Research Article

Interrelated Neuromuscular and Clinical Risk Factors That Contribute to Falls

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Abstract

Background: Neuromuscular and clinical factors contribute to falls among older adults, yet the interrelated nature of these factors is not well understood. We investigated the relationships between these factors and how they contribute to falls, which may help optimize fall risk assessment and prevention.

Methods: A total of 365 primary care patients (age = 77 ± 7 , 67% female) were included from the Boston Rehabilitative Impairment Study of the Elderly. Neuromuscular measures included leg strength and leg velocity, trunk extensor endurance, and knee range of motion. Clinical measures included memory, executive function, depressive symptoms, pain, sensory loss, vision, comorbidity, physical activity, mobility self-efficacy, and psychiatric medication. Factor analysis was used to evaluate clustering of factors. Negative binomial regression assessed the relationship of factors with three-year fall rate. Interactions were tested to examine whether clinical factors modified the relationship between neuromuscular factors and falls.

Results: Three factors emerged: (i) neuromuscular factors, pain, and self-efficacy; (ii) memory; and (iii) executive function. Having three neuromuscular impairments predicted higher fall rate (incidence rate ratio [95% confidence interval]: 3.39 [1.82–6.32]) but was attenuated by memory (1.69 [1.10–2.61]), mobility self-efficacy (0.99 [0.98–0.99]), psychiatric medication use (1.54 [1.10–2.14]), and pain (1.13 [1.04–1.23]). Pain modified the relationship between neuromuscular impairment burden (number of neuromuscular impairments) and falls. Having three neuromuscular impairments was associated with a higher fall rate in patients with high levels of pain (5.73 [2.46–13.34]) but not among those with low pain.

Conclusions: Neuromuscular impairment burden was strongly associated with fall rate in older adults with pain. These factors should be considered together during fall risk assessment, post fall assessment, and prevention.

Keywords: Falls, Fall prevention and management, Pain, Cognition

Falls are a major source of morbidity and mortality among older adults (1), affecting one third of those aged 65 years and older (2), and leading to poor outcomes such as serious injury, loss of independence, and institutionalization (3,4). Two important components of fall risk manage-

ment are medical management of clinical risk factors and rehabilitative care for mobility issues (5). Medical management often focuses on chronic disease management and medication review, while rehabilitation addresses complex mobility issues by correcting underlying neuro-

muscular impairments. Treatment for mobility issues is optimized when recognizing and accounting for interrelated clinical factors. For example, clinical risk factors like cognitive impairment and depression may require modified or individualized rehabilitative care to optimally affect functional outcomes (6). Musculoskeletal pain may influence the role of neuromuscular impairments on poor mobility (7,8). While cognition, depression, and pain have each been associated with falls (9,10), their relationship with neuromuscular impairments and how they may interact to contribute to fall risk has not been fully explored.

Previous work within the Boston Rehabilitative Impairment Study of the Elderly (Boston RISE) identified four neuromuscular attributes (leg strength, leg velocity, range of motion, and trunk extensor muscle endurance) that predict poor mobility outcomes in older adults and can be treated with rehabilitative care (11,12). This subset was derived from 11 neuromuscular attributes that have been described in the literature as being amenable to rehabilitative care and associated with poor mobility (13–16). Two of these attributes, leg velocity and trunk extensor muscle endurance, are novel since they have not been emphasized in fall prevention or fall risk management interventions or standard rehabilitative care. A better understanding of how the influence of these neuromuscular attributes on mobility-related outcomes like falls may vary depending on the presence of clinical risk factors is needed for the development of novel and more effective interventions.

When evaluating the role of various interrelated factors in one model, issues like collinearity of related risk factors pose a challenge. Factor analysis can be used as a data reduction step to cluster related risk factors into underlying latent variables. We aimed to assess which clinical and neuromuscular fall risk factors cluster into latent factors and which clinical risk factors interact with neuromuscular impairment to predict fall rate in older adults over 3 years of follow-up. We hypothesized that risk factors would cluster together to form at least two latent factors—neuromuscular and clinical factors—and that clinical risk factors modify the relationship between neuromuscular impairments and fall rate.

Methods

Design and Participants

Boston RISE is a prospective cohort study of 430 older primary care patients who were at risk of declining mobility or mobility disability at baseline. This study received Institutional Review Board approval and participants provided written informed consent. Study details and procedures have been described previously (17). Participants were recruited from primary care practices within the Greater Boston Area. Inclusion criteria were age 65 years and older, ability to communicate in English, self-reported difficulty or task modification walking half a mile and/or climbing one flight of stairs, no planned major surgery, and planning to remain in the study area for 2 or more years. Exclusions were major surgery or myocardial infarction in the previous 6 months, medical problems that could interfere with study testing, Mini-Mental State Examination (MMSE) score of less than 18 (18), and Short Physical Performance Battery (SPPB) score of less than 4 (19). Certain groups were oversampled to match the demographics of older adults within the study recruitment area. This secondary analysis included 365 participants with neuromuscular impairment and falls data.

Falls

Self-reported number of falls was measured quarterly over 3 years during annual clinic visits and every 3 months between visits by phone. Participants were asked “How many times have you fallen to

the ground in the past 3 months?” Falls were defined as any part of the body above the ankle hitting the floor or ground including falls that occurred on stairs (20). In the first and second years, 97.2% and 95.0% of fall responses were completed, respectively.

Neuromuscular Attributes

Leg strength, leg velocity, knee flexion range of motion (ROM) and trunk extensor muscle endurance have been described previously and were included based on their demonstrated relationship with poor and declining mobility (12). Strength and power were measured on each leg using a pneumatic resistance leg press machine (Keiser A420). Strength was recorded as the highest one repetition maximum (1RM) from either side and was adjusted by body mass (N/kg). Power was measured on each leg at 40% and 70% of the 1RM. The highest power was recorded as peak power. Leg velocity (m/s) was calculated by dividing peak leg press power by force. Knee flexion ROM (degrees) was measured using a goniometer. Trunk extensor muscle endurance was measured using a previously described protocol with the participant lying prone on a plinth positioned 45° from vertical with their feet on a footplate and their body supported below the waist by the table (16). Time (seconds) that the participant was able to maintain their trunk in a neutral position with their arms across their chest and their sagittal plane in line with their pelvis was recorded. Neuromuscular attributes were considered to be impaired if within the worst quartile. Sex-specific quartiles were used when the attributes' means differed between men and women (p -value < .05).

Cognition

Three neuropsychological tests assessed memory, executive function, attention, and processing speed. The Hopkins Verbal Learning Test, Revised (HVL-R) is a validated measure of verbal learning and memory (21). HVL-R includes three subscales: (i) total recall, the total number of words recalled correctly over three trials; (ii) delayed recall, the number of words recalled correctly after a 20- to 25-minute delay; and (iii) recognition, the total number of true responses recognized from the original list subtracted by the number of false positive responses of words read from a longer list. Executive function, attention, and processing speed were evaluated using the Trail Making Test (TMT) and the Digit Symbol Substitution Test (DSST). In TMT part A, the participant is instructed to draw lines connecting consecutive numbers. For part B, the participant is asked to draw lines connecting alternating numbers and letters in order (22). TMT has been shown to be reliable and valid (23). For the DSST, participants are instructed to fill in symbols corresponding to a series of numbers. The score is calculated as the number of symbols correctly assigned to the series of numbers within 90 seconds. The DSST is part of the widely used Wechsler Adult Intelligence Scale and has demonstrated good test–retest reliability (23).

Demographics and Clinical Factors

Demographic and clinical factors were examined based on their demonstrated association with falls in the geriatric literature and availability within the Boston RISE database (10,24). Body mass index (BMI) was calculated as body mass divided by height (kg/m^2). Mobility self-efficacy was measured using the Activities-specific Balance Confidence (ABC) Scale. Higher scores indicate greater self-efficacy (25). Participants self-reported their confidence in performing 16 daily activities without losing their balance or becoming unsteady. Physical activity was measured using the validated Physical Activity Scale for the Elderly (PASE). Higher scores indicate greater activity

(26). Pain was assessed using the pain severity subscale of the Brief Pain Inventory (BPI), which has been validated for non-malignant pain (27). Participants rated their level of current pain on a scale from 0 to 10. Moderate to severe pain was characterized as a score of 3 or more (28). Vision was measured using the Snellen eye chart and visual deficit was defined as inability to read the 20/50 line (29). The Semmes-Weinstein monofilament test was used to measure lower extremity sensory loss (30). Number of comorbidities was assessed using a validated self-report questionnaire that included heart disease, hypertension, lung disease, diabetes, ulcer/stomach disease, kidney disease, liver disease, anemia/other blood diseases, cancer, depression, osteoarthritis/rheumatoid arthritis, and back pain (31). The Patient Health Questionnaire-9 (PHQ-9) quantified depressive symptoms (score range: 0–27). A PHQ-9 score above 5 was used to define depressive disorder (32). Psychiatric medication use was defined as use of any medication classified under the Iowa Drug Information Service as psychotherapeutic agents.

Statistical Analyses

Age-adjusted *z*-scores were calculated for each cognitive test using normative data from healthy age-matched peers (33–37). Impairment on cognitive tests was classified as being 1.5 *SDs* below the age-adjusted mean. Mild cognitive impairment (MCI) was categorized into three subtypes: (i) amnesic, impairment on two memory tests; (ii) non-amnesic, impairment on two non-memory tests; and (iii) multiple domain, impairment on both memory and non-memory tests.

Factor analysis was used to identify unobserved subgroups among neuromuscular attributes and clinical fall risk factors (38). A minimum eigenvalue of 1 was used and varimax rotation was used to derive orthogonal factor scores. Items with a minimum factor loading of |0.40| were considered relevant for that factor. The lowest Bayesian Information Criterion (BIC) value was used to determine the optimal number of factors.

Measures were grouped into variables based on results from the factor analysis and clinical interpretability. Negative binomial regression was used to assess their relationships with fall rate. We created an ordinal variable representing neuromuscular impairment burden (number of impairments) and reported baseline characteristics

across these groups. Means and standard deviations were reported for continuous variables and frequencies and percentages were reported for categorical variables. Analysis of variance, chi-squared tests, and Fisher exact tests were used to assess differences in characteristics across groups.

We assessed whether clinical factors modified the relationship of neuromuscular impairment with fall rate by testing interactions. Analyses were stratified, when appropriate. We used SAS 9.4 for all analyses. *p*-values less than .05 were considered statistically significant.

Results

Factor analysis uncovered three main factors (Table 1): (i) neuromuscular attributes (leg strength, leg velocity, and trunk extensor muscle endurance), pain, and mobility self-efficacy scores; (ii) memory (the HVLt battery); and (iii) executive function, attention, and processing speed (the DSST, TMT A, and TMT B). In addition to the neuromuscular impairment variable, we created a categorical variable representing amnesic, non-amnesic, and multiple domain MCI, with no MCI as the reference, based on factor analysis results and previous work (33). We additionally considered knee flexion ROM, depressive symptoms, pain, mobility self-efficacy, physical activity, visual deficit, sensory loss, number of comorbidities, and psychiatric medication use for inclusion in negative binomial regression models predicting fall rate. Except for age, sex, race, and education, we removed variables that were not significant from final models.

Since leg strength and leg velocity differed between men and women ($p < .05$), we used sex-specific cutpoints based on the lowest quartile to define impairment in these attributes (strength ≤ 7.7 N/kg for women and ≤ 9.6 N/kg for men; velocity ≤ 0.8 m/s for women and ≤ 1.0 m/s for men). Trunk extensor muscle endurance did not differ by sex and impairment was defined as less than or equal to 61.2 seconds. Baseline characteristics among neuromuscular impairment burden groups are presented in Table 2. The number of impairments ranged from zero to three, with 140 participants having zero, 131 having one, 63 having two, and 31 having three impairments. Participants with greater neuromuscular impairment burden were

Table 1. Item Loadings From Factor Analysis Using Varimax Rotation

	Impairments	Memory	Non-Memory Cognition
Leg strength, N/kg	.64	-.01	-.01
Leg velocity, m/s	.51	.08	.04
Trunk extensor muscle endurance, s	.49	.13	.05
Knee flexion range of motion, degrees	.25	-.04	.13
HVLt Total Recall <i>z</i> -score	.05	.83	.27
HVLt Delayed Recall <i>z</i> -score	.05	.92	.17
HVLt Recall Discrimination <i>z</i> -score	.02	.65	.12
Digit Symbol Substitution Test <i>z</i> -score	-.01	.16	.80
Trail Making Test A <i>z</i> -score	.11	.16	.70
Trail Making Test B <i>z</i> -score	.22	.28	.75
Physical Activity Scale for the Elderly	.36	.10	.06
Brief Pain Inventory	-.41	-.02	-.13
Activities-specific Balance Confidence Scale	.65	.12	.11
Depressive symptoms, PHQ-9 score	-.22	.04	-.17
Education level	.20	.25	.30
Vision	-.19	-.09	-.15
Comorbidity count	-.30	.06	-.01

Note: HVLt = Hopkins Verbal Learning Test; PHQ-9 = Patient Health Questionnaire. Item loadings $>|0.40|$ (in bold) were considered relevant components of the factor.

Table 2. Baseline Characteristics According to Neuromuscular Impairment Burden Among 365 Boston Rehabilitative Impairment Study of the Elderly Participants

	Neuromuscular Impairment Burden				<i>p</i> -Value
	0 (<i>n</i> = 140)	1 (<i>n</i> = 131)	2 (<i>n</i> = 63)	3 (<i>n</i> = 31)	
Age, years	74.7 (6.3)	77.4 (7.1)	78.3 (6.9)	78.8 (6.9)	.0002
Sex, female (%)	92 (65.7)	87 (66.4)	46 (73.0)	20 (64.5)	.74
Race, white (%)	118 (84.3)	102 (77.9)	53 (84.1)	27 (87.1)	.43
BMI, kg/m ²	28.2 (5.2)	29.2 (6.0)	30.6 (6.0)	31.1 (6.0)	.01
College education (%)	91 (65.0)	75 (57.3)	33 (52.4)	9 (29.0)	.003
Activities-specific Balance Confidence Scale	84.2 (11.3)	77.5 (13.9)	70.5 (17.9)	57.6 (20.5)	<.0001
Physical Activity Scale for the Elderly	193.5 (67.7)	171.8 (67.6)	170 (82.2)	132.5 (41.7)	<.0001
Brief Pain Inventory	2.1 (1.7)	2.5 (1.8)	2.9 (1.7)	3.3 (2.3)	.001
MCI subtypes (%)					.39
Amnesic MCI	17 (12.1)	19 (14.5)	10 (15.9)	9 (29.0)	
Non-amnesic MCI	1 (0.7)	7 (5.3)	0 (0)	3 (9.7)	
Multiple domain MCI	27 (19.3)	29 (22.1)	13 (20.6)	10 (32.3)	
Visual deficit (%)	4 (2.9)	7 (5.3)	3 (4.8)	4 (12.9)	.14
Sensory loss (%)	37 (26.4)	36 (27.5)	21 (34.4)	14 (46.7)	.13
Comorbidity count	3.5 (1.7)	3.9 (1.8)	4.4 (1.8)	4.9 (2.1)	.0003
PHQ-9 > 5 (%)	3 (2.1)	8 (6.1)	8 (7.9)	3 (6.7)	.10
Psychiatric medication use (%)	37 (26.4)	40 (30.5)	16 (25.4)	13 (41.9)	.32

Note: BMI = body mass index; MCI = mild cognitive impairment; PHQ-9 = Patient Health Questionnaire. Mean (SD) or *N* (%). *p*-values from analysis of variance, chi-squared test, or Fisher exact test assessing differences across groups.

older, had higher BMI, higher pain scores, more chronic conditions, lower mobility self-efficacy and physical activity scores, and lower rates of college education. Groups did not differ by sex, race, cognitive impairment, visual deficit, sensory loss, depressive disorder, or psychiatric medication use.

Fall incidence rate ratios (IRRs) and 95% confidence intervals (CIs) for the following models are presented in Table 3: Model 1—neuromuscular impairment burden adjusted for age, sex, race, and education; Model 2—Model 1 + MCI subtypes; Model 3—Model 2 + mobility self-efficacy score, and psychiatric medication use; and Model 4—Model 3 + pain. Having three neuromuscular impairments was associated with over three times the fall rate compared to having no impairments in Model 1 (IRR [95% CI]: 3.39 [1.82–6.32]). In Model 2, amnesic MCI compared to no MCI and having three neuromuscular impairments was independently associated with greater falls (1.65 [1.06–2.58] and 2.79 [1.46–5.31], respectively). MCI subtypes attenuated the effect of neuromuscular impairment burden on fall rate by 18%. In Model 3, psychiatric medication use was associated with greater falls (1.54 [1.10–2.14]) and higher mobility self-efficacy score with fewer falls (0.98 [0.97–0.99]). These clinical risk factors attenuated the effect of neuromuscular impairment burden by an additional 31% (1.93 [1.01–3.66]). Higher pain score in Model 4 was associated with greater falls (1.13 [1.04–1.23]) and attenuated the effect of neuromuscular impairment burden by an additional 17% to nonsignificant. Having one or two neuromuscular impairments, non-amnesic, or multiple domain MCI did not predict fall rate in any model.

Pain score had a positive interaction with neuromuscular impairment burden ($p = .0004$). No interactions were observed between neuromuscular impairment burden and other clinical risk factors. Table 4 shows the association of neuromuscular impairment burden with fall rate stratified by high and low pain (high pain: BPI ≥ 3 ; low pain: BPI < 3). Those with high pain and three neuromuscular impairments had over five times the fall rate of those with no neuromuscular impairments (5.73 [2.46–13.34]). Neuromuscular impairment burden did not predict fall rate within the low-pain group.

Discussion

This study demonstrates that neuromuscular and clinical factors are interrelated and important to consider together when evaluating fall risk and designing fall prevention programs. Neuromuscular impairment burden may be a particularly important risk factor for falls among older adults with high levels of pain.

These results extend our previous findings, which demonstrated that leg strength, leg velocity, trunk extensor muscle endurance, and ROM independently predict poor and declining mobility among older adults (12). It is not surprising that three of these attributes clustered together into one latent factor, since each is neuromuscular in nature. Interestingly, ROM did not cluster with the other impairments and was not associated with falls. However, we only looked knee flexion ROM in this analysis. Future work should also examine the role of hip ROM, since it may be more restricted among fallers compared to non-fallers (39).

Among those with high pain, having three impairments compared to none was associated with over five times the fall rate. This novel finding may indicate that individuals with pain rely more strongly on neuromuscular attributes to prevent falls and that there is a pronounced effect of accumulated impairments over any single impairment alone. Similar findings have been observed with outcomes of mobility. In a cross-sectional analysis, Duncan and colleagues found that accumulated deficits across sensory, motor, and central processing domains better predicted variability in mobility than any single impairment alone (40). Additionally, the Health Aging and Body Composition Study found that an accumulation of impairments in sensory and motor peripheral nerve function may have a compounded effect on incident mobility disability (41). It has been suggested that the pronounced influence of accumulated impairments reflects a lack of functional reserve and an inability to compensate due to multiple deficits (40). This has important clinical relevance in that individuals with accumulated impairments and pain may be particularly vulnerable to falls, making medical management of pain and rehabilitative care crucial.

Table 3. Neuromuscular and Clinical Risk Factors Associated With Fall Rates Over 3 Years

	IRR (95% CI)			
	Model 1	Model 2	Model 3	Model 4
Neuromuscular impairment burden				
0	Ref.	Ref.	Ref.	Ref.
1	0.94 (0.65–1.37)	0.90 (0.62–1.30)	0.77 (0.53–1.12)	0.75 (0.52–1.08)
2	1.11 (0.70–1.77)	1.23 (0.77–1.96)	1.11 (0.70–1.76)	1.20 (0.76–1.89)
3	3.39 (1.82–6.32) ^a	2.79 (1.46–5.31) ^a	1.93 (1.01–3.66) ^a	1.60 (0.85–3.03)
<i>p</i> -value	<.0001	.0002	.06	.11
MCI subtypes				
No MCI	—	Ref.	Ref.	Ref.
Amnesic MCI	—	1.65 (1.06–2.58) ^a	1.51 (0.98–2.33)	1.69 (1.10–2.61) ^a
Non-amnesic MCI	—	1.39 (0.47–4.10)	1.07 (0.37–3.13)	0.92 (0.31–2.69)
Multiple domain MCI	—	0.60 (0.21–1.66)	0.65 (0.24–1.78)	0.70 (0.25–1.91)
<i>p</i> -value		.08	.25	.10
Activities-specific Balance Confidence Scale	—	—	0.98 (0.97–0.99) ^a	0.99 (0.98–0.99) ^a
Psychiatric medication use	—	—	1.54 (1.10–2.14) ^a	1.54 (1.10–2.14) ^a
Brief Pain Inventory	—	—	—	1.13 (1.04–1.23) ^a

Note: CI = confidence interval; IRR = incidence rate ratio; MCI = mild cognitive impairment. All models adjusted for age, sex, race, and education.

^a95% CI excludes 1.

Table 4. Association of Neuromuscular Impairment Burden With Fall Rates Over 3 Years, Stratified by High and Low Pain

	High Pain		Low Pain	
	N = 143	IRR (95% CI)	N = 222	IRR (95% CI)
Neuromuscular impairment burden				
0	45	Ref.	95	Ref.
1	49	1.11 (0.60–2.07)	82	0.66 (0.42–1.01)
2	32	0.55 (0.27–1.11)	31	1.41 (0.79–2.52)
3	17	5.73 (2.46–13.34) ^a	14	0.74 (0.31–1.77)
<i>p</i> -value		<.0001		.34

Note: CI = confidence interval; IRR = incidence rate ratio. Adjusted for age, sex, and race. High pain: Brief Pain Inventory ≥3. Low pain: Brief Pain Index <3.

^a95% CI excludes 1.

Given that mobility self-efficacy and pain clustered with the neuromuscular impairments in the factor analysis, it was not surprising that these clinical risk factors attenuated the effect of neuromuscular impairment burden on fall rate. However, for clinical interpretability, we chose to examine these as separate risk factors for falls. Musculoskeletal pain likely contributes to reduced confidence in preventing a fall. This is consistent with results from a small, cross-sectional study, showing that older adults with back pain had both reduced fall-related self-efficacy and poorer mobility (38). In addition, pain is likely a major contributor to reduced effort during neuromuscular testing. Without muscle imaging, we were unable to determine whether poor performance on neuromuscular testing in those with high pain was due to poorer neuromuscular physiology, reduced effort related to pain avoidance, or a combination of these factors. However, previous evidence suggests that the relationship may not be due to pain avoidance alone. A study investigating trunk muscle attenuation (fat infiltration) using computed tomography scans showed a greater effect of poor muscle composition on physical function among older adults with moderate to high back pain compared to those with low pain (8). Future studies are needed to investigate whether similar associations are seen among additional muscles and to examine the temporal relationship between pain and impaired muscle physiology and function.

We found no association between neuromuscular impairment burden and falls among participants with low pain. In contrast, leg

strength, leg velocity, and trunk extensor muscle endurance have been previously associated with mobility outcomes among Boston RISE participants with and without back pain (7). While previous findings suggest that these impairments drive mobility, regardless of pain status, there may be additional factors that drive falls, particularly in those with low pain.

Amnesic MCI predicted fall rate, which was somewhat unexpected, given that non-amnesic MCI has been associated with falls previously (42). Our findings suggest that memory may play a role in fall rate among older adults; however, we cannot rule out the role of executive function given the small number of participants with non-amnesic MCI in our study.

This study has important strengths. Fall rate was measured prospectively over a 3-year follow-up. Our findings demonstrate that both known factors, such as cognition, leg strength, and pain, and more novel factors, such as leg velocity and trunk extensor muscle endurance, are important contributors to fall risk.

Limitations include that Boston RISE is not population based. While oversampling was used to match demographics of older adults within the recruitment area, findings may not be generalizable to older adults in other locations. We assessed fall rate using quarterly phone calls, not diaries, which may have resulted in recall bias, leading to an underestimation of falls, particularly among participants with memory impairment. This would likely have resulted in bias

towards the null for the amnesic MCI–fall rate relationship. Despite this, we observed a significant relationship between amnesic MCI and fall rate. Some known fall risk factors were not assessed in this study, including environmental factors and orthostatic hypotension. We had limited statistical power in our non-amnesic MCI group. Missing data occurred for neuromuscular measures, as some found these tests to be too challenging. Although rates of missing data in this study are comparable to rates within other older adult cohort studies (8,43). Risk factors were examined at baseline and future work should examine how changes in neuromuscular impairment burden and clinical factors impact fall risk.

Our findings highlight the multifaceted relationship between neuromuscular and clinical factors contributing to falls. Neuromuscular impairment burden was strongly associated with fall rate, particularly among individuals with high pain. Within both rehabilitation and primary care, providers should consider signs of impairment in these neuromuscular attributes, particularly among patients with pain. Rehabilitation focusing on the improvement of these attributes in addition to improving pain may be a promising means of reducing falls.

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Conflict of Interest

None reported.

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