History of Fractures as Predictor of Subsequent Hip and Nonhip Fractures among Older Mexican Americans

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Objective: To examine the association between previous fracture and risk of new hip and nonhip fractures over a seven-year period among older Mexican Americans.

Method: Data used are from the Hispanic Established Population for the Epidemiological Study of the Elderly (H-EPESE) (1993–2001). Measures included history of previous fracture (hip fracture only, a nonhip fracture, hip and nonhip fractures, and no fractures), sociodemographic factors, smoking status, medical conditions (arthritis, diabetes, stroke and cancer), activities of daily living disability, and high depressive symptoms. Cox proportional regression model was used to estimate the seven-year incidence of fractures.

Results: Of the 2,589 subjects, 42 reported a hip fracture, 328 reported a nonhip fracture, and 2,219 did not report a fracture at baseline. After controlling for all covariates, the hazard ratio (HR) of new hip fracture at seven-year follow-up was 6.48 (95 % CI: 3.26–12.97) for subjects with only hip fracture at baseline and 1.96 (95 % CI: 1.22–3.16) for subjects with nonhip fracture at baseline. The HR of new nonhip fracture was 1.90 (95 % CI: 0.96–3.77) for subjects with only hip fracture at baseline and 2.62 (95 % CI: 1.95–3.52) for subjects with nonhip fracture at baseline.

Conclusions: A previous history of fractures in older Mexican Americans is the strongest predictor of recurrent fractures at hip and nonhip sites, independent of other health measures. Our findings of recurrent fractures suggest the need for more aggressive detection and adequate treatment of osteoporosis- and fall-related factors in this population.

Key words: fractures ■ elderly health ■ Mexican Americans

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INTRODUCTION

Osteoporosis and osteoporosis-related fractures contribute significantly to the increase in disability, mortality and healthcare expenditures in the elderly population. The estimated national direct expenditure (hospital and nursing home) for osteoporosis-associated fracture in 1995 was $13.8 billion[1] and is expected to increase 3–4-fold in the next 40 years.[2] The incidence of osteoporosis increases with age, with about 15 million Americans aged ≥50 years living with the disease and another 34 million with low bone mass.[3] Female gender is a major risk factor. One in two women and one in eight men are at risk of osteoporotic fractures.[4] It is estimated that 40% of women and 13% of men aged ≥50 experience one fragility fracture.[5] At least 1.5 million osteoporotic fractures occur yearly in Americans, and ≥300,000 are hip fractures.[6]

The risk of osteoporosis also varies by ethnicity. For example, studies have shown that 19% of Caucasian women aged >50 have osteoporosis, as compared to 11% of non-Hispanic black women and 17% of Hispanic women.[7] In men, 4% of Caucasians aged >50 have osteoporosis, as compared to 3% of non-Hispanic black men and 3% of Hispanics. In addition about 28–47% men aged >50 have osteopenia.[8]

The main complication of osteoporosis is the development of low trauma fractures, with the most disabling being hip fractures. Incidence of hip fractures continues to rise with the increase in the number of surviving adults aged ≥65.[9] At age 50, a white woman in the United States has a 17% lifetime risk of sustaining a hip fracture[10] and 32% lifetime risk of vertebral fracture.[11] Espino et al. showed an overall prevalence of hip fractures in older Mexican Americans of 4.0% and an overall incidence of hip fractures of 9.1 fractures/1,000 person-years for women and 4.8 fractures/1,000 person-years for men.[12] Hip fractures cause the most morbidity, with reported mortality rates up to 20–24% in the first year after a hip fracture[13,14] independent of other comorbid factors. Up to 50% of patients are unable to walk without assistance, and 33% are totally dependent or in a nursing home in the year following a hip fracture.[13,15,16] Approximately 20–30% of hip fractures occur in men,[17,18] 70–80% occur in women, and 30–50% of men die within a year of the fracture, as compared with 20% of women.[17,19] Markides et al. showed that hip fracture correlated with a higher risk of disability in older Mexican Americans compared to their Caucasian and African American counterparts.[20] Preventing fractures and disability related to osteoporosis in the elderly involves not only early recognition and treatment of osteoporosis but also eliminating falls risk factors[19] such as poor vision, gait impairment and unsafe living space. Such measures that aimed at preventing falls are especially important in those who already have osteoporotic fractures.

Klotzbuecher et al. showed that Caucasians and African-American women with osteoporotic vertebral fractures or other nonhip fractures had increased risk of new hip fractures.[21] The contribution of previous hip fracture to the risk of development of future hip and nonhip fractures is unclear. For example, Colon-Emeric et al., in 2000, showed that the increased risk of subsequent nonhip fracture (about 2.5-fold increases) posthip fracture is independent of the prehip fracture risk in older Caucasian and African Americans.[22] The increased rate of recurrent fractures suggests, at least in part, suboptimal use of antiosteoporosis and antifall interventions in those who already have fractures. One possible reason for the suboptimal use may be poor access to clinicians and healthcare services, especially by older minorities.[23]

Currently, little is known about the effect of prior fractures on subsequent hip and nonhip fractures in older Mexican Americans, one of the fastest growing ethnic groups in the United States. Therefore, we used data from the Hispanic Established Population for the Epidemiological Study of the Elderly (HEPESE) to exam-

Table 1. Descriptive characteristics of the sample by fractures at baseline (N=2,621)

Explanatory Variables	No Fracture (N=2,219)	Hip Fracture Only (N=42)	Nonhip Fracture Only (N=328)	Hip and Nonhip Fracture (N=32)
Age (mean ± SD)*	72.3 ± 6.2	77.5 ± 7.3	72.6 ± 6.4	74.4 ± 7.2
Gender (Female), n %‡	1,274 (57.4)	31 (73.8)	209 (63.7)	22 (68.8)
Marital Status (Married), n %†	1,276 (57.5)	17 (40.5)	165 (50.3)	13 (40.6)
Smoking Status, n %‡				
Never	1,324 (59.7)	21 (50.0)	165 (50.3)	20 (62.5)
Former	621 (28.0)	13 (30.9)	109 (33.2)	8 (25.0)
Current	273 (12.3)	8 (19.1)	54 (16.5)	4 (12.5)
Medical Conditions, n %				
Arthritis*	849 (38.2)	15 (35.7)	167 (50.9)	17 (53.1)
Diabetes	637 (28.7)	9 (21.4)	79 (24.1)	8 (25.0)
Stroke†	108 (4.9)	8 (19.1)	20 (6.1)	3 (9.4)
Cancer	110 (5.0)	3 (7.1)	20 (6.1)	3 (9.4)
Any ADL limitation (n %)*	170 (7.7)	14 (33.3)	42 (12.8)	8 (25.0)
Cognitive Impairment (MMSE <21) (n %)	295 (13.3)	4 (9.5)	43 (13.1)	6 (18.8)
Depressive Symptoms (CES-D ≥16) (n %)	494 (22.3)	14 (33.3)	75 (22.9)	11 (34.4)
Near Vision Impairment (n %)	494 (22.3)	11 (26.2)	84 (25.6)	6 (18.8)
Distant Vision Impairment (n %)	290 (13.1)	9 (21.4)	45 (13.7)	7 (21.9)
BMI (Kg/m^2) (n %)				
<25 Kg/m^2	654 (29.5)	15 (35.7)	104 (31.7)	9 (28.1)
25–30	887 (39.9)	16 (38.1)	131 (39.9)	11 (34.4)
≥30	678 (30.6)	11 (26.2)	93 (28.4)	12 (37.5)
Summary Performance Score of Lower Body Function (mean ± SD)*	7.1 ± 3.1	5.1 ± 4.0	6.8 ± 3.2	4.3 ± 3.1

* p value <0.0001; † p value <0.001; ‡ p value <0.01; MMSE: Mini-Mental State Examination; ADL: Activities of daily living; CES-D: Center for Epidemiologic Studies Depression Scale; BMI: body mass index

ine the risk of hip and nonhip fractures on subsequent fractures over a seven-year period among older Mexican Americans.

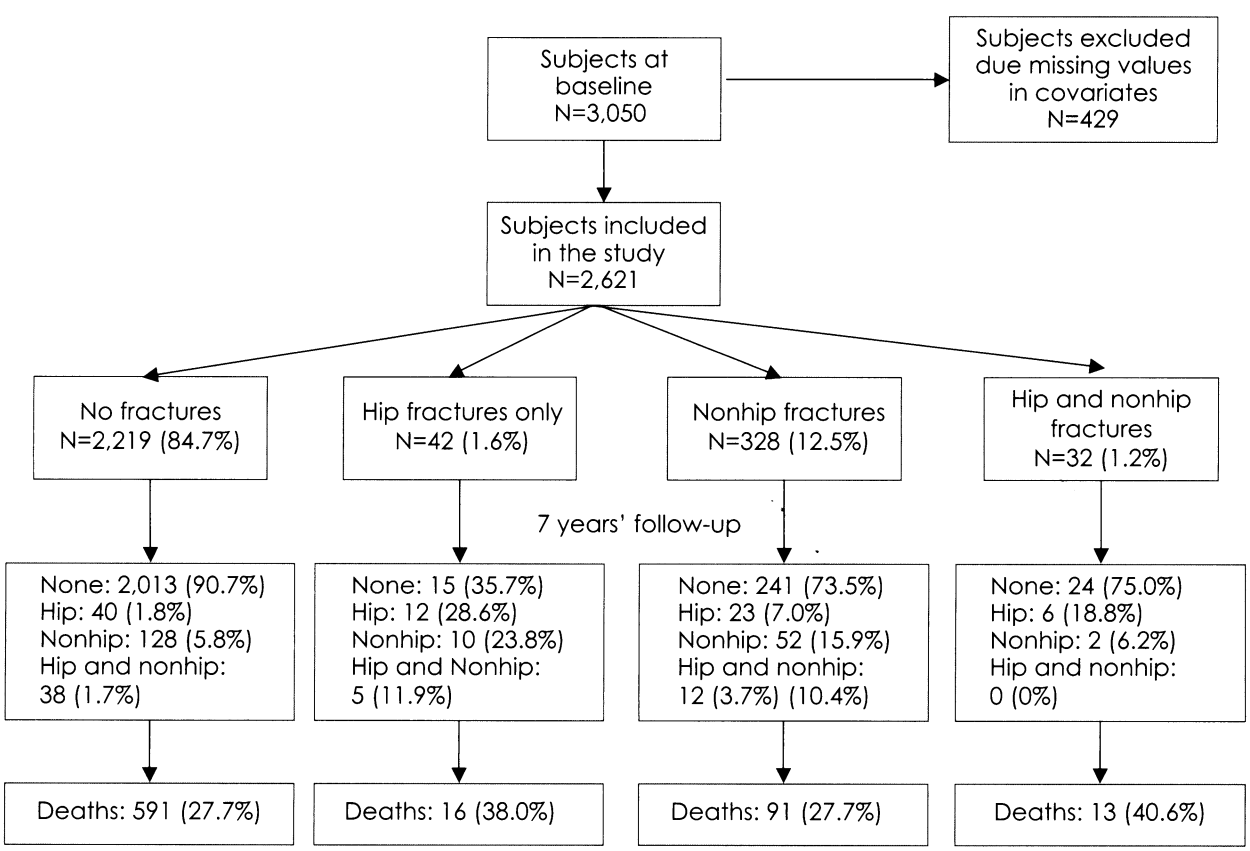
METHODS

Sample and Procedures

Data used are from the HEPESE, a longitudinal study of Mexican Americans aged ≥65, residing in Texas, New Mexico, Colorado, Arizona and California. The HEPESE was modeled after previous Established Populations for the Epidemiological Study of the Elderly conducted in New Haven, East Boston, rural Iowa and North Carolina.[24] Subjects were selected from five southwestern states (Texas, California, Arizona, Colorado and New Mexico) using area probability sampling procedures. The sample and its characteristics have been described elsewhere.[20,25] The sampling procedure assured a sample that is generalizable to approximately 500,000 older Mexican Americans living in the southwest.[24] In-home interviews were conducted in Spanish or English depending on the respondent's preference. The response rate was 83%, which was comparable to the other EPESE studies.[24] At the time of the baseline assessment during 1993–1994, 2,873 subjects (94.2%) were interviewed in person and 177 (5.8%) were interviewed by proxy. The present study used baseline data (1993–1994), and data obtained from a two-year follow-up (1995–1996), a five-year follow-up (1998–1999) and a seven-year follow-up assessment (2000–2001).

Of the 3,050 subjects interviewed at baseline, 2,621 subjects had complete data on all covariates and 429 subjects were excluded due to missing values in the covariates. Subjects excluded were significantly more likely to be older; to have ever had a heart attack, stroke, cancer, high depressive symptoms, lower score on lower body function, lower cognitive function, near and distant vision problems; and be disabled at baseline, compared with those included in the analysis. Of the 429 subjects excluded, 18 had a hip fracture, 62 had a nonhip fracture, 15 had both hip and nonhip fracture, and 324 had no fracture at baseline. Thus, the final sample consisted of 2,621 subjects with complete data for all covariates at baseline and were reinterviewed during the follow-up period. At end of the seven-year follow-up (2000–2001), 1,521 subjects were reinterviewed, 116 subjects refused to be reinterviewed, 273 subjects were lost to follow-up, and 711 subjects were confirmed dead through the National Death Index (NDI) and reports from relatives.

Figure 1. Status of the sample at the end of follow-up by type of fracture



MEASURES

History of Fractures

A prior history of fractures (hip and nonhip skeletal) was assessed by the following questions: "Since the age of 50, have you ever been told by a doctor that you had a broken or fractured hip?" and "Since the age of 50, have you ever been told by a doctor, nurse, therapist or medical assistant that you had broken or fractured other bones?" Based on fracture history, four categories were created: hip fracture only, a nonhip skeletal fracture, hip and nonhip fractures, and no fractures (as a reference category).

Covariates

Baseline sociodemographic variables included age, gender and marital status. Smoking status was assessed by asking subjects whether they had never smoked, currently smoked, or formerly smoked. The presence of various medical conditions was assessed with a series of questions asking subjects if they had ever been told by a doctor that they had diabetes, arthritis, stroke or cancer.

Functional disability was assessed by seven items from a modified version of the Katz Activities of Daily Living (ADL) scale.[26] ADL include walking across a small room, bathing, grooming, dressing, eating, transferring from a bed to a chair and using the toilet. Subjects were asked if they could perform ADL without help, if they needed help or if they were unable to do the activity. For the analysis, ADL disability was dichotomized as no help needed versus needing help with or unable to perform ≥1 of the seven ADL.

Overall, lower body function was assessed by three independent measures: a standing balance, a timed eight-foot walk and timed repeated chair stands.[27,28] For each test a five-level summary score (0–4) was created. A score of 0 indicated "unable to perform," while a 1–4 score represented approximate quartiles based on specific cut-points. The standing balance test included tandem, semitandem and side-by-side stands. Subjects were scored 1–4, with 4 indicating the highest performance. The eight-foot walk was timed to the nearest second, measured at a normal pace. Timed repeated chair stands were calculated to the nearest 10th of a second among those who demonstrated that they were first capable of standing once from a sitting position with arms folded across their chest. The timed walk and chair stands were scored in quartiles, with 1 being the slowest and 4 the fastest. Subjects in the "unable to perform" category included: 1) those who tried but were unable, 2) the interviewer or subject felt it was unsafe to perform the task, 3) the subject could not walk because of pain, or 4) for other health reasons (too ill or in hospital). A summary performance score of lower body function was calculated by summing the three individual scores. The combined scores ranged from a low of 0 (unable to perform) to a high of 12.

Depressive symptomatology was measured with the Center for Epidemiologic Studies Depression Scale (CES-D).[29] This scale consisted of 20 items that ask how often specific symptoms were experienced during the past week; responses were scored on a four-point scale (ranging from rarely or none of the time to most or all of the time: 0, 1, 2, 3) with potential total scores ranging from 0–60. Alpha reliability with these data was 0.89. We consider persons scoring ≥16 as experiencing high depressive symptomatology.[30]

Cognitive function was assessed with the Mini-Mental State Examination (MMSE), a 30-item instrument used to assess cognitive function. Scores have a potential range of 0–30, with lower scores indicating poorer cognitive ability. MMSE score was dichotomized as <21 (impaired cognition) and 21–30 (normal cognition).[31,32]

The body mass index (BMI) was computed by dividing weight in kilograms by height in meters squared (Kg/m^2). Anthropometric measurements were collected in the home using the methods and instructions employed in other EPESE studies. Height was measured using a tape placed against the wall. BMI was divided into approximate tertiles: <25.0 Kg/m^2, 25 Kg/m^2 to <30.0 Kg/m^2 and ≥30.0 Kg/m^2. Persons with BMIs of ≥30 Kg/m^2 were considered obese.[33]

OUTCOME

Incidences of hip and nonhip skeletal fractures were assessed at two-, five- and seven-year follow-up interview. We assessed three outcomes: first event of hip fracture only, first event of nonhip skeletal fracture, and first event of hip and nonhip skeletal fracture.

STATISTICAL ANALYSIS

Chi-squared, Fisher's exact test and ANOVA and post hoc Tukeys' test were used to examine the distribution of covariates for subjects by fracture categories at baseline. Cox proportional hazard regressions were used to examine the incidence of hip and nonhip fractures over a seven-year follow-up as a function of prior fracture history categories at baseline. Those subjects who died and those who were lost to follow-up were censored at the date of the last follow-up. All analyses were controlled for age, gender, marital status, smoking status, medical conditions, any ADL limitation, cognitive status, high depressive symptoms, visual function, BMI and lower body function score at baseline. All analyses were performed using the SAS® System for Windows®, version 9.1.3 (SAS Institute, Cary, NC).

RESULTS

Table 1 presents the baseline characteristics of the sample by fractures at baseline. Subjects with hip fracture, and hip and nonhip fracture were significantly more likely to be older, to be female, to have had a stroke, to be disabled and to have a lower score of lower body function when compared with subjects with nonhip fracture and no fracture at baseline. Figure 1 shows the status of the sample at the end of the seven-year follow-up by type of fracture at baseline. Of the 2,219 subjects who had no fractures at baseline, 40 had hip fracture, 128 had nonhip fractures, and 38 had hip and nonhip fractures over time. Of the 42 subjects who had hip fracture only at baseline, 12 had another hip fracture, 10 had nonhip fracture, and five had both hip and nonhip fracture over time. Of the 328 subjects who had nonhip fractures at baseline, 23 had hip fracture, 52 had another nonhip fracture, and 12 had both hip and nonhip fracture over time. Of the 32 subjects who had both hip and nonhip fractures at baseline, six had another hip fracture, two had another nonhip fracture, and none had both hip and nonhip fracture over time.

Table 2 shows the multivariable analysis predicting hazard ratio (HR) of seven-year incidence of any fracture (hip or nonhip), hip fracture, and hip and nonhip fracture as a function of previous history of fracture at baseline, after controlling for demographic variables, smoking status, medical conditions, any ADL limitation, cognitive status, high depressive symptoms, vision function, BMI and lower body function score at baseline. The HR of seven-year incidence of any type of fracture was 3.03 (95% CI: 1.77–5.19) for subjects with only hip fracture at baseline, 2.58 (95% CI: 1.97–3.38) for subjects with nonhip fracture at baseline, and 2.52 (95% CI: 1.22–5.20) for subjects with both hip and nonhip fracture at baseline. Other factors such as older age, being female, being a current smoker and having diabetes were also associated with seven-year incidence of any type of fracture.

The HR of seven-year incidence of hip fracture (Table 2) was 6.48 (95% CI: 3.26–12.89) for subjects with only hip fracture at baseline, 1.99 (95% CI: 1.24–3.19) for subjects with nonhip fracture at baseline, and 5.08 (95% CI: 2.12–12.17) for subjects with both hip and nonhip fracture at baseline. Other factors such as older age and cognitive impairment (MMSE <21) were also associated with seven-year incidence of hip fracture. BMI of ≥30 Kg/m^2 was associated with a

Table 2. Multivariable analysis predicting hazard ratio of seven-year incidence of any type of fractures (hip or nonhip), hip fracture and nonhip fracture (N=2,621)

Explanatory Variables	Hip or Nonhip Fracture	Hip Fracture	Nonhip Fracture
	HR (95% CI)	HR (95% CI)	HR (95% CI)
Fracture at Baseline			
None	1.00	1.00	1.00
Hip only	3.03 (1.77–5.19)	6.48 (3.26–12.89)	1.89 (0.95–3.73)
Nonhip only	2.58 (1.97–3.38)	1.99 (1.24–3.19)	2.65 (1.98–3.55)
Hip and nonhip	2.52 (1.22–5.20)	5.08 (2.12–12.17)	0.76 (0.19–3.08)
Age	1.03 (1.01–1.05)	1.04 (1.01–1.07)	1.02 (1.00–1.04)
Gender (Female)	2.56 (1.88–3.50)	1.24 (0.79–1.96)	3.68 (2.52–5.38)
Marital Status (Married)	1.22 (0.95–1.57)	1.23 (0.82–1.85)	1.09 (0.83–1.44)
Smoking Status			
Never	1.00	1.00	1.00
Former	1.05 (0.80–1.39)	0.70 (0.44–1.13)	1.12 (0.82–1.52)
Current	1.42 (1.00–2.02)	1.11 (0.63–1.93)	1.51 (1.01–2.24)
Medical Conditions			
Arthritis	0.95 (0.75–1.21)	1.03 (0.70–1.51)	0.93 (0.71–1.21)
Diabetes	1.34 (1.04–1.72)	1.31 (0.87–1.99)	1.31 (0.98–1.74)
Stroke	1.11 (0.70–1.76)	0.94 (0.46–1.96)	1.25 (0.74–2.11)
Cancer	1.53 (0.98–2.40)	1.77 (0.88–3.57)	1.23 (0.71–2.12)
Any ADL Limitation	1.35 (0.90–2.02)	1.25 (0.66–2.37)	1.31 (0.83–2.08)
Cognitive Impairment (MMSE <21)	1.16 (0.82–1.63)	1.84 (1.13–3.00)	0.96 (0.64–1.43)
Depressive Symptoms (CES-D ≥16)	1.22 (0.94–1.59)	1.46 (0.97–2.19)	1.08 (0.80–1.46)
Near Vision Impairment	0.84 (0.62–1.13)	0.70 (0.43–1.15)	0.90 (0.65–1.24)
Distant Vision Impairment	0.88 (0.61–1.26)	0.65 (0.35–1.22)	0.87 (0.58–1.31)
BMI (Kg/m^2)			
<25 Kg/m^2	1.00	1.00	1.00
25–30	1.02 (0.77–1.34)	0.72 (0.47–1.10)	1.12 (0.82–1.54)
≥30	0.91 (0.67–1.22)	0.62 (0.38–0.98)	0.99 (0.71–1.39)
Summary Performance Score of Lower Body Function	0.96 (0.92–1.01)	0.96 (0.90–1.03)	0.96 (0.91–1.01)

MMSE: Mini-Mental State Examination; ADL: Activities of daily living; CES-D: Center for Epidemiologic Studies Depression Scale; BMI: body mass index decreased risk of future hip fracture. The HR of seven-year incidence of nonhip fracture (Table 2) was 1.89 (95% CI: 0.95–3.73) for subjects with only hip fracture at baseline, 2.65 (95% CI: 1.98–3.55) for subjects with nonhip fracture at baseline, and 0.76 (95% CI: 0.19–3.08) for subjects with both hip and nonhip fracture at baseline. Older age and being a current smoker were also associated with seven-year incidence of hip and nonhip fracture. None of the subjects with both hip and nonhip fracture at baseline developed another hip and nonhip fracture over a seven-year period.

DISCUSSION

In the older Mexican-American population, we noted a significant increase in fracture risk in general and especially in older female subjects with previous hip or nonhip fractures. The association of prior fractures with increased risk of future fractures still remains significant, even after controlling for sociodemographics, medical conditions, disability and other health factors. Previous history of hip fracture is the single most important predictive factor in the development of another hip fracture. Similarly, a previous history of nonhip fracture was also a strong predictor of new nonhip fracture over seven years. Previous history of nonhip fracture increased the risk of the development of a hip fracture but not as high as with history of a previous hip fracture. Past hip fracture also predicts the occurrence of a future nonhip fracture, but the association was not as strong as in predicting new hip fracture. Other predictors of recurrent fractures were lower body disability, history of stroke, any ADL disability and gait/balance impairment.

Our study is consistent with other studies. For example, Cuddihy et al. showed that a previous history of nonhip fracture (forearm fracture in this case) increased the risk of developing another nonhip fracture as well as a hip fracture, but primarily the relative risk of developing another nonhip fracture is greater.[34] Nevitt et al. also showed that a previous history of vertebral fracture increases primarily another vertebral fracture incidence, but the magnitude of the association was less for a new hip fracture.[35] Colon-Emeric et al. showed an increase in nonhip fractures in patients with previous hip fractures among older Caucasians and non-Hispanic blacks. However, our study is the first that examined the risk of recurrent hip and nonhip fractures in older Mexican-American men and women.[22]

It is not clear why the risk of subsequent fractures is high in a population with known osteoporosis protective factors (e.g., high BMI). One possibility is less use of osteoporosis drugs, exercise and fall interventions, especially after the first fracture. Follin et al. showed that 75% of patients discharged after in-hospital treatment for hip fractures did not get treatment with bisphosphonates or calcium.[36] A future area of study is investigating whether better access to healthcare will reduce the incidence of osteoporosis and fractures in Mexican-American elders. Another way to increase the use of osteoporosis medications in older patients with fractures is the adoption of orthogeriatric comanagement approach on inpatient care of patients admitted for orthopedic intervention postfracture.[37] It is also important for future studies to examine factors associated with adherence to lifestyle interventions (such as weight-bearing and balance exercises, and smoking cessation) known to decrease risk of fall and bone loss.

Our study has limitations. First, the assessment of history of nonhip fractures could be underestimated because vertebral fractures (the commonest osteoporosis-related fracture) are usually asymptomatic and diagnosis may be incidental. For example, a patient has a chest x-ray because the patient presented with pneumonia to the doctor and the radiologist reports an incidental finding of wedge compression fracture in the spine. The diagnosis may also be suspected by physicians if patients notice a loss of height or develop kyphosis. This theoretically could underestimate the accuracy of actual incidence of nonhip fracture during follow-up interviews. Second, no bone mineral density (BMD) measurements were used in our study to identify those with bone loss. Using BMD measures in a future study will enhance our understanding of factors associated with bone loss in older Mexican Americans. We reran the analysis, adding the excluded 429 subjects who had missing values in their covariates; the result and conclusion of our study did not change. We decided to exclude them so as to make future studies on older Hispanics to be comparable to ours. The strengths of our study are its large sample size, its prospective design and its long follow-up as well as its inclusions of both male and female Mexican-American elders.

This study is the first that examined the risk of recurrent hip and nonhip fractures in older Mexican Americans. Our findings show that older Mexican Americans who have sustained a hip or nonhip fracture might be at high risk of new fractures. Our study suggested that, in order to prevent a new fracture, an urgent need for better screening and treatment for osteoporosis and falls in those with a history of fractures is needed. In particular, the older Mexican-American females with known risk factors (e.g., lower score in body function, increased dependency on ADLs, history of stroke or balance problems) should be targeted for more rigorous osteoporosis screening and treatment to prevent future fractures. Further studies, however, are urgently needed to develop and test interventions to improve healthcare access, use of antiosteoporosis drugs and adoption of a healthy lifestyle (e.g., smoking cessation, weight-bearing exercises) known to preserve bone mass, with the goal of preventing fracture-related disability and mortality in this population.

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