

Research Article

# A Prospective Study of Back Pain and Risk of Falls Among Older Community-dwelling Women

Lynn M. Marshall,<sup>1</sup> Stephanie Litwack-Harrison,<sup>2</sup> Peggy M. Cawthon,<sup>2</sup> Deborah M. Kado,<sup>3,4</sup> Richard A. Deyo,<sup>5</sup> Una E. Makris,<sup>6,7</sup> Hans L. Carlson,<sup>1</sup> and Michael C. Nevitt<sup>8</sup>; for the Study of Osteoporotic Fractures (SOF) Research Group

<sup>1</sup>Department of Orthopaedics and Rehabilitation, Oregon Health and Science University, Portland. <sup>2</sup>California Pacific Medical Center Research Institute, San Francisco. <sup>3</sup>Department of Family and Preventive Medicine and <sup>4</sup>Department of Internal Medicine, University of California, San Diego. <sup>5</sup>Department of Family Medicine, Oregon Health and Science University, Portland. <sup>6</sup>Department of Internal Medicine and <sup>7</sup>Department of Clinical Sciences, University of Texas Southwestern Medical Center, Dallas. <sup>8</sup>Department of Epidemiology and Biostatistics, University of California, San Francisco.

Correspondence should be addressed to Lynn M. Marshall, ScD, Department of Orthopaedics & Rehabilitation, Oregon Health and Science University, 3181 SW Sam Jackson Park Road, Mailcode OP31, Portland, OR 97239-3098. E-mail: [marshaly@ohsu.edu](mailto:marshaly@ohsu.edu)

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## Abstract

**Background.** Back pain and falls are common health conditions among older U.S. women. The extent to which back pain is an independent risk factor for falls has not been established.

**Methods.** We conducted a prospective study among 6,841 community-dwelling U.S. women at least 65 years of age from the Study of Osteoporotic Fractures (SOF). Baseline questionnaires inquired about any back pain, pain severity, and frequency in the past year. During 1 year of follow-up, falls were summed from self-reports obtained every 4 months. Two outcomes were studied: recurrent falls ( $\geq 2$  falls) and any fall ( $\geq 1$  fall). Associations of back pain and each fall outcome were estimated with risk ratios (RRs) and 95% confidence intervals (CIs) from multivariable log-binomial regression. Adjustments were made for age, education, smoking status, fainting history, hip pain, stroke history, vertebral fracture, and Geriatric Depression Scale.

**Results.** Most (61%) women reported any back pain. During follow-up, 10% had recurrent falls and 26% fell at least once. Any back pain relative to no back pain was associated with a 50% increased risk of recurrent falls (multivariable RR = 1.5, 95% CI: 1.3, 1.8). Multivariable RRs for recurrent falls were significantly elevated for all back pain symptoms, ranging from 1.4 (95% CI: 1.1, 1.8) for mild back pain to 1.8 (95% CI: 1.4, 2.3) for activity-limiting back pain. RRs of any fall were also significantly increased albeit smaller than those for recurrent falls.

**Conclusions.** Older community-dwelling women with a recent history of back pain are at increased risk for falls.

**Keywords:** Pain—Falls—Epidemiology

Back pain lasting at least 1 day in the past 3 months is reported by nearly 30% of U.S. adults aged 65 years and older (1) and leads to 30 million office visits annually in adults of any age (2). Back pain is the most prevalent type of musculoskeletal pain reported by older adults, with higher prevalence than pain in the knees, hips, or any other joint (3), and is often severe enough to restrict usual activities (4). Among older adults, back pain often co-occurs with limitations in physical functioning, such as difficulty standing or walking short distances, and with depressive symptoms (5–9). In turn, poor

physical and mental functioning are well-documented risk factors for falls (10–12), suggesting that older adults with back pain may be at high risk for falls.

Given the high prevalence and medical burden of back pain, knowledge about its relation to fall risk could be beneficial for planning public health and therapeutic interventions. However, the association of back pain and fall risk has not been adequately evaluated in prospective studies. Previous investigations used different definitions of back pain, with some assessing only chronic back pain

(13,14) and others assessing any back pain (15,16). Consequently, effects of back pain location, severity, and frequency on fall risk remain unknown. Moreover, associations of back pain and fall risk may be sex specific. Among older adults, women more often report back pain and injuries from falls than men (3,4,17).

To determine the associations of back pain with the risk of falls among community-dwelling older women, we used existing prospectively collected data from the Study of Osteoporotic Fractures (SOF) cohort. We hypothesized that any observed associations of back pain and fall risk would be explained, at least in part, by poor physical function, depressive symptoms, or other possible intermediate factors such as use of pain or other central nervous system active medications (18).

## Methods

### Participants

Between September 1986 and October 1988, 9,704 White women aged 65 years and older completed an enrollment visit in SOF, a nationwide prospective cohort study of risk factors for fractures and falls (19). Briefly, women were recruited from community-based listings in Baltimore, MD; Minneapolis, MN; Portland, OR; and Pittsburgh PA. Women needing assistance to walk or with bilateral hip replacements were ineligible. In addition, Black women initially were not recruited because of their low hip fracture rates. Institutional Review Boards at each site approved the study. All participants gave written informed consent.

From January 1989 through December 1990, the 9,339 participants alive and active in SOF were invited to complete a second visit (Visit 2) and comprehensive questionnaire. Visit 2 served as the “baseline” for this analysis.

### Back Pain Assessment

On the baseline questionnaire, women reported whether they had any back pain in the past 12 months. Those with back pain marked on a drawing of the posterior torso where their back pain usually occurred (upper, middle, or lower back). We categorized pain locations as low back only, upper or mid back only, and low back plus mid or upper back, and number of pain sites as 1, 2, or 3. Those reporting back pain were asked about severity (mild, moderate, or severe), frequency (rarely/some of the time, most of the time/always), and whether they limited their usual activities because of back pain (yes, no).

### Other Baseline Measures

Questionnaires also elicited information on age, education, cigarette smoking, drinks of alcohol per week, and self-rated health. History of physician-diagnosed conditions included Parkinson's disease, stroke, and osteoarthritis. Women also reported whether in the past 12 months they had any falls, fainting episodes, or hip pain. Instrumental activities of daily living (IADL) was coded as self-reported difficulty with at least one of the following five activities: walking 2–3 blocks, climbing 10 steps, preparing meals, doing heavy housework, and shopping for groceries or clothes. Depressive symptoms were assessed with the validated 15-item Geriatric Depression Scale (GDS) (20).

Participants were interviewed about medication use in the past 12 months with separate questions to ascertain medications used for sleep, for anxiety, and for pain (including for “arthritis, headaches, and other discomfort”). Participants underwent four physical

performance measures: usual walking pace (m/s), chair stand time (s), ability to hold tandem stands with eyes open and with eyes closed for 10 seconds, and grip strength (kg) with a handheld dynamometer (Preston Grip Dynamometer, Tokyo, Japan). Body mass index (kg/m<sup>2</sup>) was calculated from height and weight measured by study staff. Presence of vertebral fracture was determined from spine radiographs obtained at enrollment (21).

### Fall Outcomes

Every 4 months (tri-annually) after baseline, participants reported the number of times they fell in the past 4 months on brief questionnaires. Nonresponders were telephoned to obtain their fall information. In each tri-annual interval, more than 99% provided complete fall information. Each participant was followed for falls through her first three tri-annual questionnaires (about 12 months). Each woman's number of falls was summed across the three questionnaires. The primary outcome measure was 1-year risk (cumulative incidence) of recurrent falls, defined as  $\geq 2$  falls during follow-up. The secondary outcome measure was 1-year risk of any fall.

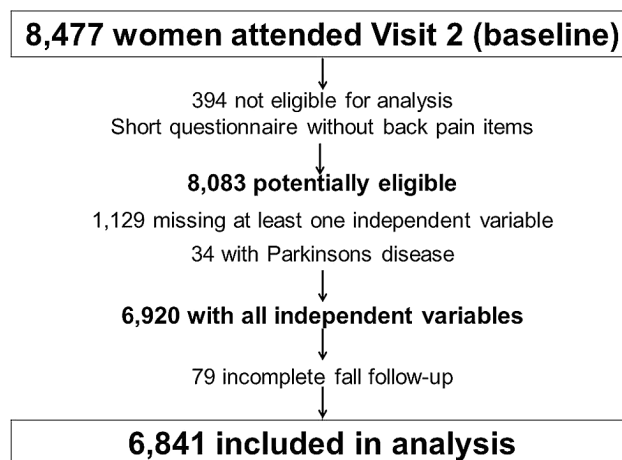
### Analytic Cohort

Of the 8,477 baseline participants, 8,083 (95%) completed the questionnaire containing back pain items. We excluded 1,129 missing at least one other independent variable deemed necessary for this analysis, 34 reporting Parkinson's disease, and 79 with incomplete falls data, leaving an analytic cohort of 6,841 women (Figure 1).

### Statistical Analysis

Analyses were conducted using SAS software version 9.4 (SAS Institute Inc, Cary, NC). Baseline characteristics in the analytic cohort were compared according to back pain severity using one-way analysis of variance for continuous variables or chi-square tests for categorical variables. Risk ratios (RRs) and 95% confidence intervals (CIs) were estimated as the measure of association between back pain and fall risk from multivariable log-binomial regression models with a robust variance estimator (22), using no back pain as the referent.

We built separate models for each fall outcome using well-established variable selection procedures and change-in-estimate methods appropriate for epidemiologic analyses (23,24). First, we constructed



**Figure 1.** Analytic cohort selection from the Study of Osteoporotic Fractures, a prospective study of U.S. women aged 65 years and older.

a base model adjusted for age and confounders. Variables in descriptive analyses that were associated with at least one back pain variable, a fall outcome, or both were assessed as possible confounders. Variables retained in the base model as confounders are shown in Table 2 footnotes. Second, we evaluated the extent to which associations of back pain and fall risk from the base models were further explained by possible intermediate factors (24). Possible intermediate factors examined were as follows: each physical performance measure, IADL difficulty, GDS score, pain medications, anxiety medications, and sleep medications. We added each variable one at a time to the base models and computed the percent attenuation in the RRs. We planned to retain in the final model the potential intermediate variables whose inclusion in the base model attenuated the RR by at least 10%. However, no variables met this criterion. The largest attenuation (8%) in RRs occurred with control for GDS, which was retained in the final model. Presenting RRs before and after adjustment for possible intermediate variables facilitates inference about their effects on the association of interest (24). Therefore, we report RRs before (Table 2) and after GDS adjustment (Figure 2).

Finally, we conducted stratified analyses to determine whether baseline age (<75 years, ≥ 75 years), hip pain (yes, no), or fall history (yes, no) modified the associations of back pain and fall risk. Tests of multiplicative interaction were performed.

In sensitivity analyses, we observed that use of an analytic cohort with complete data did not bias the results. Supplementary Tables 1–3 confirm that mean age, prevalence of back pain, risk of each fall outcome, and RRs (95% CI) from the confounding adjusted models in the analytic cohort were comparable with those from cohorts successively restricted to important study variables. Therefore, we present results only for the analytic cohort.

### Results

Back pain in the past 12 months was reported by 61% of the participants. Among those with back pain, 50% had low back pain only, 5% had pain in all three locations, 14% reported severe pain, 24% reported pain most of the time/always, and 22% reported that they limited usual activities because of pain. Participants reporting back pain differed from those who reported no back pain on most characteristics examined, except for current alcohol consumption (Table 1).

During the 1-year follow-up, 664 (10%) had recurrent falls and 1,805 (26%) had any fall. After adjustment for age and confounders, RRs were significantly elevated for any back pain in relation to recurrent falls (Table 2). Compared with peers without back pain, women with any back pain were at 1.6-fold increased risk of recurrent falls. Recurrent fall risk remained significantly elevated for all

**Table 1.** Distributions of Baseline Characteristics According to Back Pain Severity Among 6,841 Women Aged 65 Years or Older

Characteristic	Back Pain Severity			
	No back pain	Mild	Moderate	Severe
	2,670 (39%)	1,174 (17%)	2,406 (35%)	591 (9%)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	73.1 (5.0)	73.1 (4.8)	73.3 (4.9)	73.7 (5.1)
Body mass index (kg/m <sup>2</sup> )	25.9 (4.3)	26.1 (4.4)	26.5 (4.7)	27.1 (5.4)
Usual walking pace (m/s)	0.9 (0.2)	0.9 (0.2)	0.9 (0.2)	0.8 (0.2)
Chair stand time (s)	11.5 (3.9)	11.7 (3.7)	12.6 (4.7)	14.3 (7.1)
Grip strength (kg)	19 (5)	19 (5)	19 (5)	18 (5)
Geriatric depression scale (15 point maximum)	1.2 (1.8)	1.4 (1.8)	1.9 (2.2)	2.4 (2.7)
	%	%	%	%
College education	39	48	36	34
Cigarette smoking				
Current	8	6	8	11
Past	30	31	33	33
Alcohol consumption				
1–7 drinks/week	52	50	52	46
>7 drinks/week	5	5	5	4
Fair–very poor self-rated health	9	12	19	26
Stroke history	2	2	3	6
Arthritis history	50	62	74	76
Fainting in past year	3	3	4	9
Fell in the past year	25	30	33	35
Vertebral fracture	17	17	22	24
Hip pain	15	27	55	54
≥1 IADL difficulty	9	10	16	33
Tandem stands				
Eyes open <10 s	7	7	8	10
Eyes closed <10 s	34	32	36	40
Anxiety medication use	8	11	16	25
Sleep medication use	11	15	20	26
Pain medication use	52	57	71	75

Notes: IADL = instrumental activities of daily living.

**Table 2.** Risk Ratios (RRs) for Falls in Relation to Back Pain Among Older Women: Base Model (confounding adjusted) Estimates

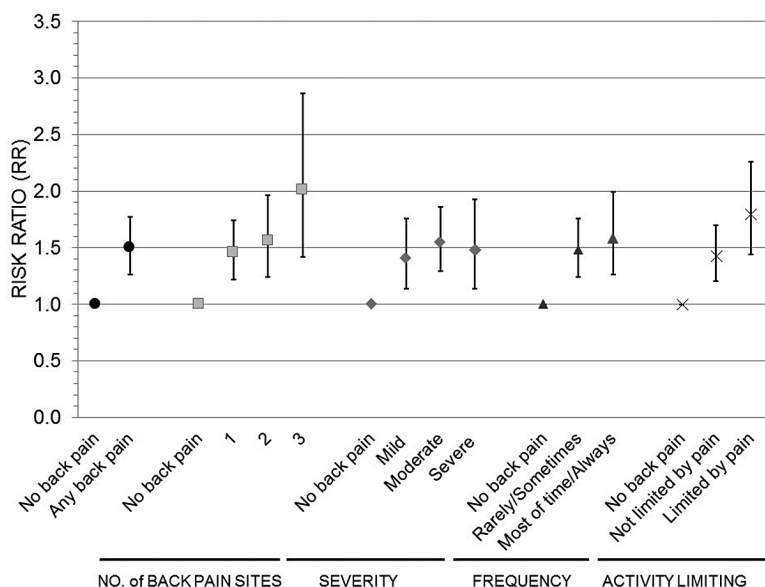
Back Pain Characteristic	N	Recurrent (≥2) Falls			Any Fall		
		% with ≥2 falls	Age-adjusted RR	Multivariable RR (95% CI)*	% with any fall	Age-adjusted RR	Multivariable RR (95% CI)†
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
Any back pain	4,169	12	1.66	1.55 (1.31, 1.83)	29	1.29	1.23 (1.13, 1.35)
<b>Location</b>							
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
Low back only	2,070	11	1.54	1.43 (1.18, 1.74)	28	1.23	1.18 (1.07, 1.31)
Mid or upper back only	1,168	12	1.66	1.59 (1.29, 1.97)	29	1.29	1.24 (1.11, 1.39)
Low back plus mid or upper back	931	13	1.91	1.75 (1.40, 2.19)	32	1.43	1.34 (1.19, 1.51)
<b>No. of back pain sites</b>							
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
1	3,050	11	1.58	1.49 (1.25, 1.78)	28	1.26	1.21 (1.10, 1.33)
2	917	12	1.73	1.63 (1.30, 2.05)	30	1.34	1.27 (1.12, 1.44)
3	202	17	2.47	2.19 (1.55, 3.08)	36	1.60	1.50 (1.23, 1.83)
<b>Severity</b>							
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
Mild	1,174	10	1.50	1.43 (1.15, 1.78)	29	1.31	1.25 (1.11, 1.40)
Moderate	2,406	12	1.71	1.60 (1.33, 1.92)	29	1.30	1.24 (1.12, 1.36)
Severe	589	12	1.76	1.61 (1.24, 2.10)	28	1.24	1.18 (1.02, 1.37)
<b>Frequency</b>							
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
Rarely / some of time	3,160	11	1.59	1.51 (1.27, 1.79)	29	1.29	1.24 (1.13, 1.36)
Most of time / always	1,009	13	1.88	1.72 (1.37, 2.15)	29	1.29	1.21 (1.06, 1.37)
<b>Limited by back pain</b>							
No back pain	2,670	7	1.0 (ref.)	1.0 (ref.)	22	1.0 (ref.)	1.0 (ref.)
No‡	3,239	10	1.51	1.45 (1.22, 1.73)	28	1.23	1.19 (1.09, 1.31)
Yes	930	15	2.16	1.96 (1.57, 2.43)	34	1.50	1.39 (1.23, 1.57)

Notes: CI = confidence interval; ref = referent level.

\*Adjusted for age, education, cigarette smoking, fainting episodes, hip pain, and history of stroke.

†Adjusted for age, education, cigarette smoking, fainting episodes, hip pain, and prevalent vertebral fracture.

‡Back pain that did not limit usual activities.



**Figure 2.** Risk ratios (RRs) for recurrent falls in relation to back pain among older women: final model estimates. RR point estimates are represented as (●) any back pain in the past 12 months, (■) number of pain sites, (◆) pain severity, (▲) pain frequency, and (x) activity limiting back pain. Error bars are 95% confidence intervals. RRs are adjusted for baseline age, education, cigarette smoking, fainting episodes, hip pain, history of stroke, and geriatric depression scale.

locations of back pain, number of pain sites, and each category of severity, frequency, and activity-limiting back pain. Similarly, RRs for any fall were significantly elevated for all categories of back pain, although these estimates were smaller than RRs for recurrent falls.

The addition of potential intermediate variables one at a time to the confounding adjusted (base) models did not strongly attenuate the RRs. For recurrent falls, change in the confounding adjusted RRs ranged from 0.6% to -8.2%. GDS adjustment produced the largest attenuation, with reductions of about 8% in RRs for back pain at three sites (-8.2%), severe back pain (-8.1%), back pain most of the time/always (-8.1%), and limiting usual activities (-8.2%). Adjustment for variables other than GDS attenuated the RRs by -5.5% or less. For the any fall endpoint, RRs changed by 0.8% to -4.4% when adjusted for each individual potential intermediate variable. Although adjustment for GDS produced the greatest attenuation in the RRs, reductions were modest (-1.6% to -4.4%).

In the final models with GDS included, all back pain categories remained independently associated with recurrent fall risk (Figure 2). For any falls, the RRs from final models adjusted for GDS were not materially changed from those reported in Table 2 (data not shown).

In stratified analyses (Table 3), any back pain was strongly associated with risk of recurrent falls among women 65–74 years but not among women 75 years or older. However, age did not affect the association of any back pain and risk of any fall. Neither history of falls nor history of hip pain modified associations of back pain with either fall endpoint.

### Discussion

Back pain emerged as an independent risk factor for falls, especially recurrent falls, in this large cohort of older U.S. women. Fall risk was significantly increased for pain in three sites throughout the back and for all categories of back pain, especially, frequent pain and pain that limited usual activities. However, even back pain in just one location, or pain that was mild, occurred rarely or sometimes, or did not limit usual activities was associated with significantly increased fall risk. Contrary to our hypothesis, these associations remained independent of physical performance, IADL difficulty, depressive symptoms, and medication use for anxiety, sleep, or pain. The association of back pain with risk of recurrent falls may depend on age.

Recent meta-analyses of prospective studies show that any bodily pain or joint pain in any location are associated with 40%–71% greater odds of any fall (25,26) and 60%–80% greater odds of recurrent falls

(25,27). In addition, chronic musculoskeletal pain is an independent fall risk factor in prospective studies among community-dwelling older U.S. adults (13,14). Compared with no chronic pain, chronic multisite musculoskeletal pain was associated with 1.5-fold increased risk of any falls in adults aged 70 years or older (13) and by 1.7-fold among older disabled women (14). These associations were independent of adjustment for physical performance and use of psychoactive or pain medications and other fall risk factors (13,14). The associations that we observed between back pain and falls are compatible with previous work, both in magnitude and independence from other factors.

In contrast to results for overall musculoskeletal pain and fall risk, prior reports on the association of back pain itself and fall risk have been null (13–16). Our results may diverge from these observations for a number of reasons including differences in ascertainment of back pain, fall follow-up methods, and the cohorts studied. For example, back pain obtained with a numeric rating scale as part of an overall chronic pain assessment was unrelated to fall risk (13). In contrast, our study showed that frequent back pain (occurring most of the time/always) was positively associated with both fall outcomes. In another study among older disabled women, chronic back and chest pain were combined together, precluding assessment of the relation between back pain only and fall risk (14). In the other reports examining any back pain, falls were assessed only once at the end of a 3- to 4-year follow-up period (15,16). In these studies, incomplete ascertainment of falls during the entire follow-up period could explain the null results. Finally, some reports combined results for women and men or included only older disabled women (13,14). Thus, our study is perhaps the largest and most complete to date regarding back pain and fall risk among community-dwelling older U.S. women.

Neither baseline fall history nor report of hip pain modified associations of back and fall risk in this cohort. Likewise, RRs for any fall were similar within age strata. However, age appeared to modify the relation between back pain and recurrent fall risk such that the association was strongest among the younger women. It is possible that this finding is due to chance, because the *p* value for the test of interaction was modest. Alternatively, it is well known that age is a strong fall risk factor (10,11). Thus, among very old women, back pain appears to be less important than other fall risk factors in the etiology of recurrent fall risk.

Altered postural responses to back pain represent a possible pathway underlying the association of back pain and fall risk. Studies using force plate measurements indicate that subjects with back pain have aberrant postural response to loss of balance, including trunk muscle stiffening and inadequate use of hip joints (28–30). Trunk

**Table 3.** Risk Ratios (RRs) for Falls in Relation to Back Pain According to Baseline Age, Fall History, and Hip Pain

Strata	≥2 Falls		<i>p</i> Interaction	Any Fall		<i>p</i> Interaction
	No Back Pain	Any Back Pain		No Back Pain	Any Back Pain	
	Multivariable RR (95% CI)*			Multivariable RR (95% CI)†		
Age <75 years	1.0 (ref.)	1.7 (1.4, 2.2)		1.0 (ref.)	1.3 (1.1, 2.4)	
Age ≥75 years	1.0 (ref.)	1.2 (0.9, 1.6)	.02	1.0 (ref.)	1.2 (1.0, 1.3)	.36
No falls in prior year	1.0 (ref.)	1.5 (1.2, 1.9)		1.0 (ref.)	1.2 (1.1, 1.4)	
Fell in prior year	1.0 (ref.)	1.3 (1.1, 1.7)	.47	1.0 (ref.)	1.2 (1.0, 1.3)	.89
No hip pain in prior year	1.0 (ref.)	1.5 (1.3, 1.9)		1.0 (ref.)	1.2 (1.1, 1.4)	
Hip pain in prior year	1.0 (ref.)	1.3 (1.0, 1.9)	.54	1.0 (ref.)	1.1 (1.0, 1.4)	.54

\*Adjusted for age, education, cigarette smoking, fainting episodes, hip pain, history of stroke, and geriatric depression scale (GDS). Age was not included in models within age strata; hip pain was not included in models within hip pain strata.

†Adjusted for age, education, cigarette smoking, fainting episodes, hip pain, prevalent vertebral fracture, and GDS. Age was not included in models within age strata; hip pain was not included in models within hip pain strata.

muscle stiffening heightens the likelihood of falling by simultaneously inhibiting compensatory use of the hip joints to regain balance and increasing reliance on ankle joints (31). Force plate measurements indicative of poor standing balance are associated with higher risk of falls (32), but associations between back pain, postural control, and falls specifically among older women remain to be determined.

Psychological responses to back pain provide another possible pathway. In a small sample of older women, those with low back pain scored on average significantly higher on a fear of movement scale and significantly lower on a balance self-efficacy scale than those without low back pain (33). In turn, fear of falling and activity avoidance both were associated with increased fall risk among community-dwelling elderly adults (34–36). However, the extent to which fear of falling or fear avoidance behavior could explain any relation between back pain and fall risk in older women is currently unknown.

This study has several limitations. First, recall of falls over 3–6 months is reasonably accurate (37,38) but may underestimate fall frequency compared with diaries (39). If any inaccuracies in fall reports in SOF were random with respect to back pain, then the RRs we observed could be underestimated. Alternatively, if participants with back pain subsequently experienced falls that caused back pain to recur or worsen, then their fall reports may be more accurate than those without prior back pain. Such systematic differences in fall reports, if they existed, would have overestimated the RRs. Second, although we had data on vertebral fractures, an important cause of back pain (21), we had no data on other spinal degenerative conditions. However, in older women or in cohorts that included women, back pain prevalence was similar in those with and without spinal degenerative conditions (40–43). Thus, these conditions are unlikely to strongly confound the association between back pain and fall risk. Third, medications were assessed by self-report and could be misclassified. Finally, SOF is composed of generally healthy, community-dwelling White women, so these results may not be applicable to other populations.

Although back pain may not exist as the only site of bodily pain, it is a common complaint in older adults with real societal and medical burden (1–4). Elucidating the negative health consequences of back pain is critical to designing effective clinical treatment and intervention strategies. In this context, our results extend previous work by showing that back pain is an independent risk factor for falls, especially recurrent falls, in the ensuing year among community-dwelling older White women. Clinicians may consider assessing fall risk in older women who present with any back pain, even pain that is mild or does not limit usual activities. Whether back pain treatment reduces fall risk in this population should be examined.

## Supplementary Material

Please visit the article online at <http://gerontologist.oxfordjournals.org/> to view supplementary material.

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## Conflict of Interest

Peggy M. Cawthon serves as a consultant to Eli Lilly and KineMed and has received grants from GSK, IMS Health, Merck, and KineMed. Richard A. Deyo has received royalties from UpToDate for authoring topics on low back pain, serves on the Board of Directors for the non-profit organization Informed Medical Decisions Foundation, and has received grant funding for

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