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KYPHOSIS AND 3-YEAR FALL RISK IN COMMUNITY-DWELLING OLDER MEN

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Abstract

PURPOSE: Research suggests an association between hyperkyphosis and falls in community-dwelling older adults, though this has not been investigated within large, population-based studies. This study sought to determine whether two measures of kyphosis prospectively predict fall risk over three years among older men.

METHODS: Within the Osteoporotic Fractures in Men Study (MrOS), we conducted two three-year prospective studies of 2,346 and 2,928 men. The first group had kyphosis measured by Cobb angle at visit 1, while the second group had kyphosis assessed with the blocks method at visit 3; both groups then self-reported falls tri-annually for three years. Poisson regression with GEE was used to obtain relative risks (RR) of falls.

RESULTS: The fall rates over three years were 651/1,000 person-years among the visit 1 sample (mean age 74±6 years) and 839/1,000 person-years among the visit 3 sample (mean age 79±5 years). In adjusted models of the visit 3 sample, the risk of falls was increased by 12% for each standard deviation increase (1.4 blocks) in the number of blocks required to achieve a neutral head and neck position (RR=1.12, 95% CI= 1.06, 1.18). Cobb angle was not associated with falls in the visit 1 sample.

CONCLUSIONS: Although Cobb angle did not predict falls in community-dwelling older men over three years, the blocks method of measuring kyphosis was predictive of falls in this population. This difference could be due to the Cobb angle's focus on thoracic kyphosis, whereas the blocks method may additionally capture abnormal cervical spine curvature.

MINI ABSTRACT

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Corinne McDaniels-Davidson, Jeanne F Nichols, Florin Vaida, Lynn Marshall, and Deborah M Kado declare that they have no conflicts of interest.

Hyperkyhosis is thought to be a fall risk factor in older adults. This large study of older men found that fall risk increased with greater kyphosis measured with the blocks method, but did not find an association between kyphosis and falls when measured by the commonly used Cobb angle method.

Keywords

Kyphosis; hyperkyphosis; falls; Cobb angle; older adults

INTRODUCTION

As the United States population continues to age, more attention has been brought to the causes of morbidity and mortality unique to older adults. Falls, for example, increase with age and result in the most common fatal and non-fatal injuries among older adults.[1,2] In a recent national survey, 26.5% of men aged 65 and older reported experiencing a fall in the preceding 12 months and more than 8% had experienced a fall injury.[1] Because falls pose a serious risk to the health of older adults, it is vital to understand, and potentially mitigate, the conditions and characteristics that increase fall risk.

While many fall risk factors are well understood, some potential risk markers are emerging. Commonly accepted risk factors for falls in community-dwelling adults include increasing age, female sex, psychotropic drug use, comorbidities, cognitive impairment, history of falls, lower extremity weakness, balance deficit, gait problems, vertigo, mobility limitations, and fear of falling.[2,3] Some studies have suggested a link between hyperkyphosis and increased fall risk.[4–9]

Hyperkyphosis is a common condition among older adults, classically presenting as forward curvature in the upper spine.[10] It has been associated with negative outcomes in older men including impaired lower extremity physical function,[11] reduced physical function,[12] impaired balance or gait,[6,7,13,14] and mortality.[15] Although estimates of prevalence vary by measurement method and cut point;[12,15,16] hyperkyphosis may affect as many as 44% of community-dwelling older men.[17] Results from mixed-gender cross-sectional studies examining the association between hyperkyphosis and falls have been mixed,[4,18] though two small prospective studies recently demonstrated greater fall risk with increasing kyphosis.[5,19]

To further investigate the relationship between hyperkyphosis and fall risk, we examined the association prospectively in two large study samples of older adult men, each with different kyphosis measures, within the Osteoporotic Fractures in Men study (MrOS). We hypothesized that greater kyphosis would result in a higher risk of falls over three years among community-dwelling older men.

METHODS

Subjects

Between 2000 and 2002, the Osteoporotic Fractures in Men Study (MrOS; http://mrosdata.sfcc-cpmc.net) recruited and enrolled 5,994 participants at six sites across the United States: Birmingham, AL; Minneapolis, MN; Palo Alto, CA; Pittsburgh, PA; Portland, OR; and San Diego, CA. Details regarding recruitment strategies at each of the six sites have been described previously.[20] Enrollees were community-dwelling, ambulatory men aged 65 and older. This observational longitudinal cohort study was designed to study the risk factors for and sequelae of fractures in older men.[20,21] Surviving participants were recalled periodically for additional follow-up clinic visits. Two separate cohorts (originating from clinic visit 1 and clinic visit 3) are the focus of the current study.

The Visit 1 sample is comprised of a sample of those who attended the first MrOS visit between 2000 and 2002. Of the 5,994 Visit 1 participants, Cobb angle measurements of kyphosis were available for 2,351. These 2,351 men were randomly selected for Cobb measurements for a previous study[22] from a group of 5,229 who had attended both Visit 1 and Visit 2 and had lateral spine radiographs taken at both visits. For the purposes of this study, five participants of those 2,351 with Cobb angle measures were excluded due to lack of follow-up data leaving 2,346 in the Visit 1 sample.

Between 2006 and 2009, 4,681 surviving participants attended Visit 3. Kyphosis was assessed using the blocks method in only a portion of visit participants due to delays in funding, implementation, and validation of the measure across all six study sites. Only those attending Visit 3 in its later phases had the blocks measure (n=2,931).[11] Of these, three participants were excluded from the present analysis due to lack of follow-up data, leaving 2,928 in the Visit 3 sample. As both samples were taken from the same large cohort, there was some overlap in participants (n=1,136), however the samples were analyzed as two separate studies with Visit 1 and Visit 3 forming the “baseline” assessment for each of the measures of kyphosis with three subsequent years of follow-up.

The Institutional Review Boards at each of the six study centers approved the MrOS protocol; written informed consent was obtained from all participants.

Kyphosis measures

In the Visit 1 sample, Cobb angle of kyphosis was calculated from baseline digital lateral-lying thoracic spine radiographs, as previously described by Katzman and colleagues.[23] Trained study personnel calculated the Cobb angle by placing digitized points marking the top plate of the T4 vertebrae and the bottom plate of T12 vertebrae. Optasia software was then used to connect the points and determine the angle of intersection. When T4 and/or T12 were unable to be visualized, T5 and T11 were used. Each assessment was conducted once by an experienced densitometrist and researcher. The greater the Cobb angle, the greater the degree of kyphosis in that individual. This radiographic lateral-lying assessment has demonstrated excellent agreement with standing measures of kyphosis in previous research.[24]

Kyphosis at Visit 3 was assessed with the blocks method pioneered by the Rancho Bernardo Study,[15] as previously described by Katzman and colleagues.[11] Due to hyperextension of the neck, hyperkyphotic individuals are unable to lie flat comfortably. While lying supine, blocks 1.7 cm in depth were placed under the participant's occiput, as needed, until a neutral head and neck position was achieved. The number of blocks required to achieve the neutral position was recorded as the blocks measure, and corresponds to the severity of kyphosis.

Ascertainment of falls

After each study visit, participants were mailed one-page questionnaires every four months (tri-annually) to assess incident falls. Participants who reported falling in the preceding four months were asked to indicate the number of times (1, 2, 3, 4, or 5+). Those not responding to the questionnaires received follow-up telephone calls. Falls data from nine questionnaires (covering three years) after the in-person visit for each participant were included in the present study.

Clinic-based measures

Clinical measures were taken at both clinic visits. Height and weight were measured using a Harpenden Stadiometer (Holtain Ltd., Crymych, Dyfed, UK) and balance beam or digital scale, respectively. Body mass index (BMI) was calculated as the participant's weight in kilograms divided by height in meters squared. Total hip bone mineral density (BMD) was measured by dual-energy X-ray absorptiometry (DXA) using Hologic QDR 4500 densitometers at all study sites. Lower extremity strength was assessed through two performance tests: the time required to stand five times from a chair, and six meter usual pace walking speed. The Teng Modified Mini-Mental State Exam (3MS) was administered to assess cognitive function; higher scores (0–100) indicate better cognitive function.

Study surveys

Participants were surveyed at both visits about their: age; race (white or non-white); smoking status (ever or never); alcohol intake (calculated drinks per week); use of medications with sedative effects including benzodiazepines, opioid analgesics, and SSRI or tricyclic antidepressants; history of osteoporosis (yes or no); comorbidities (yes or no) including diabetes, Parkinson disease, or history of stroke; falls in the previous year (yes or no); trouble with dizziness (yes or no); and self-assessed quality of health (good/excellent or fair/poor/very poor).

Statistical analysis

The same statistical methods were employed for both study samples. Descriptive statistics (mean, standard deviation [SD] or frequency, percent) were computed for each study sample. Univariable and multivariable Poisson regression models with generalized estimating equations (GEE) were used to model the number of falls per four-month interval over three years. Each study subject contributed up to nine time points as the outcome. Poisson regression was chosen to model the counts of fall events and GEE (with compound symmetry correlation structure) was chosen to account for repeated participant fall counts (up to nine per individual).

In univariable analyses, relative risks (RR) and 95% confidence intervals (CI) adjusted for clinic site were reported for each covariate per SD for continuous covariates. In adjusted models the main predictor was Cobb angle of kyphosis for the Visit 1 sample and blocks measure of kyphosis for the Visit 3 sample. All multivariable models were minimally adjusted for age and weight based on hypotheses about the causal pathways between hyperkyphosis and future falls. Variables that were thought to potentially confound the association between kyphosis and falls were added to the minimally adjusted model one-by-one and remained in the model if the main effect RR changed by ≥|10%|. Adjusted RRs, 95% CIs, and p-values (Wald test) were reported for each variable in the multivariable models (per SD for continuous variables). We conducted sensitivity analyses with the final models by running them as overdispersed Poisson models with the total number of falls over three years as the dependent variable and the offset set as the natural log of the number of years at risk; the same results were achieved. Predicted risk of falls for an average member of the sample was obtained through these overdispersed Poisson models. SAS software version 9.4 (SAS Institute, Cary, NC) was used for all analyses.

RESULTS

Visit 1 sample

Characteristics of the 2,346 men in the Visit 1 sample are found in Table 1. Mean age of the Visit 1 sample was approximately 74 years. Cobb angle followed a normal distribution with a mean Cobb angle of 38.6°. More than half of the sample reported that they were past or current smokers and participants imbibed a mean of nearly five alcoholic drinks per week. Twenty percent of the men reported a fall in the previous year. Cognitive function was high as measured by the 3MS and most assessed their health as *good* or *excellent*.

Participants in the Visit 1 sample returned an average of 8.75 questionnaires (of nine) sent every four months to assess falls; 91% had complete follow-up with all nine questionnaires returned. Among the 2,346 men in the study, 1,184 (50%) had one or more falls over three years, 741 (32%) had two or more falls, 489 (21%) had three or more falls, and 31 (<2%) had 20+ falls. In total, subjects experienced 4,462 falls over 6,854.67 person-years of follow-up in the three years after Visit 1, giving a fall rate of 651 falls per 1,000 person-years.

Univariable risk of falls over three years were calculated for each Visit 1 characteristic using Poisson regression models with GEE to compute RRs and 95% CIs (adjusted for clinic site; Table 1). Increasing age, shorter height, higher BMI, use of medications with sedative effects, history of osteoporosis, history of assessed comorbidities, having fallen in the previous year, experiencing trouble with dizziness, greater chair stand time, slower walking speed, lower 3MS score, and poorer self-assessed quality of health were all associated with an increase in the risk of falls over three years in univariable models. Race, weight, Cobb angle of kyphosis, total hip BMD, smoking status, and alcohol consumption did not significantly increase the univariable risk of falls among the Visit 1 sample.

In multivariable Poisson models, Cobb angle was not significantly associated with falls over three years after adjustment for clinic site, age, and weight (Table 2). Increasing age and greater weight were both significantly associated with increased risk of falls over three years

in the adjusted model. None of the assessed covariates (listed in Table 1) were considered to be statistical confounders by our *a priori* definition.

The fall rate based on an overdispersed Poisson model (results not shown) was 0.63 falls per person-year, given mean Cobb angle; age; and weight (and controlling for clinic site). This rate is slightly lower than the calculated crude rate of 0.65 falls per person-year.

Visit 3 sample

Characteristics of the 2,928 men in the Visit 3 sample are found in Table 3. Among those with the blocks measure at Visit 3, mean age was 79 years, and most were white. Blocks, the measure of kyphosis, followed an approximately normal distribution; participants required a mean of 2.6 blocks to achieve a neutral head position while supine. Mean height was 173 cm and BMI was 27 kg/cm^2. More than half of the sample identified as past or current smokers and participants drank an average of four alcoholic beverages per week. Nearly a third recalled falling at least once in the previous year. Participants' cognitive function was good as measured with the 3MS, and most self-assessed their health as *good* or *excellent*.

Participants in the Visit 3 sample returned an average of 8.6 ± 1.4 tri-annual falls questionnaires of the nine sent in the three years after Visit 3, and 89% returned all nine questionnaires. Among the 2,928 men in the analysis, 1,598 (55%) had at least one fall over the three years, 1,070 (37%) had two or more falls, 764 (26%) had three or more falls, and 49 participants (<2%) had 20+ falls. Participants experienced 7,039 falls over 8,385 person-years of follow-up, yielding a fall rate of 839/1,000 person-years over three years.

In univariable analyses (Table 3), we found increasing age, identifying as racially white, increasing blocks measure of kyphosis, lower total hip BMD, medication use with sedative effects, ever having osteoporosis, having one of three identified comorbidities, recalling a fall in the preceding year, reporting trouble with dizziness, higher chair stand time, slower usual-speed walking pace, lower 3MS exam score, and lower rated quality of health to be associated with fall risk over three years in Poisson regression models with GEE (adjusted for clinic site only). All RRs were in the expected direction. Height, weight, BMI, smoking status, and alcohol consumption were not significantly associated with increased risk for falls in these analyses.

In the multivariable model, kyphosis as measured by the blocks method was associated with falls over three years. For each standard deviation increase in the blocks measure of kyphosis assessed at Visit 3, the adjusted risk of falls increased by 12% after adjustment for clinic site, age, and weight (Table 4). Increasing age was also significantly associated with increased risk of falls over three years in the adjusted model. None of the assessed covariates (listed in Table 3) were considered to be statistical confounders by our *a priori* criteria.

The fall rate based on an overdispersed Poisson model (results not shown) was 0.80 falls per person-year, given mean blocks; age; and weight (and controlling for clinic site). This rate is slightly lower than the calculated crude rate of 0.84 falls per person-year.

DISCUSSION

In this study, kyphosis measured by the blocks method was predictive of falls over three years in older adult men. For every 1.4 block (SD) increase, there was a 12% increase in the risk of falls over three years in adjusted models. However, kyphosis measured by the Cobb angle was not associated with risk of falls over three years in this population. These seemingly disparate results could indicate that in men, the increase in fall risk is associated with upper spine curvature, including the thoracic and cervical spine, captured by blocks method but not with the Cobb angle measure, which isolates thoracic curvature (from T4 to T12) only. Indeed, Tran and colleagues found that among three measures of kyphosis, the blocks method had the lowest correlation with Cobb angle, suggesting that these two kyphosis measures are capturing slightly different aspects of kyphosis curvature (r_s=0.63).[25]

Past research has produced mixed results about the relationship between kyphosis, balance, and falls.[7,26,27] One large retrospective study of 1883 community-dwelling older men and women found the blocks measure was associated with self-reported falls in the previous year among community-dwelling older men.[4] In a study of 51 men and women, Cobb angle was predictive of incident falls over 6–12 months.[5] This study, however, was limited by varied follow-up time and the underrepresentation of men (n=12/51). In a longitudinal study of 72 older men and women, we had previously reported that blocks, Cobb angle, and two other measures of kyphosis were strongly predictive of falls over twelve months, with each standard deviation increase in the measures more than doubling the odds of a fall during the follow-up period.[9] In that study, the blocks measure conferred the strongest association, more than tripling the odds of a fall for each standard deviation increase. However, the study was limited by underrepresentation of men (n=20/72) and potential bias due to convenience sampling. Similar to our present results of the Cobb angle measure, a study of 92 men and women found that thoracic kyphosis measured with the SpinalMouse®, a computerized handheld device rolled along a subject's spine to analyze curvature, was not associated with recall of falls from the previous year.[18]

One explanation for the disparate findings between the Cobb angle and block measures and falls could be age. The men in the Visit 3 sample were nearly six years older than the men in the Visit 1 sample. Participants in the Visit 3 sample were also, on average, 1 cm shorter, 2 kg lighter, drank slightly less, and may have been somewhat healthier (lower assessed medication use, lower osteoporosis diagnoses, and fewer assessed comorbidities). They also had slightly worse chair stand times, slightly slower walking speeds, and reported more falls in the preceding year. The cohorts differed, too, in univariable analyses. Race was not significantly associated with fall risk in the Visit 1 sample but was in the Visit 3 sample. Similarly, height and BMI were significantly associated with fall risk in the Visit 1 sample but were not in the Visit 3 sample. Thus, besides age, these differences between the two study populations, or some selection bias in the Visit 3 convenience sample, or kyphosis measurement incongruences might explain why only the blocks measure predicted falls.

Alternatively, the blocks measure may be a better measure of clinically important postural changes in men versus women. In two other studies where the blocks measure was completed in both sexes, men were more kyphotic than women.[15,28] In addition to thoracic

kyphosis, the blocks measure captures fixed flexion of the cervical spine that may confer additional challenges to maintaining steady balance.

Strengths of this study include: the large sample sizes, prospective ascertainment of falls, and analytic strategy to incorporate these repeated falls measures. Participant retention and response to the tri-annual questionnaires was excellent; post-Visit 1 there was an average of 2.9 ± 0.5 years of follow-up, and post-Visit 3 there was an average of 2.9 ± 0.3 years of follow-up (of 3 possible). Our fall rates were similar to those in the published literature; fall rates post-Visit 3 (0.84/person-year) were similar to those reported among men in the MOBILIZE Boston study (0.92/person-year) with similar mean ages (post-Visit 3 mean age = 79 ± 5; MOBILIZE mean age = 78 ± 5).[29] Our rates were higher than those found in men through the 2014 Behavioral Risk Factor Surveillance System (0.66/person-year), though these were calculated based on 12-month recall.[1]

This study has some limitations. Although the Visit 1 sample was randomly selected, they were only selected from the 87% of original study participants who had both Visit 1 and Visit 2 lateral radiographs, and so may not be representative of the entire Visit 1 sample. The Visit 3 sample must be considered a convenience sample, due to the late initiation of the blocks measure during the window of time the visits were taking place. Since 1,136 participants were in both visits, we assessed whether they differed from those unique to the Visit 3 convenience sample on any of the 18 sample characteristics listed in Table 3; they did not. In addition, because the measures of kyphosis were taken on different participants at different time points (when the participants were different ages), we cannot make direct comparisons between them. Lastly, fall rates may be underestimates due to recall bias as the four-month recall for falls ascertainment may have missed lesser falls that would have been captured through monthly follow-up.

In the largest and longest prospective study of kyphosis and incident falls in community-dwelling older men to date, we found that the blocks method but not the Cobb angle was predictive of falls over three years. Compared to women, older men tend to suffer from worse block-measured kyphosis that may prove to be more clinically important and useful than Cobb angle kyphosis. This type of hyperkyphosis can be easily diagnosed by observing whether or not a patient can lie flat on the examining table without neck hyperextension. Randomized controlled spinal extension exercise trials have demonstrated improvements in kyphotic older persons.[30] However, before broad clinical recommendations or policies can be made, future studies should investigate whether improving posture and balance may prevent falls among older men with accentuated kyphosis.

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Table 1:

Visit 1 Sample Characteristics and Univariable Risks of Falls Over 3 Years Using Poisson Regression (n=2,346)

	Distribution	Univariable Risks of Falls Over 3 Years Using Poisson Regression[a,b]		
Variable	**Mean ± SD or N (%)**	**RR per SD**	**95% CI**	**p-value**
Age, *years*	73.6 ± 5.9	**1.28**	**1.18, 1.38**	**<.001**
Race/ethnicity				
non-white	246 (10)		REF	
white	2100 (90)	1.02	0.74, 1.40	.900
Height, *cm*	174.2 ± 6.8	**0.92**	**0.84, 0.99**	**.046**
Weight, *kg*	83.4 ± 13.3	1.04	0.96, 1.13	.297
Body mass index, kg/m^2	27.4 ± 3.8	**1.10**	**1.02, 1.20**	**.019**
Cobb angle, *degrees*	38.6 ± 11.4	1.07	0.98, 1.17	.139
Total hip BMD, g/cm^2	0.955 ± 0.139	0.93	0.85, 1.00	.070
Smoking status				
never	850 (36)		REF	
past or current	1496 (64)	0.90	0.76, 1.07	.228
Drinks per week	4.7 ± 7.4	0.95	0.87, 1.03	.206
Medication[c] use				
no	2137 (91)		REF	
yes	209 (9)	**2.29**	**1.84, 2.86**	**<.001**
Ever had osteoporosis				
no	2254 (96)		REF	
yes	92 (4)	**1.44**	**1.01, 2.04**	**.043**
Comorbidities[d]				
no	1942 (83)		REF	
yes	404 (17)	**1.71**	**1.40, 2.09**	**<.001**
Fallen in the past year				
no	1871 (80)		REF	
yes	475 (20)	**3.46**	**2.94, 4.06**	**<.001**
Trouble with dizziness				
no	1715 (73)		REF	
yes	631 (27)	**1.75**	**1.47, 2.08**	**<.001**
Chair stand time, *sec*	11.2 ± 3.4	**1.23**	**1.14, 1.32**	**<.001**
Walking speed, *m/sec*	1.20 ± 0.23	**0.74**	**0.67, 0.81**	**<.001**
Teng 3MS Exam scoree[e]	93.1 ± 6.4	**0.85**	**0.79, 0.91**	**<.001**
Self-rated quality of health				
good or excellent	2001 (85)		REF	
fair or poor or very poor	344 (15)	**1.94**	**1.57, 2.39**	**<.001**

[a]All models adjusted for clinic site

[b] RRs are presented per standard deviation increase in predictor variable

[c] Medications include benzodiazepines, opioid analgesics, and SSRI or tricyclic antidepressants

[d] Comorbidities include Parkinson disease, diabetes, or history of stroke

[e] Teng Modified Mini-Mental Status Exam

Table 2:

Multivariable Risk of Falls Over 3 Years Using Poisson Regression with GEE[a] in the Visit 1 Sample (n=2,346)

Variable	RR per SD	95% CI	p-value
Cobb angle of kyphosis, *degrees*	1.04	0.95, 1.14	.357
Age, *years*	**1.31**	**1.20, 1.43**	**<.001**
Weight, *kg*	**1.12**	**1.03, 1.22**	**.009**

[a]Model adjusted for clinic site

Table 3:

Visit 3 Sample Characteristics and Univariable Risks of Falls Over 3 Years Using Poisson Regression (n=2,928)

	Distribution	Univariable Risks of Falls Over 3 Years Using Poisson Regression[a,b]		
Variable	**Mean ± SD or N (%)**	**RR per SD**	**95% CI**	**p-value**
Age, *years*	79.2 ± 5.2	**1.26**	**1.20, 1.32**	**<.001**
Race/ethnicity				
non-white	330 (11)		REF	
White	2598 (89)	**1.40**	**1.17, 1.67**	**<.001**
Height, *cm*	173.2 ± 6.9	0.97	0.92, 1.02	.247
Weight, *kg*	81.4 ± 13.5	0.99	0.94, 1.05	.800
Body mass index, kg/m^2	27.1 ± 3.9	1.01	0.96, 1.06	.753
Blocks measure of kyphosis, *1.7cm block*	2.6 ± 1.4	**1.17**	**1.11, 1.23**	**<.001**
Total hip BMD, g/cm^2	0.939 ± 0.148	**0.92**	**0.87, 0.97**	**.003**
Smoking status				
never	1164 (40)		REF	
past or current	1762 (60)	0.97	0.88, 1.07	.565
Drinks per week	4.1 ± 6.2	0.98	0.93, 1.03	.391
Medication[c] use				
No	2491 (85)		REF	
Yes	437 (15)	**1.77**	**1.58, 1.99**	**<.001**
Ever had osteoporosis				
No	2704 (92)		REF	
Yes	224 (8)	**1.41**	**1.19, 1.65**	**<.001**
Comorbidities[d]				
No	2269 (77)		REF	
Yes	659 (23)	**1.32**	**1.18, 1.47**	**<.001**
Fallen in the past year				
No	2041 (70)		REF	
Yes	887 (30)	**3.19**	**2.92, 3.49**	**<.001**
Trouble with dizziness				
No	2102 (72)		REF	
Yes	826 (28)	**1.71**	**1.55, 1.89**	**<.001**
Chair stand time, *sec*	11.8 ± 3.8	**1.21**	**1.17, 1.26**	**<.001**
Walking speed, *m/sec*	1.23 ± 0.24	**0.74**	**0.70, 0.78**	**<.001**
Teng 3MS Exam score[e]	92.0 ± 7.1	**0.90**	**0.86, 0.94**	**<.001**
Self-rated quality of health				
good or excellent	2514 (86)		REF	
fair or poor or very poor	411 (14)	**1.53**	**1.35, 1.73**	**<.001**

[a]All models adjusted for clinic site

[b] RRs are presented per standard deviation increase in predictor variable

[c] Medications include benzodiazepines, opioid analgesics, and SSRI or tricyclic antidepressants

[d] Comorbidities include Parkinson disease, diabetes, or history of stroke

[e] Teng Modified Mini-Mental Status Exam

Table 4:

Multivariable Risk of Falls Over 3 Years Using Poisson Regression with GEE[a] in the Visit 3 Sample (n=2,928)

Variable	RR per SD	95% CI	p-value
Blocks measure of kyphosis	**1.12**	**1.06, 1.18**	**<.001**
Age, *years*	**1.25**	**1.19, 1.31**	**<.001**
Weight, *kg*	1.04	0.99, 1.10	.118

[a]Model adjusted for clinic site