5)	89 (30.6)
Obese	79 (25.4)	51 (22.1)	76 (31.4)	34 (17.6)	53 (20.4)	19 (18.8)	59 (30.0)	54 (18.6)
Diagnosis								
<5y	35 (11.3)	36 (15.6)	28 (11.6)	20 (10.4)	41 (15.8)	23 (22.8)	10 (5.1)	19 (6.5)
Years since diagnosis								
5–9	59 (19.0)	51 (22.1)	32 (13.2)	69 (35.8)	56 (21.5)	23 (22.8)	33 (16.8)	91 (31.3)
10–19	117 (37.6)	79 (34.2)	77 (31.8)	43 (22.3)	102 (39.2)	29 (28.7)	59 (30.0)	82 (28.2)
≥20	100 (32.2)	59 (25.5)	75 (31.0)	60 (31.1)	61 (23.5)	25 (24.8)	64 (32.5)	93 (32.0)
Vision trouble								
Yes	159 (51.1)*	83 (35.9)	100 (41.3)*	52 (26.9)	91 (35.0)*	29 (28.7)	54 (27.4)*	61 (21.0)
No	146 (47.0)*	147 (63.6)	141 (58.3)*	139 (72.0)	164 (63.1)*	71 (70.3)	142 (72.1)*	225 (77.3)
Average imbalance severity rating (min–max)	5.6 (0–10)*	5.5 (0–10)*	5.4 (0–10)	4.2 (0–10)*	3.6 (0–10)*	3.5 (0–10)*	4.8 (0–10)	3.3 (0–10)*
Average weakness severity rating (min–max)	5.0 (0–10)*	6.3 (0–10)*	6.3 (0–10)	4.0 (0–9)	3.5 (0–10)*	4.9 (0–10)*	6.1 (0–10)	3.7 (0–10)
Median problems thinking rating (IQR)	1.0 (1–2)	1.0 (0–1)*	1.0 (0–2)*	0.0 (0–1)	1.0 (0–2)	0.0 (0–1)*	1.0 (0–1)*	0.0 (0–1)
Average no. of comorbid conditions (min–max)	3.8 (0–9)*	3.9 (0–9)	4.9 (1–10)*	4.1 (0–10)*	3.0 (0–8)*	3.4 (0–9)	4.4 (0-9)*	3.6 (0–8)*
Mobility								
No limitation (1)	85 (27.3)*	56 (24.2)*	25 (10.3)	21 (10.9)*	154 (59.2)*	56 (55.5)*	22 (11.2)	33 (11.3)*
Mild limitation (2)	56 (18.0)*	62 (26.8)*	38 (15.7)	25 (12.9)*	37 (14.2)*	13 (12.9)*	36 (18.3)	6 (2.1)*
Moderate limitation (3)	85 (27.3)*	65 (28.1)*	73 (30.2)	40 (20.7)*	23 (8.9)*	9 (8.9)*	51 (25.9)	12 (4.1)*
Severe limitation (4)	72 (23.2)*	39 (16.9)*	77 (31.8)	96 (49.7)*	31 (11.9)*	14 (13.9)*	59 (30.0)	171 (58.8)*
Nonwalker (5)	13 (4.2)*	9 (3.9)*	28 (11.6)	9 (4.7)*	15 (5.8)*	9 (8.9)*	29 (14.7)	66 (22.7)*

NOTE. Values are n (%). Numbers may not add up because of missing data.
Abbreviations: BMI, body mass index; IQR, interquartile range.
* Statistically significant difference between those who did and did not report falling within each diagnostic group ($P<.05$).
† Physical activity was measured by using the IPAQ.

level, duration of disability, number of comorbid conditions, and imbalance for those with MS; mobility level and imbalance for participants with MD; age and self-reported vision problems for those with PPS; and mobility level, number of comorbid conditions, and physical activity level for those with SCI. The standard goodness-of-fit tests showed the distance between observations and covariate patterns, suggesting that the fit of the models is good and is not overfit. The Hosmer-Lemeshow goodness-of-fit test was not statistically significant for all 4 models ($P>.05$), also suggesting that the models are adequate. The receiver operating characteristic analysis for the model yielded an area under the curve (C statistic) of .76 for MS, .75 for MD, .63 for PPS, and .75 for SCI, suggesting a good association between the factors and outcome variable.

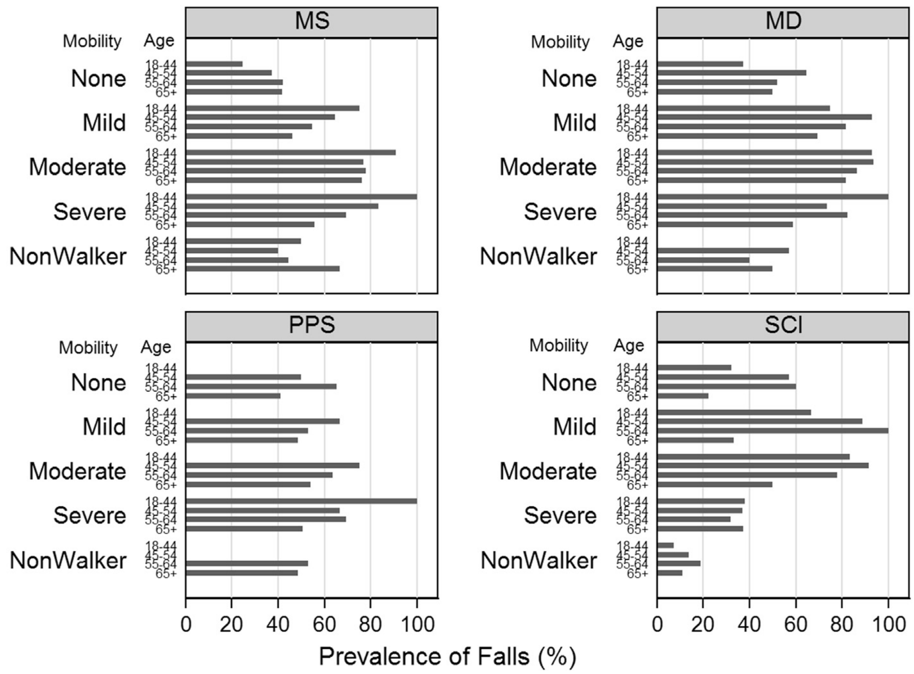

Fig 1 Prevalence of falls by the diagnostic group and age groups nested within mobility levels.

Discussion

To our knowledge, this study represents the first attempt to compare the prevalence of falls across these 4 diagnostic groups of individuals with long-term physical disabilities. The study participants aging with MS, MD, PPS, and SCI had a higher prevalence of falls than did other community-dwelling older adults. The prevalence of falling was highest for those with MD (70%), followed by individuals with PPS (55%), MS (54%), and SCI (40%). These fall rates are similar to those previously reported in individuals with MS[2,11,13] but are lower than those found in people with PPS (74%[18]) and SCI (75%[48]) by other researchers. Differences may be due to the definition of a fall and the reporting period used by Bickerstaffe,[18] Brotherton[48] and colleagues. Both these studies reported falls over the past 12 months compared with our 6-month time frame.[18,48] However, the prevalence of falls in our SCI sample is similar to that reported in a prospective study by Phonthee et al[34,49] (39%). Overall, findings from the present study support previous research reporting high fall rates among individuals aging with physically disabling conditions, as well as variability in these rates between groups. The high prevalence supports the need to address falls in these populations.[11,13,15,18,19,48]

Among those reporting falls, mobility level was found to be a common factor across all groups except for participants with PPS. However, several risk factor differences were identified between diagnostic groups. For individuals with MS and MD, imbalance was a significant factor. The number of comorbidities was significant in groups with MS and SCI; age differed significantly for people with MS and PPS. Other variables included curvilinear age (age^2), higher level of weakness, and duration of disability in people with MS; self-reported vision problems in those with PPS; and physical activity level in people with SCI. These between-group differences may be capturing differences in pathology or typical impairments or both. Self-reported vision problems emerged as a risk factor only in those with PPS. Because this group was older (95.5% were age >55y), visual problems may be capturing normal aging changes. Regular vision checks are recommended for older adults to prevent falls.[50]

Findings from this study also suggest that the prevalence of falling peaks in middle-age groups (55−64y) in individuals with MS, PPS, and SCI and at a slightly younger age (45−54y) in those with MD. This is similar to previous research in community-dwelling adults.[31,32,51] However, younger adults (18−44y) in our sample were not completely free from falls (MS, 44%; MD, 37% of individuals without mobility limitation; SCI, 53% of individuals who use assistive devices and outdoor power mobility). Although older adults are often the target for fall prevention programs, our findings suggest that health care providers should begin asking about falls and providing fall prevention information to younger (ie, middle-aged) individuals with a disabling condition, even though these individuals may not consider themselves at risk for falls. Furthermore, fall prevention initiatives and programs should work to appeal to and attract younger populations of individuals with long-term physical disabilities as well as to older adults.

The findings also indicate that different risk factors may be relevant to different diagnostic groups. These group differences suggest that there is a need for some degree of customization of fall prevention programs because one size is not likely to fit all. Some of these key factors (eg, vision trouble and physical activity) are amenable to rehabilitation and self-management strategies in fall prevention programs, which is consistent with the multifactorial intervention approach advocated for older adults.[52]

Study limitations

The data analyzed in this article were obtained via self-reported surveys, which may be subject to recall bias and potential underreporting of falls. The data are also cross-sectional, and the

Table 3 Results of 4 forward logistic regression models (1 for each diagnostic group) of risk factors that distinguished adults with a physical disability who reported falling from those who did not

Disability	Risk Factors	OR (95% CI)	*P*
MS (n=564*)	Age	1.12 (0.98–1.28)	.100
	Curvilinear age (age^2)	1.00 (1.00–1.00)	.051
	Women	0.51 (0.31–0.85)†	.009†
	Mobility (mild vs none)	1.78 (1.03–3.07)†	.037†
	Mobility (moderate vs none)	4.08 (2.26–7.38)†	<.001†
	Mobility (severe vs none)	2.62 (1.41–4.90)†	.002†
	Mobility (nonwalker vs none)	0.69 (0.27–1.76)	.432
	Years since diagnosis	1.16 (0.88–1.54)	.287
	Number of comorbid conditions	1.24 (1.07–1.23)†	<.001†
	Current imbalance severity rating	1.14 (1.06–1.23)†	<.001†
MD (n=332*)	Mobility (mild vs none)	3.44 (1.65–7.14)†	.001†
	Mobility (moderate vs none)	4.19 (1.80–9.75)†	.001†
	Mobility (severe vs none)	1.42 (0.62–3.21)	.399
	Mobility (nonwalker vs none)	0.55 (0.18–1.64)	.290
	Current imbalance severity rating	1.18 (1.08–1.30)†	<.001†
PPS (n=436*)	Age	0.98 (0.96–1.00)	.063
	Vision trouble (yes/no)	1.81 (1.21–2.80)†	.004†
SCI (n=336*)	Mobility (mild vs none)	6.01 (1.91–18.9)†	.002†
	Mobility (moderate vs none)	6.11 (2.34–16.0)†	<.001†
	Mobility (severe vs none)	1.00 (0.51–1.98)	.991
	Mobility (nonwalker vs none)	0.25 (0.08–0.78)†	.017†
	Number of comorbid conditions	1.18 (1.03–1.35)†	.020†
	Physical activity‡	1.19 (0.98–1.45)	.072

Abbreviations: CI, confidence interval; OR, odds ratio.
* Numbers may differ from table 2 because of missing data.
† Statistical significance at the .05 level.
‡ Weekly total metabolic equivalents measured by using the IPAQ.

time frame for many of the questions and instruments varies (eg, in the last 6mo, 7d, today), both of which preclude inferences of causality among the study variables. Moreover, a number of measures used in the analyses (eg, trouble thinking and vision) were single-item measures and may not be as reliable as multiple-item scales. In addition, the study participants were not recruited randomly, and our findings may not generalize to populations of individuals aging with the conditions studied. All these limitations indicate that replication of the study findings would be necessary before we can determine which are reliable.

Conclusions

Preventing falls, especially in individuals aging with physical disabilities, is of significant importance to patients, caregivers, health care providers, and policymakers. A better understanding of the frequency, severity, and correlates of falls in various diagnostic and age groups is an important first step toward designing and implementing effective fall prevention programs for these individuals.

Clinical implications

Findings from this study suggest that (1) risk factors differ between individuals aging with MS, MD, PPS, and SCI and that fall prevention programs may be more effective if addressing specific factors associated with falls in each diagnostic group (eg, modular programs) and (2) younger (ie, middle-aged) individuals should be queried about falls and should receive information on fall prevention. Future prospective research about falls and fall risk factors across these 4 diagnostic groups would aid in the development of fall prevention programs that could minimize the prevalence and negative consequences of falling.

Supplier

a. Stata, version 6.0; StataCorp, 4905 Lakeway Dr, College Station, TX 77845.

Keywords

Accidental falls; Mobility limitation; Multiple sclerosis; Muscular dystrophy; Postpoliomyelitis syndrome; Rehabilitation; Spinal cord injuries

Corresponding author

Patricia Noritake Matsuda, PT, PhD, DPT, Department of Rehabilitation Medicine, University of Washington, Seattle, WA 98195. *E-mail address:* pmatsuda@uw.edu.

References

1. Finlayson ML, Peterson EW. Falls, aging, and disability. Phys Med Rehabil Clin N Am 2010;21:357-73.
2. Peterson EW, Cho CC, von Koch L, Finlayson ML. Injurious falls among middle aged and older adults with multiple sclerosis. Arch Phys Med Rehabil 2008;89:1031-7.

3. Sleet DA, Moffett DB, Stevens J. CDC's research portfolio in older adult fall prevention: a review of progress, 1985-2005, and future research directions. J Safety Res 2008;39:259-67.
4. Stevens JA, Mack KA, Paulozzi LJ, Ballesteros MF. Self-reported falls and fall-related injuries among persons aged>or=65 years—United States, 2006. J Safety Res 2008;39:345-9.
5. Rubenstein LZ. Falls in older people: epidemiology, risk factors and strategies for prevention. Age Ageing 2006;35:ii37-41.
6. Thomas KE, Stevens JA, Sarmiento K, Wald MM. Fall-related traumatic brain injury deaths and hospitalizations among older adults—United States, 2005. J Safety Res 2008;39:269-72.
7. National Council on Aging. Falls prevention. Available at: http://www.ncoa.org/improve-health/falls-prevention/. Accessed July 8, 2014.
8. Panel on Prevention of Falls in Older Persons, American Geriatrics Society and British Geriatrics Society. Summary of the Updated American Geriatrics Society/British Geriatrics Society clinical practice guideline for prevention of falls in older persons. J Am Geriatr Soc 2011;59:148-57.
9. Tromp AM, Pluijm SM, Smit JH, Deeg DJ, Bouter LM, Lips P. Fall-risk screening test: a prospective study on predictors for falls in community-dwelling elderly. J Clin Epidemiol 2001;54:837-44.
10. Cattaneo D, De Nuzzo C, Fascia T, Macalli M, Pisoni I, Cardini R. Risks of falls in subjects with multiple sclerosis. Arch Phys Med Rehabil 2002;83:864-7.
11. Finlayson ML, Peterson EW, Cho CC. Risk factors for falling among people aged 45 to 90 years with multiple sclerosis. Arch Phys Med Rehabil 2006;87:1274-9.
12. Matsuda PN, Shumway-Cook A, Bamer AM, Johnson SL, Amtmann D, Kraft GH. Falls in multiple sclerosis. PM R 2011;3:624-32; quiz 632.
13. Matsuda PN, Shumway-Cook A, Ciol MA, Bombardier CH, Kartin DA. Understanding falls in multiple sclerosis: association of mobility status, concerns about falling, and accumulated impairments. Phys Ther 2012;92:407-15.
14. Nilsagard Y, Lundholm C, Denison E, Gunnarsson LG. Predicting accidental falls in people with multiple sclerosis — a longitudinal study. Clin Rehabil 2009;23:259-69.
15. Wiles CM, Busse ME, Sampson CM, Rogers MT, Fenton-May J, van Deursen R. Falls and stumbles in myotonic dystrophy. J Neurol Neurosurg Psychiatry 2006;77:393-6.
16. Lord SR, Allen GM, Williams P, Gandevia SC. Risk of falling: predictors based on reduced strength in persons previously affected by polio. Arch Phys Med Rehabil 2002;83:757-63.
17. Legters K, Verbus NB, Kitchen S, Tomecsko J, Urban N. Fear of falling, balance confidence and health-related quality of life in individuals with postpolio syndrome. Physiother Theory Pract 2006;22:127-35.
18. Bickerstaffe A, Beelen A, Nollet F. Circumstances and consequences of falls in polio survivors. J Rehabil Med 2010;42:908-15.
19. Brotherton SS, Krause JS, Nietert PJ. A pilot study of factors associated with falls in individuals with incomplete spinal cord injury. J Spinal Cord Med 2007;30:243-50.
20. Amatachaya S, Wannapakhe J, Arrayawichanon P, Siritarathiwat W, Wattanapun P. Functional abilities, incidences of complications and falls of patients with spinal cord injury 6 months after discharge. Spinal Cord 2011;49:520-4.
21. Nelson AL, Groer S, Palacios P, et al. Wheelchair-related falls in veterans with spinal cord injury residing in the community: a prospective cohort study. Arch Phys Med Rehabil 2010;91:1166-73.
22. Anstey KJ, Burns R, von Sanden C, Luszcz MA. Psychological well-being is an independent predictor of falling in an 8-year follow-up of older adults. J Gerontol B Psychol Sci Soc Sci 2008;63:P249-57.
23. Nachreiner NM, Findorff MJ, Wyman JF, McCarthy TC. Circumstances and consequences of falls in community-dwelling older women. J Womens Health (Larchmt) 2007;16:1437-46.
24. Rubenstein LZ, Josephson KR. Falls and their prevention in elderly people: what does the evidence show? Med Clin North Am 2006;90:807-24.
25. Scott V, Wagar B, Sum A, Metcalfe S, Wagar L. A public health approach to fall prevention among older persons in Canada. Clin Geriatr Med 2010;26:705-18.
26. Stevens JA, Baldwin GT, Ballesteros MF, Noonan RK, Sleet DA. An older adult falls research agenda from a public health perspective. Clin Geriatr Med 2010;26:767-79.
27. Ambrose AF, Paul G, Hausdorff JM. Risk factors for falls among older adults: a review of the literature. Maturitas 2013;75:51-61.
28. Harris JE, Eng JJ, Marigold DS, Tokuno CD, Louis CL. Relationship of balance and mobility to fall incidence in people with chronic stroke. Phys Ther 2005;85:150-8.
29. Behrman AL, Light KE, Flynn SM, Thigpen MT. Is the functional reach test useful for identifying falls risk among individuals with Parkinson's disease? Arch Phys Med Rehabil 2002;83:538-42.
30. Studenski S, Duncan PW, Chandler J, et al. Predicting falls: the role of mobility and nonphysical factors. J Am Geriatr Soc 1994;42:297-302.
31. Painter JA, Elliott SJ, Hudson S. Falls in community-dwelling adults aged 50 years and older: prevalence and contributing factors. J Allied Health 2009;38:201-7.
32. Li W, Keegan TH, Sternfeld B, Sidney S, Quesenberry CP, Kelsey JL. Outdoor falls among middle-aged and older adults: a neglected public health problem. Am J Public Health 2006;96:1192-200.
33. Talbot LA, Musiol RJ, Witham EK, Metter EJ. Falls in young, middle-aged and older community dwelling adults: perceived cause, environmental factors and injury. BMC Public Health 2005;5:86.
34. Phonthee S, Saengsuwan J, Siritaratiwat W, Amatachaya S. Incidence and factors associated with falls in independent ambulatory individuals with spinal cord injury: a 6-month prospective study. Phys Ther 2013;93:1061-72.
35. Bodkin AW, Robinson C, Perales FP. Reliability and validity of the gross motor function classification system for cerebral palsy. Pediatr Phys Ther 2003;15:247-52.
36. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 1997;39:214-23.
37. Wood E, Rosenbaum P. The gross motor function classification system for cerebral palsy: a study of reliability and stability over time. Dev Med Child Neurol 2000;42:292-6.
38. Tomioka K, Iwamoto J, Saeki K, Okamoto N. Reliability and validity of the International Physical Activity Questionnaire (IPAQ) in elderly adults: the Fujiwara-kyo Study. J Epidemiol 2011;21:459-65.
39. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35:1381-95.
40. IPAQ. International Physical Activity Questionnaire. Available at: www.ipaq.ki.se/ipaq.htm. Accessed July 8, 2014.
41. Rosenberg DE, Bombardier CH, Artherholt S, Jensen MP, Motl RW. Self-reported depression and physical activity in adults with mobility impairments. Arch Phys Med Rehabil 2013;94:731-6.
42. Bombardier CH, Fann JR, Tate DG, et al. An exploration of modifiable risk factors for depression after spinal cord injury: which factors should we target? Arch Phys Med Rehabil 2012;93:775-81.
43. Centers for Disease Control and Prevention. National Health Interview Survey. 2013. Available at: http://www.cdc.gov/nchs/nhis.htm. Accessed January 10, 2014.

44. Smith G, Della Sala S, Logie RH, Maylor EA. Prospective and retrospective memory in normal ageing and dementia: a questionnaire study. Memory 2000;8:311-21.
45. Royston P, Amber G, Sauerbrei W. The use of fractional poloynomials to model continuous risk variables in epidemiology. Int J Epidemiol 1999;28:964-74.
46. Hosmer DW, Lemeshow S. Applied logistic regression. 2nd ed. New York: John Wiley & Sons, Inc; 2000.
47. StataCorp. Stata Statistical Software. 2011. Available at: www.stata.com. Accessed January 10, 2014.
48. Brotherton SS, Krause JS, Nietert PJ. Falls in individuals with incomplete spinal cord injury. Spinal Cord 2007;45:37-40.
49. Phonthee S, Saengsuwan J, Amatachaya S. Falls in independent ambulatory patients with spinal cord injury: incidence, associated factors and levels of ability. Spinal Cord 2013;51:365-8.
50. Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 2012;(9):CD007146.
51. Coote S, Finlayson M, Sosnoff JJ. Level of mobility limitations and falls status in persons with multiple sclerosis. Arch Phys Med Rehabil 2014;95:862-6.
52. Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev 2012;9:CD007146.