FALL INCIDENCE ACCORDING TO RACE AND ETHNICITY AMONG OLDER U.S. MEN

by

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Abstract

Falls among older adults are common, often resulting in serious injury. Previous studies suggest that fall risk is lower among members of minority populations compared with members of white populations. These studies were primarily conducted among older women or were retrospective in design. Consequently, the descriptive epidemiology of falls among older community dwelling men is lacking. To better quantify fall risk among men by race/ethnicity, we conducted a prospective study in the Osteoporotic Fractures in Men (MrOS) Study, a cohort of community-dwelling U.S. men aged 65 years and older from 6 regions of the U.S. Baseline information was obtained from self-reported questionnaires and standardized measures. Incident falls over 12 months were reported on tri-annual mailed questionnaires. Among the 5914 men in the analysis, 5353 (90.5%) were defined as non-Hispanic white, 244 (4.1%) as non-Hispanic African American, 191 (3.2%) as non-Hispanic Asian, and 126 (2.1%) as Hispanic. The crude 12-month fall cumulative incidence estimates were 25.4% among whites, 26.3% among African American, 23.7% among Asian, and 24.2% among Hispanic men. We observed no significant differences in fall risk according to race or Hispanic ethnicity in age-adjusted or multivariate analyses controlling for potential fall risk factors. The multivariate risk ratios and 95% confidence intervals (CI) in each group compared with whites were 1.01 (95% CI: 0.73-1.40) for African American, 0.92 (95% CI: 0.64-1.34) for Asian, and 1.03 (95% CI: 0.65-1.62) for Hispanic. Factors associated with fall risk in previous studies such as fall history, neuromuscular performance and use of certain medications were also related to fall risk in this study but did not contribute to variation in fall risk by race or ethnicity. This study demonstrated that previous reports of reduced fall risk among non-white men is likely spurious due to differences in 12-month recall of falls according to race and ethnicity. We observed no disparity in 12-month fall risk ascertained at 4-month intervals according to race or Hispanic ethnicity in this cohort of older men.

Chapter 1

INTRODUCTION

Falls are a major public health concern among older persons. Falls are reported by 30-50% of older adults living in the community and 25% of all falls in this population result in serious injury (Blake et al., 1988; O'Loughlin et al., 1993). Falls are associated with 90% of all hip fractures (Grisso et al., 1991; Varney et al., 1992, Melton et al., 1993; Marks et al., 2003) and hip fractures are associated with greater mortality, disability and medical costs than all other osteoporotic fractures combined (Phillips et al., 1986; Chrischilles et al., 1991).

The economic implications of fractures are also great; fractures in the United States may cost as much as 20 billion dollars per year, with hip fractures accounting for over a third of the total (Praemer et al., 1992). Although most falls do not result in a fracture, falling is a serious problem that may result in emotional distress, fear of falling, activity limitations and loss of independence (Vellas et al., 1987; Tinetti et al., 1988). Thus, prevention of falls becomes a major objective in lowering morbidity and enhancing the quality of life of the population ages 65 years and older.

Gender and hip fracture risk

Higher fracture risk in women has led to a focus on female study populations. Consequently, few studies have investigated osteoporosis, falls and fractures among men. Although osteoporotic fracture rates are greatest among older U.S. women, approximately 30% of all hip fractures occur in men (Poor et al., 1995). As the elderly population and longevity increases, it is estimated that 6.8 million men will experience a hip fracture by 2050 (Poor et al., 1995). Hip fractures account for the greatest morbidity and mortality of all fractures, especially in men and African Americans (Cooper et al., 1992; Jacobsen et al., 1992). One study observed that 1-year mortality after a hip fracture was 31% in men compared with 17% in women who had experienced a hip fracture (Forsen et al., 1999).

Race, ethnicity and hip fracture risk

Whites experience higher hip fracture rates than non-white populations (Melton et al., 1996; Baron et al., 1996) with a two to three times higher incidence in white compared with nonwhite women (Gallagher et al., 1980). Japanese men and women have lower risk of hip fracture despite a lower average bone mass than whites. This suggests that Japanese would be at higher risk for fractures, when actually the incidence of hip fractures is half that among whites (Ross et al., 1991a). Since Japanese have lower risk of hip fractures despite their lower bone mass, it has been hypothesized that lower fall frequency may account for this discrepancy (Ross et al., 1991b).

As African American and Hispanic women also have lower risk of hip fracture compared to white women (Bauer 1988), it is of interest to know if differences in fall risk explain differences in hip fracture risk among various race and ethnic groups. Previous research has supported this hypothesis as fall frequency has generally been reported to be higher among whites (Nevitt et al., 1989; Davis et al., 1997; Aoyagi et al., 1998; Hanlon et al., 2002).

Fall risk factors

Over 400 potential risk factors for falls have been identified (Masud et al., 2001). Risk factors are classified as intrinsic (individual) or extrinsic (environmental). Intrinsic risk factors are generally accepted to play a predominant role in the etiology of falls and are believed to be the best predictors of falls among the elderly (Honeycutt et al., 2002). Known intrinsic risk factors are visual and cognitive impairments, stroke or degenerative disease, use of certain medications or a combination of medications, postural hypotension and poor neuromuscular performance. Additionally, intrinsic risk factors are of particular interest because most are modifiable. Neuromuscular fitness components such as gait, balance and strength have been found to be strong predictors of falls (Nevitt et al., 1989; Lord et al., 1994) and these factors have received particular attention due to the potential to develop interventions targeting these factors in order to prevent falls.

Recently published guidelines by the American Geriatrics Society rank the top 4 risk factors for falls as 1) muscle weakness, 2) history of falls, 3) gait deficit, and 4) balance deficit (American Geriatrics Society 2001). Diminished strength in the elderly is predominantly due to lower muscle mass (Newman et al., 2003) and declines in muscle mass, leg strength and power and stability are each associated with a greater fall risk in older persons (Blake et al., 1988; Campbell et al., 1989; Nevitt et al., 1989; Lord et al., 2001). Power, defined as the rate at which muscle force does mechanical work, is a major determinant of muscle functional ability and may surpass strength as an important determinant of mobility and neuromuscular function in older adults (Bassey et al., 1992; Foldvari et al., 2000; Bean et al., 2003). However, muscle power in relation to fall risk has not been studied.

Postural stability, as indicated by measures of either static or dynamic balance, is lower among those who fall than among those who do not. It is particularly low among those who fall frequently (Gehlsen et al., 1990; Lord et al., 1994; Maki et al., 1994; Dargent-

Molina et al., 1996). Higher body mass and specifically higher fat mass is associated with poorer stability that may increase fall risk (Winters et al., 2000). Regular physical activity has been demonstrated to significantly reduce fall risk (Carter et al., 2001).

Impaired vision, specifically, inadequate depth perception and poor contrast sensitivity are each independently associated with increased fall risk (Lord et al., 1991; Turano et al., 1994). The association between poor vision and instability is well documented (Lord et al., 2000; Brooke-Wavell et al., 2002) and numerous studies have established impaired vision as an independent risk factor for falls (Tinetti et al., 1988; Nevitt et al., 1989; Lord et al., 1991; Lord et al., 2001).

Several prevalent medical conditions and diseases have been shown to increase fall risk such as urinary incontinence (de Rekeneire et al., 2003), diabetes (Schwartz et al., 2002), dizziness (Graafmans et al., 1996), arthritis, chronic obstructive pulmonary disease and Parkinsons disease (Nevitt et al., 1989; Lawlor et al., 2003). Central nervous system active medication use, particularly benzodiazepine use, has repeatedly been shown to be a risk factor for falls as use may impair neuromuscular function and cognition and may cause sedation, dizziness and postural disturbances (Ensrud et al., 2002).

Gender and fall frequency

Falls have been established to be a major risk factor for fracture in women and data has suggested a similar relationship in men, but the relationship is not adequately described. Sex differences such as lower extremity strength may influence or affect the nature of falls in men, yet studies of large cohorts of men to confirm this are lacking. One cross-sectional study of falls observed that in men, the mid quintile of leg muscle strength was protective for falls while no relationship between falls and leg muscle strength was seen in women (de Rekeneire et al., 2003). Previous studies have reported higher frequency of falls in women compared with men. One study observed 24.1% of women compared to 18.3% of men reported a fall (de Rekeneire et al., 2003). In native Japanese, 19% of women and 9% of men reported one or more falls during the previous year while 17% of Japanese American women reported one or more falls compared to 11% of Japanese American men (Aoyagi et al., 1998). Another study of Japanese American men and women living in Hawaii observed higher incidence rates for falls in women (267 per 1000 person-years) compared with men (139 per 1000 person-years) (Davis et al., 1997).

Race, ethnicity and fall frequency

While there have been numerous investigations of falls and associated risk factors in the elderly, there is limited information, however, about the association between falls and race or ethnic origin. Recent publications suggest racial differences in fall incidence may exist, however, these studies contain limitations, especially for determining racial differences in men.

Previous studies examining fall risk in Asian populations suggest a reduced risk of falls compared to whites. In the Hawaii Osteoporosis Study (HOS), fall incidence among community-dwelling women in Japan was lower compared with fall incidence in Caucasian women in the Study of Osteoporosis Fractures (SOF). Falls in both studies were assessed by mailed questionnaire at 4-month intervals. In age-adjusted analyses, white women were almost twice as likely to fall compared to the Japanese women (OR 1.8; 95% CI: 1.6-2.0) (Davis et al., 1999).

In a similar analysis, fall incidence of older, independent Japanese Americans participating in the HOS Study were lower compared with age-adjusted fall incidence rates for predominately white populations in other published studies from Finland, Canada and New Zealand. Age-adjusted rate ratios of falls for predominantly white populations compared with the Japanese participants ranged from 1.8 to 2.3 for women and from 2.6 to 4.7 for men. Aside from the lower incidence of falls observed in the Japanese, risk of injuries from falls was similar for the Japanese and white populations (Davis et al., 1997).

In community-dwelling older persons, similar prevalence of falls during the previous year was reported in native Japanese and Japanese Americans and the prevalence was half the fall prevalence for both male and female Caucasians observed in other studies (Aoyagi et al., 1998). A small prospective analysis of male and female nursing home residents both in Japan and in the United States observed nearly a 4-fold higher fall risk in Americans compared to the Japanese residents (Lipsitz et al., 1994).

Previous studies have observed a similar or lower fall risk in African Americans compared with whites. In a retrospective study of mobility, balance and falls among elderly women, African Americans reported similar fall frequencies during the previous 12 months before study entry (32.8%) compared to whites (32.2%) (Means et al., 2000). In a small prospective study with weekly follow-up for 1 year, Nevitt et al. (1989) observed that whites were 2.3 times more likely to report a single fall compared to blacks. White race was also a significant predictor of two or more falls.

A prospective study with an over-sampled population of African Americans observed a 23% reduced risk for African Americans recalling falls in the previous 12 months compared to their Caucasian counterparts. Race was not a significant predictor of multiple falls (Hanlon et al., 2002). In a cross-sectional analysis of falls in both sexes, white men were 1.4 times more likely to fall compared to black men. This association was not observed in women (de Rekeneire et al., 2003).

Less information is known about fall risk in Hispanic or Latino populations. In a small prospective study of community-dwelling Mexican-American women, fall frequency among the participants was similar or slightly higher than in similar studies among Caucasian women (Schwartz et al., 1999). Information on fall frequency among Hispanic men has not been reported in the literature.

Comparison of fall risk factors by race/ethnicity

A few of the previous studies examining differences in fall frequency by race observed variability for some established risk factors for falls. It is possible that these differences cause a modifying effect of race on known risk factors for falls, which explain any differences found in fall frequency.

Nursing home residents in Japan and the United States demonstrated significant differences in quadriceps strength, gait speed, current medications and mobility. The U.S. residents were observed to have a lower risk of falling with increasing leg muscle strength while no relationship between falls and muscle strength was observed in Japanese residents. The Japanese men and women also demonstrated slower gait speeds than their American counterparts. The investigators suggest that the relationship between falls and muscle weakness may be modified by characteristics of the individuals, their culture and their environment (Lipsitz et al., 1994).

Compared to white women in the Study of Osteoporotic Fractures, Japanese women in the Hawaiian Osteoporosis Study differed substantially in their neuromuscular performance. The white women demonstrated greater quadriceps strength and faster hand and foot reaction times while the Japanese women demonstrated better functioning on the neuromuscular performance and balance tests. In age-adjusted analyses, white women were nearly twice as likely to fall compared with Japanese women (OR 1.8; 95% CI: 1.6-2.0). After adjustment for neuromuscular test performance and the number of functional disabilities, the odds ratio for fall risk remained essentially the same (OR 1.8; 95%CI 1.5, 2.1). Thus, adjustment for these factors did not explain the differing risk of falls (Davis et al., 1999).

Hanlon et al. (2002) observed that fall frequency was 23% lower among African Americans compared to whites. Due to design constraints, the study was not able to examine muscle strength or balance differences between the groups and thus was not able to speculate on factors that may have mediated or contributed to these differences.

Hispanic and Caucasian women may have more similar risk factors for falls. In one small study of Hispanic women, fall frequency and identified risk factors for falls were similar to previously established risk factors among non-Hispanic Caucasian women (Schwartz et al., 1999). Data on risk factors for falls among Hispanic men have not been reported.

Given the importance of falls in independent functioning of the elderly and the limited information on the association between race and falls particularly in men, a large prospective study on race, ethnicity and fall incidence in older men is needed to accurately describe the patterns of falls across different racial categories. Performance-based characteristics may be responsible for differences in fracture risk between populations (Aoyagi et al., 2001) yet there are few studies comparing neuromuscular function in relation to falls among race and ethnic groups.

Previous studies have observed varying fall frequency within the same study populations. Cummings et al. (1988) observed higher fall frequency when follow-up for falls was performed weekly compared with recall of falls during the preceding 3,6, or 12 months. Lachenbruch et al. (1991) observed a larger number of falls were reported in participants' diary and weekly follow-up compared with falls that had been reported in the same population during a previous study in which falls were collected every 3 months by a quarterly questionnaire. These studies suggest that the manner in which falls are ascertained and the period of time participants are asked to remember falling influences the frequency of falls reported.

The objectives of this study were 1) to estimate the cumulative incidence of falls among older men, 2) to examine fall risk for variation by race or Hispanic ethnicity, and 3) to assess fall recall period and accuracy of fall reporting by race and ethnicity. We hypothesized that there would be a difference in cumulative incidence among race and Hispanic ethnicity in our study population of community-dwelling older men and variance in risk factors for falls may explain the racial fall patterns.

Chapter 2

METHODS

Participants

This analysis is part of the Osteoporotic Fractures in Men (MrOS) Study, a multi-center prospective cohort study that will provide essential information about osteoporosis and associated issues of aging in men. A total of 5995 community-dwelling men ages 65 years or older were recruited from the general population in six geographic regions across the United States: Birmingham, Alabama; Minneapolis, Minnesota; Palo Alto, California; Pittsburgh, Pennsylvania; Portland, Oregon and San Diego, California. These sites were chosen to assure geographic and ethnic diversity in the overall study population. Enrollment began in April 2000 and was completed in April 2002. The recruitment method of each site was through mass mailings to male community-members ages 65 or older, although each metropolitan area did have the flexibility to use the most appropriate strategy to recruit locally.

Participants were considered ineligible if they met any of the following exclusion criteria: 1) unable to walk without the assistance of another person, 2) have had a bilateral hip replacement, 3) not competent to give informed consent, 4) not expected to reside near the clinical site for the duration of the study, or 5) have medical conditions (in the judgment of the study physicians) which make it unlikely that they would survive the duration of the study.

Baseline Questionnaire

At enrollment, each MrOS participant completed a comprehensive questionnaire. Items regarding demographic characteristics, medical history, current medication prescription and over-the-counter medication use, lifetime tobacco smoking, current alcohol use, and recent physical activity were ascertained. Urinary symptom index was determined according to the American Urological Association (Barry et al., 1992).

Participants reported race and ethnicity as African American, American Indian, Alaska Native, Asian, Pacific Islander, Hispanic or Latino, or White. Men were permitted to indicate multiple categories on the questionnaire. In this analysis, men were included if they reported a single race and no ethnicity or if they indicated Hispanic ethnicity regardless of race category marked. We excluded 71 men either because they reported more than 1 race or reported a race that in total had small numbers. For example, only 7 men reported race as American Indian, therefore that group was not included in the final analysis. Ten participants were excluded because they died or terminated before the first follow-up questionnaire and thus did not contribute any information on falls during follow-up. Of the 5914 men in the final analysis, 5353 (90.5%) were white non-Hispanic, 244 (4.1%) were African American non-Hispanic, 191 (3.2%) were Asian non-Hispanic and 126 (2.1%) were Hispanic. We took this approach in order to classify the participants according to accepted demographic practice but also because there was little overlap between the racial categories and Hispanic ethnicity.

Physical activity in the past seven days was quantified using the Physical Activity Scale for the Elderly (PASE) (Washburn et al., 1993), a test designed to capture leisure activities such as gardening and quantify them into a reliable measurement of physical activity. The reliability of the PASE instrument administered by mail is high (r=0.84 for test-retest reliability over 3-7 days) (Washburn et al., 1993). A total PASE score and scores for each activity domain are computed according to published information (Washburn et al., 1993). In order to specifically determine daily walking status, as part of the baseline questionnaire, participants were asked, "Do you take walks for exercise, daily or almost everyday?"

Body Composition

Total lean mass and total body fat mass were obtained by dual energy x-ray absorptiometry (DXA). All study sites used the same model of fan beam scanner (QDR Model 4500W, Hologic Inc., Waltham, MA) for consistency between measures. All measures were obtained and analyzed using the manufacturer's specifications. Scans were analyzed at the clinical sites and the results transmitted to the Coordinating Center (University of California at San Francisco) for quality assurance and collation. Height was obtained using a stadiometer. Weight was measured by the use of a standard scale. Body mass index (BMI) was calculated as weight (kg)/height $(m)^2$.

Visual Function

Measures of visual acuity, contrast sensitivity and depth perception were obtained with standard assessments. Visual acuity was measured using Bailey-Lovie letter charts (Bailey and Lovie, 1976) at a distance of 10 feet with uniform illumination and the use of any corrective eyewear. If a participant was unable to read the chart at the standard distance of 10 feet, the test was readministered at 5 feet. To account for this, the visual acuity score was adjusted for these participants by subtracting 15 from the score recorded in the raw data file to account for the alternative distance. A VISTECH VCTS 6500 wall chart (Vision Contrast Test System, Vistech Consultants Incorporation Dayton, OH, USA), and light meter was used to measure contrast sensitivity for the Pelli-Robson test (Pelli et al., 1988). A score of 2.0 indicates normal contrast sensitivity of 100 percent. Scores less than 2.0 signify poorer contrast sensitivity. Depth perception was measured using the Frisby Stereo Test (Richmond Products, Boca Raton, FL) (Frisby 1980). Higher scores on the Frisby Stereo Test indicate poorer depth perception.

Neuromuscular performance

Participants completed an array of standardized performance-based tests. These include power, grip strength, leg power, walking speed, narrow walk and chair stands.

Grip strength was ascertained with a Jamar Hydraulic Hand Dynamometer (Bolingbrook, IL) for two trials in each hand while the participant was seated. The dynamometer registers maximum grip force in kilograms. Grip strength is classified as the average grip strength of all trials. Leg power was ascertained in each leg with a Nottingham Power Rig (University of Nottingham, Nottingham UK) (Bassey et al., 1992) for nine trials while the participant was seated on the device. The Nottingham Power Rig registers maximum leg extension power in watts. Leg power is classified as the average of the maximum value of the nine trials for each leg. Chair stand time was measured as the time to stand up from a seated position in a chair 5 times without use of the arms. Walking speed was calculated from the time required for the participants to walk their usual pace over a 6-meter course. Usual walking speed was calculated as the average of two trials. The narrow walk was assessed by the timing and evaluation of the subject's ability to walk within two lines spaced 20 centimeters apart, for a length of 20 meters. Deviations were defined as not staying within the lines by stepping on or over the lines. The number of deviations was recorded. For any trial, 3 or more deviations resulted in an invalid trial. The test was performed up to three times or until 2 valid times were obtained.

For the grip strength, leg power, chair stand and narrow walk tests, participants were classified as physically unable to perform the test if the men met any of the specific exclusion criteria for any test or if participants attempted but could not complete the test. After recoding the missing neuromuscular test measures according to this criterion, we were unable to categorize 494 men missing leg power measures. Therefore, we created a missing category for the leg power test in order not to exclude data for these participants in subsequent analyses.

Follow-up procedures

Follow-up for incident falls during the 12-months after baseline was conducted with self-reported tri-annual questionnaires. The questionnaires are mailed on March 1, July 1 and November 1 of each study year. All of these tri-annual questionnaires assess number of falls during the previous 4-month period. Participants are asked to indicate yes or no if they have fallen during this time. If they mark yes, they are further asked to mark the number of falls (1, 2, 3, 4, or 5 or more falls). All participants are to return the 4-month questionnaire even if they have no fall or fracture outcome to report. Those who do not respond to any questionnaire are contacted by telephone by a research assistant. Inconsistencies on returned questionnaires are followed with a telephone call to the subject for clarification. Mortality assessment was initiated primarily through queries from unreturned questionnaires. Other methods such as review of obituary columns in local newspapers were used.

Fall ascertainment

The participants were followed through three tri-annual questionnaire cycles (12 months). Participants were not followed during the same calendar period since the enrollment period spanned two years. Instead, follow-up was during the first 12 months from the date of enrollment for each participant. The primary analysis dichotomized the outcome into those who reported a fall and those who did not over the 12-month follow-up period. We also classified the outcome as no falls, one fall and ≥ 2 falls. This analysis is restricted to follow-up of one year in order to estimate the one-year cumulative incidence of falls and to make comparisons.

Data Collection and Management

Detailed protocol training and certification of staff and a computer-based process of data quality review was implemented to minimize variability and errors in data collection at the multiple sites.

All data were recorded on 'teleforms' with 'bubbles' that are filled in for the appropriate response to all questions. When a questionnaire from a participant was received at the study site, it was reviewed for completeness and consistency by study personnel.

All completed questionnaires were faxed to the Coordinating Center by study personnel at each site on a dedicated fax line. The information was transferred directly into a computer file. Data validity checks (range, logic) were performed automatically on the computer using programs that ran as data were received. This process produced a file that was posted on a secure website indicating which questions on a particular questionnaire needed to be edited by study personnel at the site. These edits were also manually reviewed by Coordinating Center staff to ensure that any edit requests were legitimate.

Statistical Analysis

We first examined the frequency and distribution of all possible risk factors for falls. Second, we examined these fall risk factors by race and ethnic group. We used Pearson's chi-square test for categorical variables and one-way analysis of variance for continuous measures in order to determine if there were significant differences by race or ethnicity. Third, we examined the characteristics of interest according to fall cumulative incidence. Fall cumulative incidence was computed as the number of men who reported a fall during the 12-month follow-up period divided by the size of the study population for analysis. We determined a characteristic was associated with falls by assessment of the risk ratio (RR), 95% confidence interval (95% CI) and p-values for the univariate logistic regression analysis.

We estimated crude and age-adjusted RR according to race/ethnicity. Multivariate logistic regression was used to estimate fall risk for each race and Hispanic ethnicity. We estimated the odds ratio for falling to approximate the risk ratios for each group after adjusting for age, study site and other potential confounding factors described below. Potential confounding variables were analyzed for their association with race/ethnic groups and for their relation with incident falls. Results are presented as risk ratios and 95% confidence intervals.

The multivariate model was manually constructed in two stages (Figure 1). First, five subgroups of potential confounding variables were independently analyzed: demographic/lifestyle traits, visual function, neuromuscular performance, body composition and prevalent medical conditions. Subgroups were created to manage the large number of correlated variables and limit potential autocorrelation problems. Within each subgroup, variables were ranked according to the age-adjusted relation to falls.

The ordered variables were sequentially fit into the model with age and race/ethnicity starting with the variables demonstrating the strongest association with the outcome. Age-adjusted associations were used in place of unadjusted associations, as age confounded the relation between falls and most characteristics. With each addition of a variable, two criteria were considered: 1) Is the variable associated with falls (assessment of RR, 95% CI and p-values)?, and 2) Does addition of the variable change the RR for any race variable by 10% or more?

Once a "best model" was determined for each subgroup, these models were combined by sequential addition to the largest subgroup (medical history). With each addition, the variables were reassessed for significance in the combined model using the criteria listed above. Once all variables from the best subgroup models were added, any variable not meeting the inclusion criteria of a p-value ≤ 0.10 was sequentially removed from the combined model, beginning with the variable with the highest p-value. To ensure that no variables were erroneously disregarded, each variable not in the final model was re-entered into the final model and reassessed for significance. We also performed sensitivity analyses with the neuromuscular function variables and body composition variables such as replacing chair stands with grip strength or other similar measures, to determine if one or the other variable improved model fit or affected the race/ethnicity risk ratios.

The Hosmer and Lemeshow Goodness of Fit Test was used to assess model fit (Hosmer and Lemeshow, 1980). Model discrimination was assessed using the area under the Receiver Operating (ROC) curve (Hanley and McNeil, 1982). Individual components of the model were examined by plotting of the Pearson Residuals and the Deviance Residuals.

In order to assess the influence of fall recall on our results, we utilized fall data collected on the midstudy questionnaire. This questionnaire is mailed to participants between July 2002 and June 2004, depending on the date of enrollment. On this questionnaire, men self-reported whether they had experienced a fall during the previous 12 months. The 12-month period queried at midstudy covered approximately the same 12-month period from enrollment used in the main analyses.

Statistical analyses were performed using SAS version 8.1 software (SAS Institute, Cary, NC, USA).

Chapter 3

RESULTS

The distribution of possible fall risk factors assessed at baseline according to race/ethnic group are presented in Table 1. At enrollment, white men reported the highest prevalence of having a fall in the previous 12 months, reported the highest proportion of daily walkers and demonstrated the fastest narrow walk speed and 2^{nd} fastest 6-meter walk speed averages. This group reported the highest prevalence of cancer, osteoporosis, and low thyroid and the lowest prevalence of diabetes and hypertension.

African Americans were younger on average than their other cohort members with 44% of men in the lowest age group (65-69 years old). African American men reported the highest percent of men in the lowest education category, with fair/poor/very poor health status, current smokers and being unmarried. As a group, African Americans reported the lowest average PASE scores and had the highest percentage of men with a body mass index greater than or equal to 30 kg/m^2 and highest average total body lean mass. This group demonstrated the highest leg power and grip strength averages, the longest average time to complete 5 chair stands and slowest average speeds on the 6-meter and narrow walk tests. African Americans reported the greatest percentage of central nervous system medication use and walking aid use. This group also reported the highest prevalence of several medical conditions including more severe urinary symptoms, history of dizziness, arthritis, diabetes, stroke, angina, congestive heart failure and hypertension.

Asian men in this cohort had the greatest percentage of men in the highest education level, reported the highest percentage of non-drinkers, non-smokers and married men.

This group reported the lowest frequency of falls in the preceding year. Notable physical attributes included the greatest proportion of men with a BMI less than 25 kg/m^2, the shortest average height, lowest total body fat mass and total body lean mass. This group demonstrated the lowest leg power and grip strength averages yet had the shortest average time to complete 5 chair stands.

Hispanic men reported the highest percentage of men reporting excellent health, the highest average alcohol intake and the highest total body fat mass. This group performed the fastest average 6-meter walk speed and were tied with African Americans for the highest grip strength average. The greatest percentage of high thyroid/Graves disease was reported in this group along with the lowest percentage of men reporting a history of dizziness or stroke.

Multiple falls during the 12-month follow-up period were reported by 693 men (Table 2). Because of small numbers of non-white men reporting greater than 2 falls, all subsequent analyses were conducted with falls dichotomized as 0 or 1+ falls. During the 12-month follow-up period, at least one incident fall was reported by 1483 (25.4%) men. Of those reporting falls, the 12-month cumulative incidence estimates were 25.4% among white, 26.3% among African American, 23.7% among Asian and 24.2% among Hispanic men. These frequencies were not significantly different ($p=.92$).

The distribution of possible fall risk factors assessed at baseline according to fall status are presented in Table 3. Age, study site, self-reported health status, alcohol intake, fall history, daily walkers, and physical activity were significantly associated with falling. Demographic characteristics not associated with falls were race/ethnicity, marital status and smoking status.

Increasing body mass index, height and whole body lean mass were not related to falls while greater whole body total fat was associated with one or more falls. Poor contrast sensitivity, visual acuity and depth perception were all associated with falls.

Decreasing grip strength, lower extremity power, 6-meter walk speed and narrow walk speed were strongly related to falls (all $p<.0001$). Increasing time to complete 5 chair stands was also strongly associated with falling ($p<.0001$). Central nervous system (CNS) medication use, walking aid use, a urinary symptom index of moderate/severe, history of dizziness, stroke, Parkinsons Disease, angina, cancer, osteoporosis, arthritis, diabetes, prostatitis, high thyroid/Graves disease, congestive heart failure, chronic obstructive pulmonary disease and heart attack were associated with one or more falls while hypertension and low thyroid levels were not related to falls.

In age-adjusted analyses, we observed no significant differences in fall risk according to race or Hispanic ethnicity. Risk ratios and 95% CI in each group compared with white men were 1.14, 95%CI: 0.84-1.53 for African American, 0.95, 95%CI: 0.67-1.34 for Asian, and 1.01, 95%CI: 0.66-1.53 for Hispanic.

Multivariate logistic regression was used to estimate fall risk for each race and Hispanic ethnicity while controlling for potential fall risk factors. The final multivariate model included age, study site, CNS medication use, education level, grip strength, narrow walk speed, daily walking status, history of falls, dizziness, walking aid use, Parkinsons disease, history of high thyroid/Graves disease, arthritis and urinary symptom index.

The RR for each variable in the multivariate model is presented in Figure 2. Fall risk did not differ by race or ethnic group. RR and 95% CI in each group compared with white men were 1.01, 95%CI: 0.73-1.40 for African American, 0.92, 95%CI 0.64-1.34 for Asian, and 1.03, 95%CI: 0.65-1.62 for Hispanic. CNS medication use, higher education level, reduced grip strength, slower narrow walk speed, walking aid use, history of falls, dizziness, arthritis, Parkinsons disease and greater urinary symptom index were significantly associated with increased fall risk while self-reported daily walking was associated with reduced risk. These variables remained in the model as a result of the analytic process described above.

For the final multivariate model, the area under the ROC curve was 0.69, which indicates good ability of the model to discriminate between fallers and non-fallers. The Hosmer and Lemeshow goodness-of-fit test (p=.69) demonstrates good fit and shows the data do not deviate significantly from the logistic regression model.

To assess if previous fall history modified the relation of race/ethnicity with subsequent falls, we stratified men by whether or not they reported at baseline falling the previous year. First, we limited the participants to men not reporting a previous fall (n=4661). We then performed the multivariate model and observed RR and 95% CI in each group compared with white men of 0.95, 95%CI: 0.64-1.39 for African American, 0.96, 95%CI 0.63-1.46 for Asian, and 0.87, 95%CI: 0.49-1.56 for Hispanic. Second, we limited the participants to men reporting a previous fall at baseline (n=1253). Again, we performed the multivariate model and observed RR and 95% CI in each group compared with white men of 1.33, 95%CI: 0.67-2.62 for African American, 0.89, 95%CI 0.39-2.02 for Asian, and 1.40, 95%CI: 0.62-3.19 for Hispanic. These results suggest that African American and Hispanic men who have fallen previously may have a greater risk of subsequent falls, whereas report of previous falls did not appear to influence risk among Asian men.

Seventy-three participants did not report fall data on one or more of the tri-annual questionnaires and thus were not included in the final multivariate analysis. Follow-up data were missing from 1.1% of white men, 3.3% of African American men, 2.6% of Asian men and 1.6% of Hispanic men (Table 4). These differences by group in loss to follow-up were statistically significant (p=0.01). To examine whether missing fall information could have affected our results, we performed the multivariate analysis after recoding the fall information for each participant in two ways. First, we classified each participant with missing fall data as having fallen during 12 months of follow-up. Second, we classified each participant with missing fall data as not having fallen during the follow-up period. When missing fall data were recoded as a fall, RR and 95% CI in each group compared with white men were 1.12, 95%CI: 0.82-1.53 for African American, 0.96, 95%CI 0.67-1.38 for Asian, and 1.05, 95%CI: 0.67-1.63 for Hispanic. Missing fall data recoded as not falling produced RR and 95% CI in each group compared with white men of 0.98, 95%CI: 0.71-1.35 for African American, 0.92, 95%CI 0.63-1.33 for Asian, and 1.03, 95%CI: 0.66-1.62 for Hispanic. These results indicate that loss to follow-up among race/ethnic groups does not account for our observation of no difference in fall risk among groups.

We performed similar analyses on missing data for the baseline tests of grip strength and the narrow walk (n=51). We classified each participant with missing fall data as having first the highest and then the lowest possible measures and reran the multivariate model each time. These analyses did not produce any significant differences in fall risk by race/ethnic group and indicate that the lack of significance between race/ethnic groups was not due to missing baseline measures.

To examine whether the use of data on falls recalled in the past 12 months would produce a different association, we reran analyses using fall data collected on the mid-study questionnaire. Of the 5914 men in our analysis, 5617 men had also completed the midstudy questionnaire. The results are presented in Table 5. Unlike our primary fall outcome assessed with the tri-annual questionnaires, the midstudy fall outcome was significantly different by race and ethnic group (p=.03).

When recall of falls in the past 12 months was used as the outcome for the multivariate logistic regression model instead of the fall outcome collected on the tri-annual questionnaires, we observed that Asian men were significantly less likely to report falls in the past 12 months compared with whites. African Americans also appeared to have a reduced risk of falls compared with whites based on this assessment.

Chapter 4

DISCUSSION

In this prospective investigation among community-dwelling U.S. men ages 65 years and older, we observed no differences in the 12-month cumulative incidence of falls according to race or ethnicity. During the 12-month follow-up period, 25% of the study population reported at least one fall. Among white, African American, Asian and Hispanic men this estimate was 25.4%, 26.3%, 23.7% and 24.2%, respectively. Although several fall risk factors varied significantly, these differences did not contribute to a variation in fall risk among race or ethnic groups. An important observation from this study is the discrepancy between fall risk estimated with information from different lengths of fall recall periods.

This analysis does have limitations. The tri-annual questionnaire did not collect detailed information about falls, such as how the fall occurred or if any injury (other than a fracture) occurred as a result of the fall. It has been suggested that individuals are more likely to remember a fall if it results in a serious injury (Cummings et al., 1988; Lachenbruch et al., 1991). It is possible that less severe falls not associated with an injury were not reported which would result in an underestimation of fall frequency. We were not able to determine if such an occurrence affected the results in our study.

Although MrOS is a large cohort, the number of men from minority populations was small. We can see this by the relatively wide confidence intervals around the risk ratios for each group. It is possible that we did not have enough men to detect a difference, although previous research conducted in smaller study populations did observe racial differences in fall risk. However, many of these studies included men and women together (Nevitt et al., 1989; Hanlon et al., 2002; de Rekeneire et al., 2003).

We were not able to differentiate between one-time and recurrent fallers due to the small number of multiple falls in non-whites. Previous research suggests there may be a notable difference between one-time fallers and recurrent fallers as one-time fallers may be characteristically more closely related to non-fallers (Masud et al., 2001). It is possible that fall risk varies by race only in recurrent fallers. This pattern was apparent in this study. When we stratified by report of previous falls at baseline, we observed that the risk ratios for falls in the follow-up period were higher among African Americans and Hispanic men with previous falls.

The study population is a volunteer cohort and may possess qualities that differentiate the participants from the general population. Overall, the MrOS participants were generally healthy for their age and we might have observed fewer falls than if we had studies less healthy individuals. However, racial differences in fall frequency have been observed in a healthy elderly population (de Rekeneire et al., 2003). In addition, the distribution of nonwhite men differed greatly by geographic region and recruiting methods are known to differ by region as well.

Due to the number of statistical assessments we performed, this study has an increased likelihood of making a type I error. We recognized this limitation and took steps to try to minimize the likelihood that we would make such errors. These steps included using biologic hypotheses to guide variable selection and to analyze using variable subgroups.

This study had important strengths as well. While previous research has been primarily focused on women, MrOS is the first large prospective study to examine fall risk factors exclusively in older men. We collected fall data prospectively, thereby limiting the potential for recall bias to influence our results. The cohort was diverse; we were able to examine multiple racial and ethnic classifications within the same cohort while previous studies only examined one other group compared to whites within the same study population (Hanlon et al., 2002; de Rekeneire et al., 2003) or compared a single racial or ethnic group to published fall data for whites in other studies or populations (Aoyagi et al., 1998; Schwarz et al., 1999; Davis et al., 1999).

Due to the design of MrOS, we were able to examine many of the established risk factors for falls. We were able to determine that these risk factors did not confound the relationship between race, ethnicity and falls. The risk ratio estimates for these other risk factors were consistent with previously published research. Previous falls (Covinsky et al., 2001; Stalenhoff et al., 2002), higher education level (Tromp et al., 2001; Stel et al., 2003), lower physical activity (Tromp et al., 2001), reduced grip strength (Nevitt et al., 1989; Tromp et al., 2001; Stel et al., 2003) reduced narrow walk performance (Nevitt et al., 1989), CNS medication use (Ensrud et al., 2002), walking aid use (Stel et al., 2003), dizziness (Graafmans et al., 1996) Parkinsons disease (Nevitt et al., 1989), arthritis (Lawlor et al., 2003) and urinary symptoms (de Rekeneire et al., 2003) have all previously been shown to be associated with falls. These factors were independently associated with fall risk in the present study as well.

We observed an unequal distribution of neuromuscular performance between groups as in previous studies (Davis et al., 1999; Aoyagi et al., 2001). Asian men performed the best on chair stands yet displayed the lowest leg power and grip strength. Japanese women have shown similar performance in chair stands and balance tests over white women while white women demonstrated greater grip and quadriceps strength (Davis et al., 1999). In a similar study, Japanese and Japanese American women performed better than white women on chair stand time and walking speed tests (Aoyagi et al., 2001). American nursing home residents had reductions in fall risk with increasing quadriceps strength while no relationship was observed for quadriceps strength and falls in Japanese nursing home residents (Lipsitz et al., 1994). These results suggest that Asians have some neuromuscular advantages compared with whites, although this did not translate to a lower fall risk in Asian men in our study.

Less information is known about neuromuscular performance in other race/ethnic groups compared with whites. In our cohort, African American men had higher mean leg power and grip strength measures yet had the slowest mean speed on the 6-meter and narrow walk tests. Our results suggest that like Asians, African Americans may have certain advantages in neuromuscular performance over other races. Hispanic males had neuromuscular performance more similar to the white men in our study, which is consistent with observations of chair stand performance in Mexican-American women (Schwartz et al., 1999). However, the performance measures did not contribute to any racial differences in fall risk in the present study.

Several potential risk factors for falls were not associated with the risk of falling in our analysis. Most notably, visual function (acuity, depth perception and contrast sensitivity) and total body fat mass were not independently associated with fall risk in this analysis. While highly significant differences were observed between groups for all performance-based tests, we found lower grip strength and slower narrow walk speed to be the most predictive of falls and were the only variables of this type to be included in the final model.

Another strength of this study is our minimal loss to follow-up. Only 1.2% of participants did not report fall status over the 12-month period. Consideration of missing fall data and missing baseline characteristics in the analyses did not expose a potential explanation for the lack of race/ethnic difference in fall risk.

Differences in measurement of falls may explain why results from this study differ from previous reports of racial variation in fall risk. Many of the previous studies investigating race and fall frequency did not prospectively collect fall data (Aoyagi et al., 1998; Means et al., 2000; de Rekeneire et al., 2003) or relied on fall information recalled in the past one year period (Hanlon et al., 2002). Long-term recall for ascertaining falls in the elderly has shown limited accuracy (Cummings et al., 1988; Lachenbruch et al., 1991). Our study examined whether the period over which falls were recalled contributed to racial variation in fall risk. When we compared the 12-month cumulative incidence of falls estimated from recall of 4 months assessed tri-annually with recall of 12 months for approximately the same time period, we observed that white and Hispanic men recalled a higher proportion of falls for the 12-month recall than the 4 month recall. African Americans and Asian men, on the other hand, remembered falling less with the 12-month recall than the 3 tri-annual questionnaires. These results demonstrate that lower risk of falls observed among African Americans and Asian men using a single recall over 12 months are likely spurious owing to differences in recall. Thus, fall surveillance in population-based studies should occur more frequently and assess a time period of a few months.

Chapter 5

Summary and Conclusions

In this prospective study over 12 months among men ages 65 years and older, 25% reported falling. The potential for serious injury and other adverse consequences of falls among U.S. men of this age is great. However, we observed no disparity in 12-month fall risk according to race or Hispanic ethnicity in this cohort of older men utilizing recall of falls from tri-annual questionnaires. This study demonstrated that previous reports of reduced fall risk among non-white men is likely spurious due to differences in 12-month recall of falls according to race and ethnicity. To estimate fall risk accurately, fall surveillance in population-based studies should be assessed frequently with shortened periods of recall. This analysis supports previous research in demonstrating that falls are an important public health issue even among healthy older men.

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Table 1: Distribution at enrollment of demographic characteristics and possible risk factors for falling according to race* and Hispanic ethnicity among 5,914 U.S. men ages 65 years and older: Osteoporotic Fractures in Men Study (MrOS).

Characteristic	White	African American	Asian	Hispanic	p-value
Number of Men	5353	244	191	126	
	N (%)	**N (%)**	**N (%)**	**N (%)**	
Site: Birmingham	859 (16.1%)	99 (40.6%)	0	1 (0.8%)	<.0001
Minneapolis	934 (17.5%)	48 (19.7%)	3 (1.6%)	8 (6.4%)	
Palo Alto	794 (14.8%)	20 (8.2%)	89 (46.6%)	78 (61.9%)	
Pittsburgh	977 (18.3%)	23 (9.4%)	0	2 (1.6%)	
Portland	875 (16.4%)	44 (18.0%)	59 (30.9%)	12 (9.5%)	
San Diego	914 (17.1%)	10 (4.1%)	40 (20.9%)	25 (19.8%)	
SELF-REPORTED QUESTIONNAIRE					
Age group: 65 – 69	1519 (28.4%)	108 (44.3%)	59 (30.9%)	46 (36.5%)	<.0001
70 – 74	1529 (28.6%)	59 (24.2%)	59 (30.9%)	40 (31.8%)	
75 – 79	1292 (24.1%)	58 (23.8%)	53 (27.8%)	32 (25.4%)	
≥80	1013 (18.9%)	19 (7.8%)	20 (10.5%)	8 (6.4%)	
Mean age (SD)	73.8 (5.9)	71.7 (5.1)	73.0 (5.1)	72.0 (4.8)	
Education level: Elementary – High School	1236 (23.1%)	119 (48.8%)	23 (12.0%)	32 (25.4%)	<.0001
Some College	1230 (23.0%)	51 (20.9%)	37 (19.4%)	36 (28.6%)	
College-some graduate school	1562 (29.2%)	40 (16.4%)	65 (34.0%)	35 (27.8%)	
Graduate School	1325 (24.8%)	34 (13.9%)	66 (34.6%)	23 (18.3%)	
Married	4419 (82.6%)	162 (66.4%)	178 (93.2%)	106 (84.1%)	<.0001
Self-rate overall health: Excellent	1842 (34.4%)	57 (23.4%)	44 (23.0%)	49 (38.9%)	<.0001
Good	2778 (51.9%)	132 (54.1%)	109 (57.1%)	58 (46.0%)	
Fair – very poor	731 (13.7%)	55 (22.5%)	38 (19.9%)	19 (15.1%)	
Average Alcohol intake: None	1823 (34.1%)	123 (50.4%)	104 (54.7%)	34 (27.0%)	<.0001
Less 1 drink/day	2087 (39.0%)	81 (33.2%)	63 (33.2%)	57 (45.2%)	
1+ drink /day	1436 (26.9%)	40 (16.4%)	23 (12.1%)	35 (27.8%)	
Cigarette smoking status: Never	2006 (37.5%)	81 (33.2%)	86 (45.0%)	49 (38.9%)	<.0001
Past	3179 (59.4%)	136 (55.7%)	100 (52.4%)	74 (58.7%)	
Current	167 (3.1%)	27 (11.1%)	5 (2.6%)	3 (2.4%)	
Fallen in last 12 months	1155 (21.6%)	43 (17.6%)	28 (14.7%)	27 (21.4%)	.07
Walk daily	2693 (50.3%)	100 (41.0%)	89 (46.6%)	60 (47.6%)	.03
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Physical Activity Scale for the Elderly	146.8 (67.8)	131.1 (70.4)	144.0 (67.6)	164.3 (73.6)	<.0001
CLINIC INTERVIEW	**N (%)**	**N (%)**	**N (%)**	**N (%)**	
Central nervous system medication use**	394 (7.4%)	19 (7.8%)	6 (3.1%)	5 (4.0%)	.07
PHYSICAL EXAMINATION OR OBJECTIVE MEASUREMENT					
Body mass index: <25 kg/m^2	1453 (27.2%)	52 (21.4%)	90 (47.1%)	25 (19.8%)	<.0001
25 - <30 kg/m^2	2755 (51.5%)	112 (46.1%)	91 (47.6%)	68 (54.0%)	
≥30 kg/m^2	1144 (21.4%)	79 (32.5%)	10 (5.2%)	33 (26.2%)	
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Height (cm)	174.5 (6.6)	174.0 (7.2)	166.8 (5.9)	170.4 (6.3)	<.0001
Total fat mass (kg)	21.85 (7.07)	21.66 (7.617)	16.87 (4.88)	22.27 (6.68)	<.0001
Total lean mass (kg)	57.12 (7.03)	59.56 (9.08)	49.44 (5.68)	55.81 (7.48)	<.0001

Characteristic	White	African American	Asian	Hispanic	p-value
Leg power (watts)	209.4 (62.5)	212.1 (73.7)	187.5 (55.0)	211.6 (54.9)	<.0001
Average grip strength (kg)	38.6 (8.1)	39.1 (9.4)	35.9 (7.0)	39.1 (7.4)	<.0001
5 chair stands (seconds)	11.1 (3.3)	11.5 (3.5)	9.8 (2.5)	10.6 (3.0)	<.0001
6m walk speed (m/s)	1.21 (0.22)	1.08 (0.26)	1.17 (0.26)	1.23 (0.20)	<.0001
Narrow walk speed (m/s)	1.15 (0.27)	1.05 (0.25)	1.08 (0.30)	1.14 (0.26)	<.0001
VISUAL FUNCTION	**N (%)**	**N (%)**	**N (%)**	**N (%)**	
Depth perception: ≤85 (better)	4317 (80.7%)	196 (80.3%)	140 (73.3%)	101 (80.2%)	.25
>85 (poorer)	573 (10.7%)	23 (9.4%)	28 (14.7%)	12 (9.5%)	
Missing category	463 (8.7%)	15 (10.3%)	23 (12.0%)	13 (10.3%)	
Contrast sensitivity: ≤1.60 (poorer)	2385 (44.7%)	125 (52.1%)	91 (47.9%)	51 (41.1%)	.09
>1.60 (better)	2953 (55.3%)	115 (47.9%)	99 (52.1%)	73 (58.9%)	
Visual acuity: ≥61 (best)	1728 (32.4%)	87 (36.3%)	42 (22.1%)	41 (32.8%)	.07
≥56 - <61	1797 (33.7%)	80 (33.3%)	71 (37.4%)	39 (31.2%)	
<56 (poor)	1815 (34.0%)	73 (30.4%)	77 (40.5%)	45 (36.0%)	
MEDICAL HISTORY					
Uses walking aid	150 (2.8%)	27 (11.1%)	6 (3.1%)	3 (2.4%)	<.0001
Moderate/severe urinary symptom index* **	2473 (46.2%)	116 (47.5%)	73 (38.2%)	54 (42.9%)	.14
Prostatitis	1342 (25.1%)	55 (22.5%)	32 (16.8%)	43 (34.1%)	.00
Dizziness	1339 (25.0%)	73 (29.9%)	50 (26.2%)	27 (21.4%)	.26
Parkinsons Disease	48 (0.9%)	2 (0.8%)	1 (0.5%)	0	.70
Arthritis	2531 (47.3%)	137 (56.2%)	82 (42.9%)	51 (40.5%)	.01
Cancer	1622 (30.3%)	54 (22.1%)	31 (16.2%)	24 (19.1%)	<.0001
Osteoporosis	198 (3.7%)	6 (2.5%)	4 (2.1%)	3 (2.4%)	.41
Diabetes	532 (9.9%)	56 (23.0%)	31 (16.2%)	20 (15.9%)	<.0001
Stroke	308 (5.8%)	18 (7.4%)	9 (4.7%)	2 (1.6%)	.13
Heart attack	756 (14.1%)	31 (12.7%)	13 (6.8%)	18 (14.3%)	.04
Angina	767 (14.3%)	44 (18.0%)	14 (7.3%)	16 (12.7%)	.01
Congestive Heart Failure	270 (5.0%)	25 (10.3%)	7 (3.7%)	7 (5.6%)	.00
Hypertension	2244 (41.9%)	147 (60.3%)	95 (49.7%)	53 (42.1%)	<.0001
Low Thyroid	392 (7.3%)	7 (2.9%)	9 (4.7%)	6 (4.8%)	.02
High thyroid/Graves	82 (1.5%)	5 (2.1%)	4 (2.1%)	3 (2.4%)	.73
Chronic Obstructive Pulmonary Disease	577 (10.8%)	33 (13.5%)	9 (4.7%)	13 (10.3%)	.03

*Racial characterization is based on self-report. All men indicating Hispanic ethnicity are included in the Hispanic category only

**Central nervous system medication use is defined as use of any of the following types of medications: selective serotonin reuptake inhibitors (SSRI), Benzodiazepine, Nonbenzodiazepine anticonvulsant

***American Urological Association Symptom Index (Barry et al., 1992)

Table 2: Evaluation of 12-month cumulative incidence for 0, 1 and ≥ 2 falls by race and ethnic group among 5,914 U.S. men ages 65 years and older: Osteoporotic Fractures in Men Study (MrOS).

	NO FALL	1 FALL	≥ 2 FALLS
White	3948 (75%)	719 (14%)	628 (12%)
African American	174 (74%)	30 (13%)	32 (14%)
Asian	142 (76%)	25 (13%)	19 (10%)
Hispanic	94 (76%)	16 (13%)	14 (11%)

Table 3: Distribution of demographic characteristics and potential risk factors for falls according to fall status at 12 months of follow-up: Osteoporotic Fractures in Men Study (MrOS).

CHARACTERISTIC	N	ONE OR MORE FALLS	p value
Number of men	5841	1483 (25.4%)	
Race/Ethnicity			
White	5295	1347 (25.4%)	.92
African American	236	62 (26.3%)	
Asian	186	44 (23.7%)	
Hispanic	124	30 (24.2%)	
Age (years)			
65 – 69	1721	360 (20.9%)	<.0001
70 – 74	1670	408 (24.4%)	
75 – 79	1418	370 (26.1%)	
≥80	1032	345 (33.4%)	
Study Site			
Birmingham	941	259 (27.5%)	.03
Minneapolis	991	257 (25.9%)	
Palo Alto	959	258 (26.9%)	
Pittsburgh	1000	245 (24.5%)	
Portland	986	257 (17.3%)	
San Diego	964	207 (21.5%)	
Self-rated overall health			
Excellent	1976	425 (21.5%)	<.0001
Good	3037	781 (25.7%)	
Fair – Very Poor	826	276 (33.4%)	
Married	4818	1202 (25.0%)	.09
Education level			
Some elementary – High School	1393	345 (24.8%)	.00
Some College	1343	295 (22.0%)	
College - some Graduate school	1681	447 (26.6%)	
Graduate school	1424	396 (27.8%)	
Average alcohol intake			
None	2062	561 (27.2%)	.04
< 1 drinks per day	2253	562 (24.9%)	
1+ drinks per day	1518	358 (23.6%)	
Cigarette smoking status			
Never	2189	555 (25.4%)	.50
Past	3450	884 (25.6%)	
Current	201	44 (21.9%)	
Fall in last 12 months	1231	567 (46.1%)	<.0001
Walk daily	2913	670 (23.0%)	<.0001
Physical Activity Scale for the Elderly			
<89.6 (1st quintile)	1148	334 (29.1%	.03
≥89.6 - <126.0	1176	282 (24.0%)	
≥126.0 - <158.5	1162	288 (24.8%)	
≥158.5 - <197.4	1184	299 (25.3%)	
≥197.4 - <487.0	1168	280 (24.0%)	
Central nervous system medication use	416	164 (39.4%)	<.0001
BODY COMPOSITION			
Body Mass Index (kg/m²)			
<24.3 (1st quintile)	1160	298 (25.7%)	.07
≥24.3 - <26.1	1168	303 (25.9%)	
≥26.1 - <27.9	1170	289 (24.7%)	
≥27.9 - <30.2	1173	267 (22.8%)	
≥30.2 - <57.0	1168	326 (27.9%)	
Height (cm)			
<168.5 (1st quintile)	1152	307 (26.7%)	.42
≥168.5 - <172.4	1172	274 (23.4%)	
≥172.4 - <175.7	1156	297 (25.7%)	
≥175.7 - <179.7	1179	308 (26.1%)	
≥179.7 - <199.0	1180	297 (25.2%)	
Whole body total fat (kg)			
<15.8 (1st quintile)	1148	289 (25.2%)	.03
≥15.8 - <19.2	1167	273 (23.4%)	
≥19.2 - <22.6	1165	286 (24.6%)	
≥22.6 - <27.1	1161	284 (24.5%)	
≥27.1	1164	335 (28.8%)	

Whole body total lean mass (kg)			
<50.7 (1st quintile)	1150	315 (27.4%)	.14
≥50.7 - <54.7	1162	280 (24.1%)	
≥54.7 - <58.3	1167	270 (23.1%)	
≥58.3 - <62.8	1163	297 (25.5%)	
≥62.8	1163	305 (26.2%)	
VISUAL FUNCTION			
Depth perception			
≤85	4702	1162 (24.7%)	.04
>85 (poorer)	628	182 (29.0%)	
Missing category	511	139 (27.2%)	
Contrast sensitivity			
≤1.60	2611	727 (27.8%)	<.0001
≥1.65 (poorer)	3210	746 (23.2%)	
Visual acuity			
-9 to 55	1979	408 (21.7%)	<.0001
56 to 60	1964	520 (26.5%)	
61 to 70 (better)	1881	408 (21.7%)	
PERFORMANCE TESTS			
Average grip strength (kg)			
≥44.0 (4th quartile)	1481	287 (19.4%)	<.0001
≥38.50 - <44.0	1432	307 (21.4%)	
≥33.0 - <38.50	1438	374 (26.0%)	
<33.0	1380	476 (34.5%)	
Unable	101	33 (32.7%)	
5 chair stands (seconds)			
< 8.97 (1st quartile)	1420	310 (21.8%)	<.0001
≥8.97 - <10.56	1421	298 (21.0%)	
≥10.56 - <12.60	1416	355 (25.1%)	
≥12.60 - <57.00	1407	441 (31.3%)	
Unable	157	73 (46.5%)	
Power max both legs (watts)			
≥247.8 - <491.5 (4th quartile)	1305	265 (20.3%)	<.0001
≥206.4 - <247.8	1268	264 (20.8%)	
≥164.7 - <206.4	1290	322 (25.0%)	
≥0 - <164.7	1278	39 (30.7%)	
Unable	214	84 (39.3%)	
Missing	486	156 (32.1%)	
Average 6-meter walk speed (m/s)			
≥1.38728 - <2.2 (5th quintile)	1182	242 (20.5%)	<.0001
≥1.26050 - <1.38728	1166	257 (22.0%)	
≥1.15053 - <1.26050	1166	255 (21.9%)	
≥1.02041 - <1.15053	1163	300 (25.8%)	
≥0 - <1.02041	1154	423 (36.7%)	
Narrow walk speed (m/s)			
≤1.32 (4th quartile)	1415	286 (20.2%)	<.0001
≥1.16 - <1.32	1277	264 (20.7%)	
≥0.97 - <1.16	1336	312 (23.4%)	
<0.97	1280	401 (31.3%)	
Unable	497	203 (40.9%)	
MEDICAL HISTORY			
Uses walking aid	181	89 (49.2%)	<.0001
Moderate/severe urinary symptom index*	2676	788 (29.5%)	<.0001
Dizziness	1464	491 (33.5%)	<.0001
Stroke	328	121 (36.9%)	<.0001
Parkinsons Disease	50	27 (54.0%)	<.0001
Angina	827	253 (30.6%)	.00
Cancer	1708	488 (28.6%)	.00
Osteoporosis	208	71 (34.1%)	.00
Arthritis	2766	828 (29.%)	<.0001
Diabetes	629	180 (28.6%)	.05
Prostatitis	1451	409 (28.2%)	.00
High thyroid/Graves	92	32 (34.8%)	.04
Congestive Heart Failure	302	97 (32.1%)	.01
Chronic Obstructive Pulmonary Disease	620	184 (29.7%)	.01
Hypertension	2506	656 (26.2%)	.23
Low Thyroid	405	112 (27.7%)	.28
Heart attack	802	228 (28.4%)	.03

***American Urological Association Symptom Index (Barry et al., 1992)

Table 4: Assessment of potential bias from loss to follow-up among race and Hispanic ethnicity. Results from the final multivariate logistic regression model*.

	% missing follow-up	RR (95% CI) excluding missing	RR (95% CI) missing = fall	RR (95% CI) missing = no fall
White	1.1	1.0	1.0	1.0
African American	3.3	1.01 (.73, 1.40)	1.12 (0.82, 1.53)	0.98 (.71, 1.35)
Asian	2.6	0.92 (.64, 1.34)	0.96 (0.67, 1.38)	0.92 (.63, 1.33)
Hispanic	1.6	1.03 (.65, 1.62)	1.05 (0.67, 1.63)	1.03 (.66, 1.62)

*The multivariate logistic regression model is adjusted for age, study site, education level, CNS medication use, grip strength, narrow walk speed, walking aid use, history of falls, dizziness, arthritis, Parkinsons disease and greater urinary symptom index.

Table 5: Comparison of falls recalled during the 12-month follow-up period with two different recall assessments: the Osteoporotic Fractures in Men (MrOS) Study.

	Interval of recall for report of falls during the 12-month follow-up period					
	Previous 4 months 3 times/year N = 5841			Previous 12 months 1 time N = 5617		
	N	Fall Cumulative Incidence (%)	RR* (95% CI)	N	Fall Cumulative Incidence (%)	RR* (95% CI)
White	5295	25.4	1.0	5103	28.5	1.0
African American	236	26.3	1.01 (0.73, 1.40)	216	24.1	0.73 (0.52, 1.03)
Asian	186	23.7	0.92 (0.64, 1.34)	180	20.0	0.55 (0.37, 0.81)
Hispanic	124	24.2	1.03 (0.65, 1.62)	118	32.2	1.23 (0.82, 1.86)

*RR estimates for each fall assessment are adjusted for age, study site, education level, CNS medication use, grip strength, narrow walk speed, walking aid use, history of falls, dizziness, arthritis, Parkinsons disease and greater urinary symptom index.

Figure 1: Flow chart describing the systematic approach employed to manually build the multivariate logistic regression model used to estimate fall risk for each race and Hispanic ethnicity.

Univariate analysis

Divide variables into 5 subgroups

⇓ ⇓ ⇓ ⇓ ⇓

Demographic **Medical** **Visual** **Body Composition** **Performance tests**

⇓

Rank according to association with falls

⇓

Sequentially enter each variable into logistic regression model

Retain if $p<.10$

⇓

"Best" logistic regression model within each subgroup

⇓

Sequentially add predictors from final subgroup models

⇓

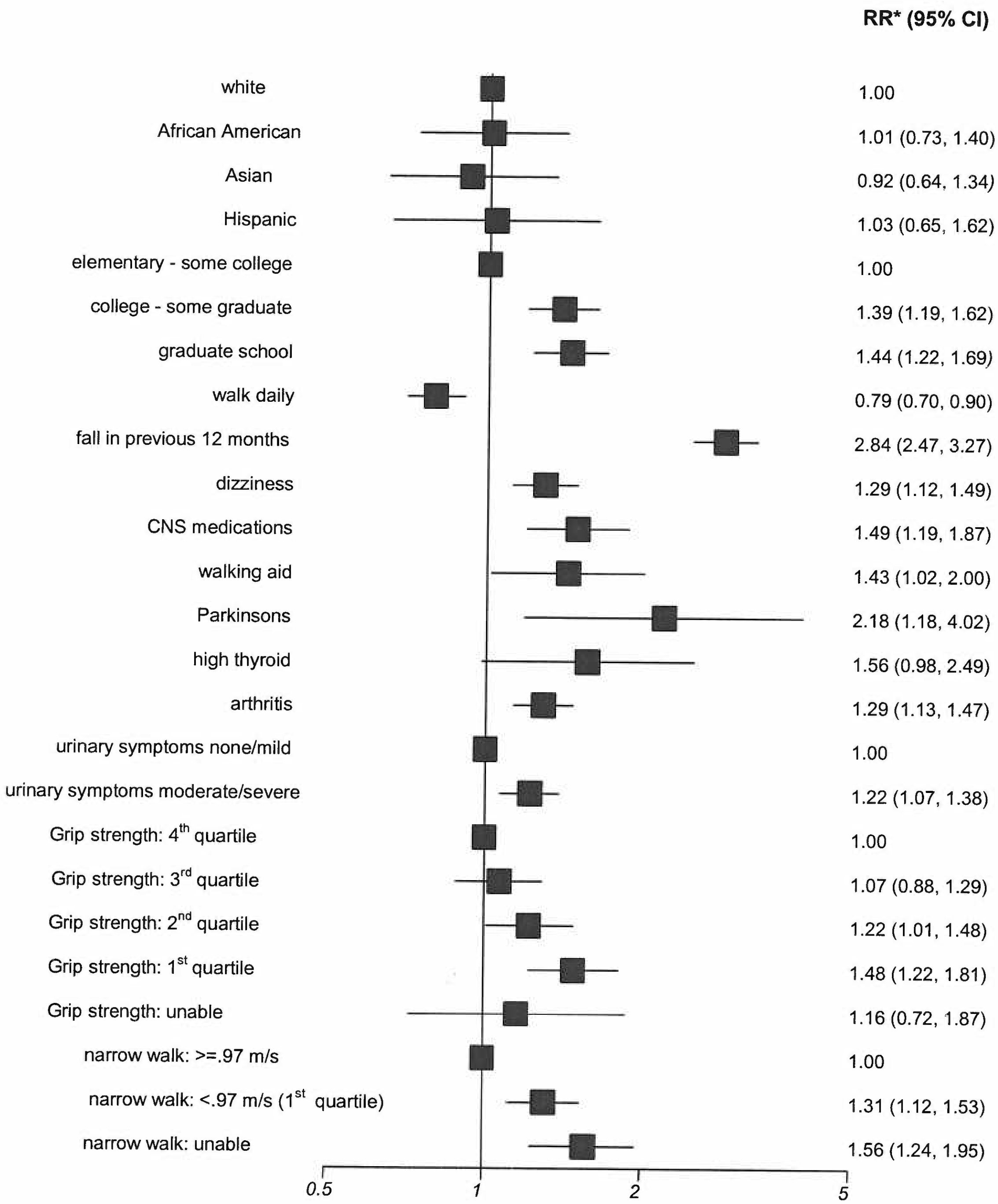
Assess RR, 95%CI, p values

Retain if race/ethnicity RR change 10% or more

⇓

FINAL MULTIVARIATE LOGISTIC REGRESSION MODEL

Figure 2: Relative risk of falling during 12 months of follow-up: results of a multivariate logistic regression analysis.



*RR estimates are adjusted for age and study site.

APPENDIX A

Classification of Variables

Characteristic	Assessment Method	Classification groups
DEMOGRAPHIC AND LIFESTYLE		
Race/Ethnicity	Self-report	White non-Hispanic (reference) African-American non-Hispanic Asian non-Hispanic Hispanic
Age (years)	Self-report date of birth	65 - 69 (reference) 70 - 74 75 - 79 ≥ 80
Study site	Determined by clinic enrolled	Birmingham (reference) Minneapolis Palo Alto Pittsburgh Portland San Diego
Highest level of education completed	Self-report	Some elementary – High School (reference) Some college College graduate – some Graduate School Graduate school graduate
Marital status	Self-report	Separated/not married (reference) Married
Fall during previous 12 months	Self-report	No falls (reference) 1 or more falls in previous year
Health status	Self-report	Excellent (reference) Good Fair/poor/very poor
Physical Activity Score for the Elderly (PASE)	Self-report	Quintiles: <89.5714 (reference) ≥89.6 - <126.0 ≥126.0 - <158.5 ≥158.5 - <197.4 ≥197.4 - <487.0
Daily walking status	Self-report	Not walk daily (reference) Walk daily

Central nervous system medication use	Clinic Interview	No (reference) Use of one or more of the following types of medication: selective serotonin reuptake inhibitors, benzodiazepine, non-benzodiazepine anticonvulsant
Average alcohol intake	Self-report	None (reference) Less than 1/day 1+/day
Cigarette smoking status	Self-report	Never (reference) Past Current
BODY COMPOSITION		
Whole body total fat mass (kg)	Obtained from dual x-ray absorptiometry scan (DXA)	Quintiles: <15.88 (reference) ≥15.88- <19.18 ≥19.18 - <22.63 ≥22.63 - <27.12 ≥27.12 - <61.61
Whole body total lean mass (kg)	Obtained from dual x-ray absorptiometry scan (DXA)	Quintiles: <50.75 (reference) ≥50.75 - <54.66 ≥54.66 - <58.28 ≥58.28 - <62.77 ≥62.77 - <86.52
Height (cm)	Measured by use of a stadiometer	Quintiles: <168.50 (reference) ≥168.50 - <172.35 ≥172.35 - <175.70 ≥175.70 - <179.70 ≥179.70 - <199.0
Body mass index (kg/m^2)	Calculated value from weight and height measures	Quintiles: <24.29 (reference) ≥24.29 - <26.09 ≥26.09 - <27.89 ≥27.89 - <30.19 ≥30.19 - <57.00
Weight (kg)	Measured on a standard scale	Quintiles: <72.0 (reference), ≥72.0 - <78.5 ≥78.5 - <85.1 ≥85.1 - <93.5 ≥93.5 - <160.0
VISUAL FUNCTION		
Acuity	Calculated score from Bailey-Lovie test (distance-adjusted # of letters read correctly)	61-70 (reference = greater acuity) 56 - <61 <56

Depth perception	Calculated score from Frisby Stereo test (# trials correctly completed)	≤85 (reference = greater depth perception) >85 missing (reasons unknown)
Contrast sensitivity	Log of calculated score from Pelli-Robson test (# letters read correctly)	≥1.65 (reference = greater contrast sensitivity) ≤1.60
PERFORMANCE MEASURES		
Chair stands (seconds)	Seconds to complete 5 stands without use of arms	Quartiles: <8.97 (reference = fastest) ≥8.97 - <10.56 ≥10.56 - <12.60 ≥12.60 - <57.00 Unable to complete 5 chair stands
Average grip strength both hands (kg)	Measured by use of a dynamometer	Quartiles: ≥44.0 (reference = strongest) ≥38.50 - <44.0 ≥33.0 - <38.50 ≥0 - <33.0 Unable to complete grip strength
Maximum power for both legs (watts)	Measured by use of a Nottingham power rig	Quartiles: ≥247.8 (reference = strongest) 206.4 - <247.8 164.7 - <206.4 0 - <164.7 Unable to complete power test Missing (reasons unknown)
Narrow walk speed (m/s) using best time	Calculated value from the time to complete the Narrow walk test	Quartiles: ≤1.32 (reference = fastest) ≥1.16 - <1.32 ≥0.97 - <1.16 ≥0 - <0.97 unable to complete narrow walk test
Average 6-meter walk speed (m/s)	Calculated value from the time to complete 6-meter walk	Quintiles: ≤1.39 (reference = fastest) ≥1.26 - <1.39 ≥1.15 - <1.26 ≥1.02 - <1.15 ≥0 - <1.02
PREVALENT MEDICAL CONDITIONS		
Walking aid use	Self-report	Does not use walking aid (reference) Uses walking aid
History of dizziness	Self-report	None (reference) History of dizziness
History of stroke	Self-report	None (reference) History of stroke

History of Parkinsons disease	Self-report	None (reference) Parkinsons disease
History of diabetes	Self-report	None (reference) History of diabetes
History of arthritis	Self-report	None (reference) History of arthritis
History of osteoporosis	Self-report	None (reference) History of osteoporosis
Urinary symptom index score	Self-report	None/mild (reference) Moderate/severe
History of cancer	Self-report	None (reference) History of cancer
History of angina	Self-report	None (reference) History of angina
History of myocardial infarction	Self-report	None (reference) History of myocardial infarction
Congestive heart failure (CHF)	Self-report	None (reference) History of CHF
Chronic obstructive pulmonary disease (COPD)	Self-report	None (reference) History of COPD
High thyroid/Graves disease	Self-report	None (reference) History of high thyroid/Graves disease
History of low thyroid	Self-report	None (reference) History of low thyroid